

Epidemiology, Types of Acquired Brain Injury, & Determinants of Recovery

Resource Facilitation Regional Conference
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Epidemiology

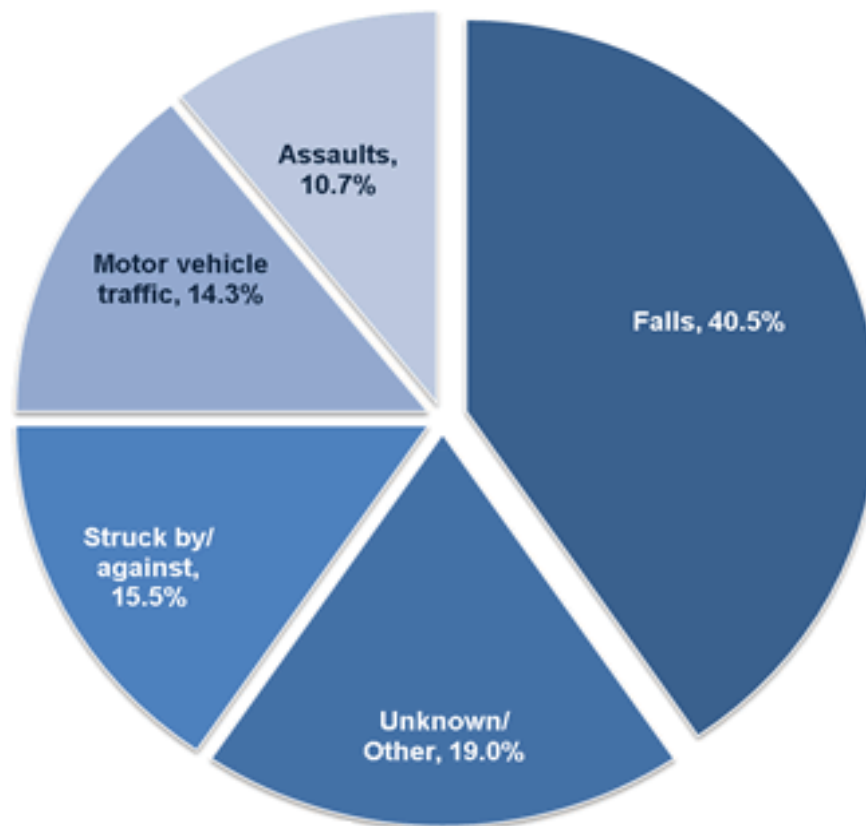
- In 2010, about 2.5 million emergency department (ED) visits, hospitalizations, or deaths were associated with TBI in the United States.
- Over the past decade (2001–2010), while rates of TBI-related ED visits increased by 70%, hospitalization rates only increased by 11% and death rates decreased by 7%.



So what does that mean?

Epidemiology

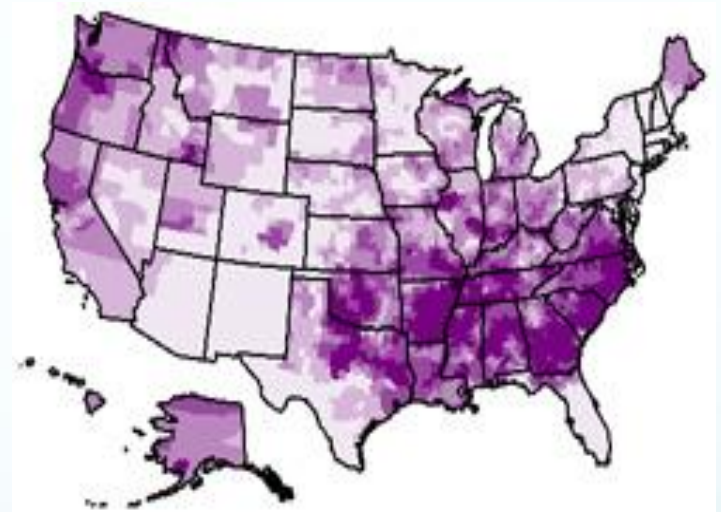
Leading Causes of TBI



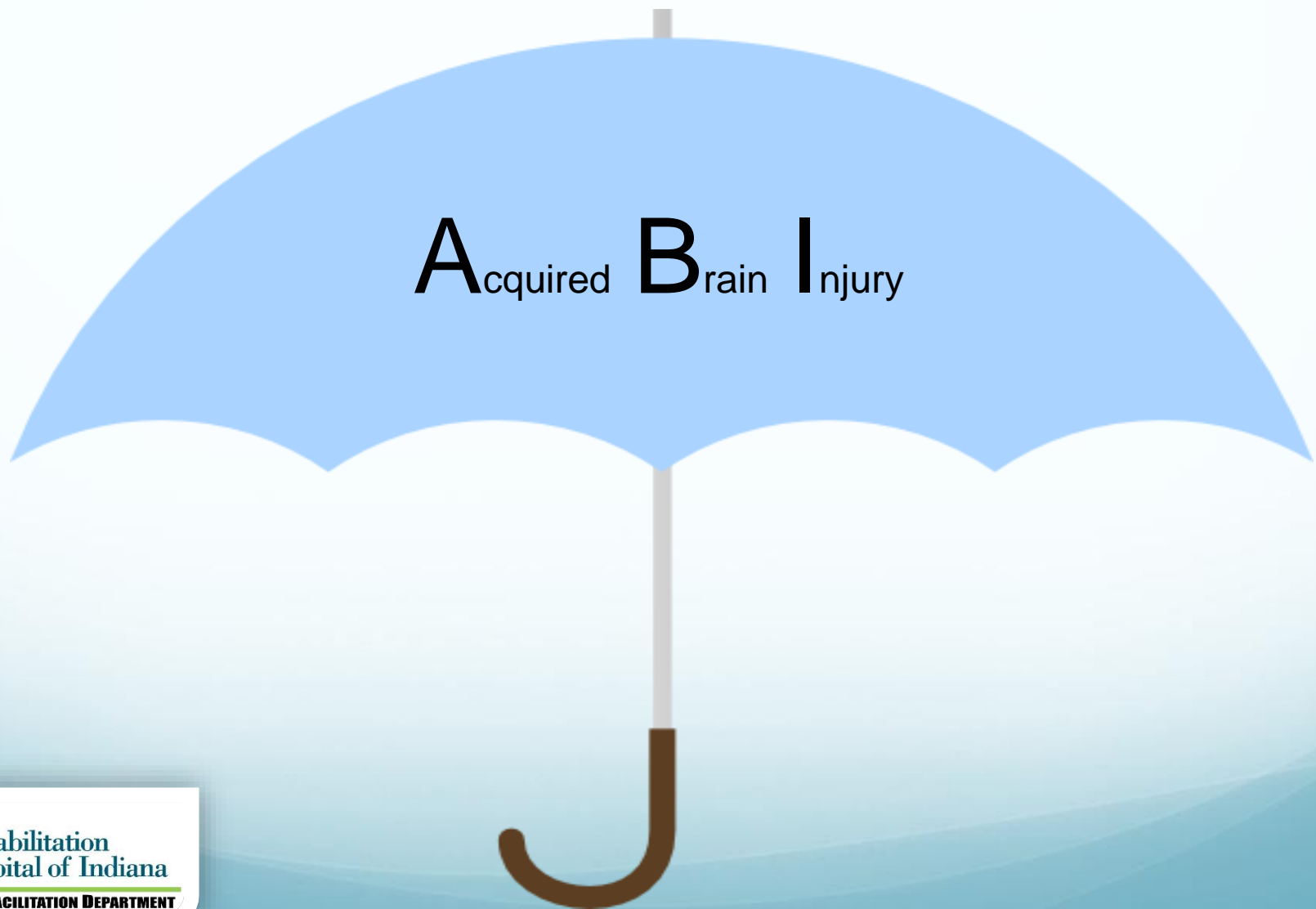
U.S. 2006-2010

Epidemiology

- Stroke is the leading cause of serious, long-term disability in the United States.
- Strokes can and do occur at ANY age. Nearly one fourth of strokes occur in people under the age of 65.



The “Umbrella” of Acquired Brain Injury



Acquired Brain Injury

ABI

- There are two categories of ABI, *traumatic* and *non-traumatic*.
- Traumatic
 - Contusion
 - Diffuse Axonal Injury (DAI)
- Non-traumatic
 - Stroke
 - Anoxic / Hypoxic
 - Brain Tumor
 - Brain Surgery
 - Infection
 - Toxic / Metabolic Injury
 - Electrocutation / Struck by lightning

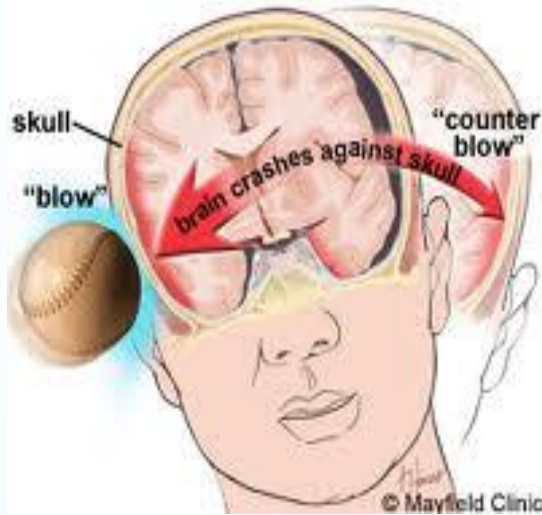


Traumatic Brain Injury (TBI)

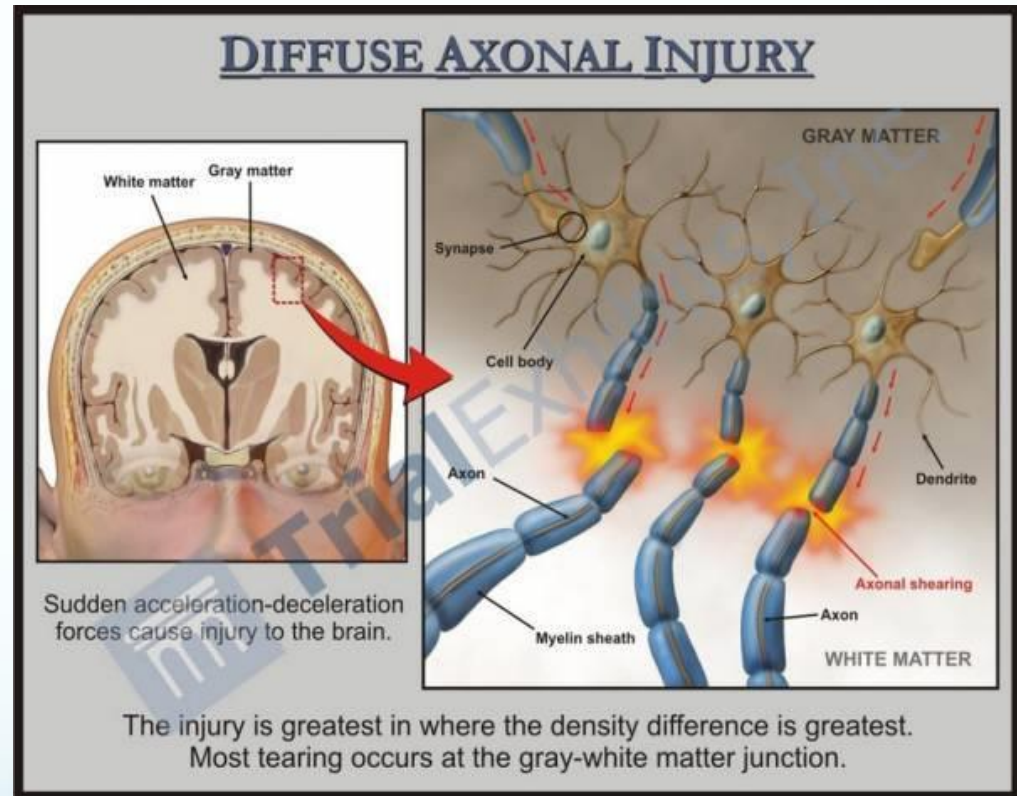
- “TBI occurs when an external mechanical force causes brain dysfunction.” (Mayo Clinic)
- **“Traumatic brain injury (TBI)** is a nondegenerative, noncongenital insult to the brain from an external mechanical force, possibly leading to permanent or temporary impairment of cognitive, physical, and psychosocial functions, with an associated diminished or altered state of consciousness.”

Mechanisms of Traumatic Injuries

Coup – Contrecoup injury



Diffuse Axonal Injury



Severity of TBI

	Mild	Moderate	Severe
Imaging	Normal	Normal / Abnormal	Normal / Abnormal
LOC	0-30 minutes	> 30 minutes < 24 hours	> 24 hours
AOC	A moment up to 24 hours	> 24 hours	Severity based on other criteria
PTA	0-1 day	> 1 and < 7 days	> 7 days
GCS	13-15	9-12	3-8

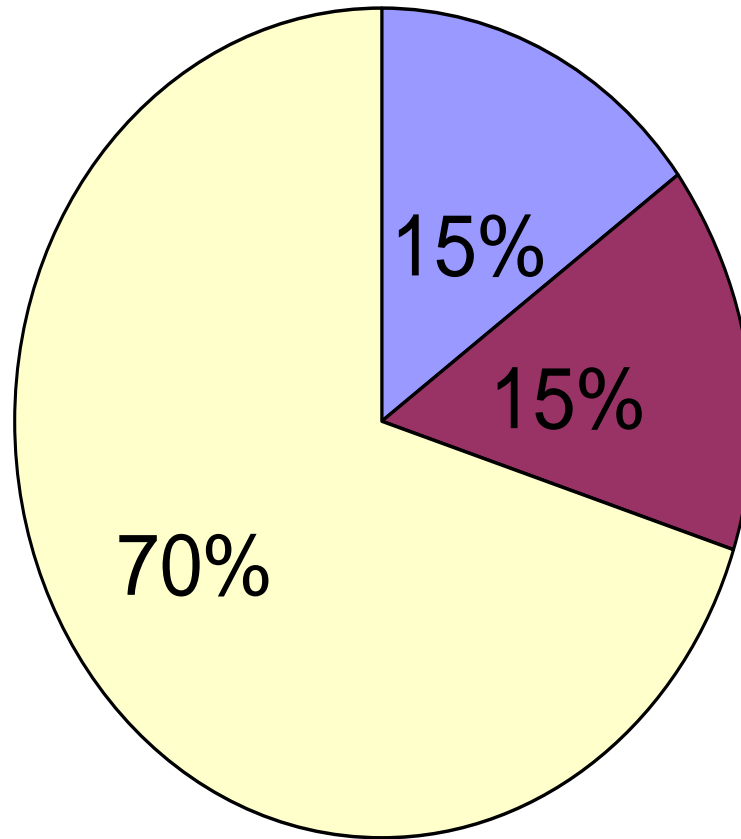
Classification based on 2009 VA/DoD Clinical Practice Guidelines for Management of Concussion/Mild Traumatic Brain Injury

*LOC = loss of consciousness

*AOC = alteration of consciousness / mental state

*PTA = post-traumatic amnesia

*GCS = Glasgow Coma Scale



- Moderate to Severe TBI
- Mild with Persisting Sx
- Mild w/o Persisting Symptoms

Moderate to Severe TBI

- Basic cognitive skills may be disrupted:
 - Sustaining attention
 - Concentrating on tasks at hand
 - Remembering newly learned material
 - Processing of information
 - Solving problems / making decisions
- Neurobehavioral changes are common:
 - Decreased inhibition and impulsivity
 - Difficulty with initiation
 - Diminished awareness of weaknesses / limitations
 - Social inappropriateness
- Possible emotional & social consequences:
 - Increased irritability / aggression
 - Depression & anxiety
 - Mood lability
 - Social withdrawal

*** Can also experience physical & other medical complications related to the TBI

TBI Consequence		Functional Impact on Behavior
Attention deficit	→	Difficulty focusing on or responding to required tasks or directions on the job or in the classroom
Memory deficit	→	Difficulty understanding or remembering new information or directions
Irritability or Anger	→	Incidents with co-workers / supervisors
Uninhibited or Impulsive Behavior	→	Poor Inhibition of emotions or desires (e.g., making inappropriate jokes, drug use, rage)
Executive Function deficit	→	Difficulty organizing behavior to execute stated intentions or goals (e.g., don't actually do what they wanted or said they would do)

Mild TBI (mTBI)

- mTBI and concussion are often thought of as interchangeable terms
- Diagnostic Criteria for MTBI by the American Congress of Rehabilitation Medicine

A traumatically induced physiological disruption of brain function, as manifested by at least one of the following:

- Any loss of consciousness
- Any loss of memory before or after injury
- Any alteration of mental state
- Focal neurological deficit that may or may not be transient
- Severity of Injury does not exceed the following:
 - LOC \leq 30 minutes
 - After 30 minutes, an initial GCS score of 13-15
 - PTA \leq 24 hours

Common Consequences of mTBI

Physical

- Headache
- Nausea
- Vomiting
- Blurred or Double Vision
- Seeing Stars or lights
- Dizziness
- Sensitivity to light or noise
- Tinnitus

Behavioral - Emotional

- Drowsiness
- Fatigue/Lethargy
- Irritability
- Anxiety
- Depression
- Sleeping more than Usual
- Difficulty Falling Asleep

Cognitive

- Feeling “Slowed Down”
- Feeling “in a Fog” or “dazed”
- Difficulty Concentrating
- Difficulty Remembering

PCS Diagnosis (ICD-10)

- History of head trauma with LOC preceding symptom onset by a maximum of 4 weeks



- Symptoms in 3 or more of the following categories:
 - Headache, dizziness, malaise, fatigue, noise intolerance
 - Irritability, depression, anxiety, emotional lability
 - Subjective concentration, memory or intellectual difficulties w/o neuropsychological evidence of marked impairment
 - Insomnia
 - Reduced alcohol tolerance
 - Preoccupation with Sx's, fear of brain damage with hypochondriacal concern and adoption of sick role

mTBI and Post-concussive syndrome (PCS)

- Diagnosed concussion
- PCS is a “hot topic” and heavily debated
- Diagnostic criteria can vary
 - Symptoms appearing within one week
 - Symptoms of at least 3 months duration
- Symptoms typically resolve within 3-6 months
 - Roughly 10-20% have continued symptoms
- Persistent Post-Concussive Syndrome (PPCS)
 - Symptoms lasting longer than 3 or 6 months
- “Permanent” PCS???



Persistent PCS (PPCS)

- “Miserable Minority”
- Prevalence estimates vary:
 - $\leq 5\%$ by 6-12 months (*Iverson, 2005*)
 - 7-15% have any symptoms one year postinjury (*Hall et al., 2005*)
 - 10-20% of MTBI pts who have persistent symptoms at 6-12 months and beyond (*Millis and Putnam, 1996*)
- Incidence of PPCS: ~ 27/100,000
 - Equal to annual incidence of Parkinson’s Disease, Multiple Sclerosis, Guillain-Barre, motor neuron disease, myasthenia gravis combined (*Satz, et al., 1999*)

Secondary Post-traumatic Injury

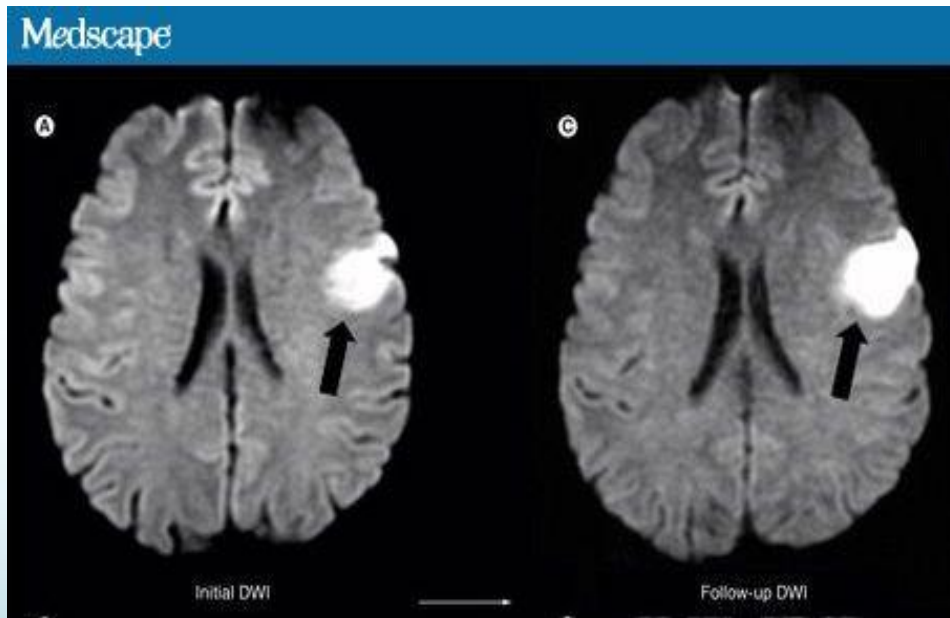
- Initial injury sets in motion molecular and hormonal changes in the brain
- These chemical reactions can be destructive to the brain
- These changes can continue to occur for weeks to years post-traumatic injury

Non-traumatic Brain Injuries

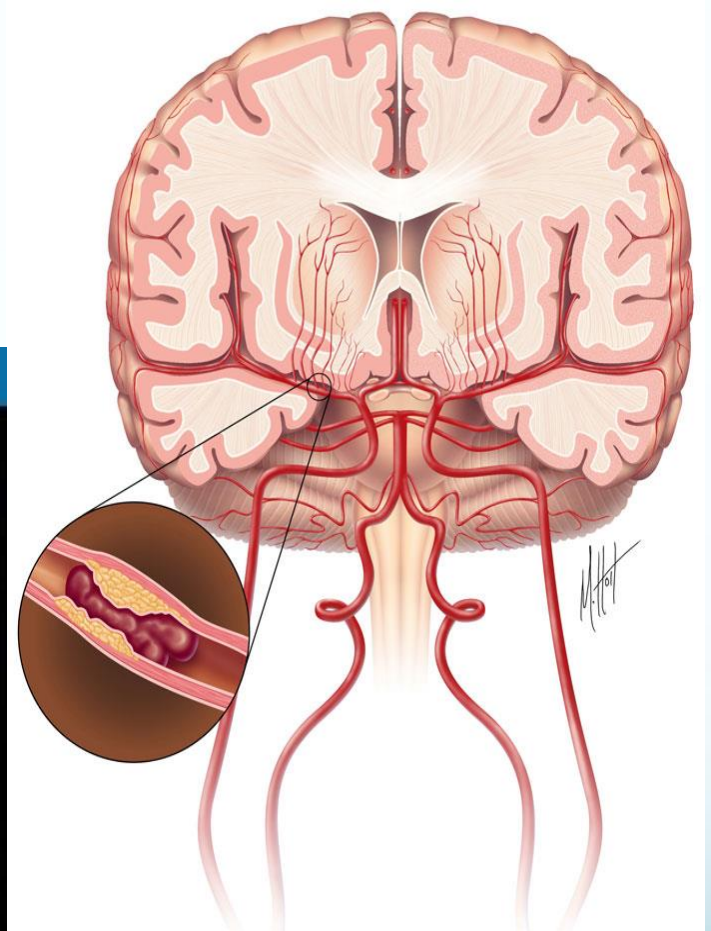
- Stroke
- Anoxic / Hypoxic
- Brain Tumor
- Brain Surgery
- Infection
- Toxic / Metabolic Injury
- Electrocution / Struck by lightning
- Hydrocephalus

Stroke

- Ischemic Stroke
 - Most common type of stroke



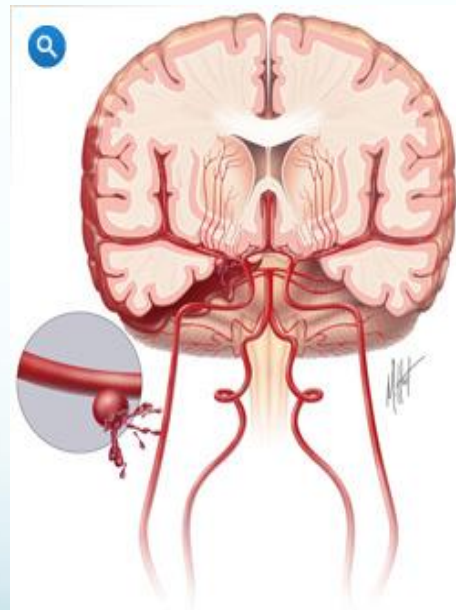
DWI = Diffusion-weighted imaging



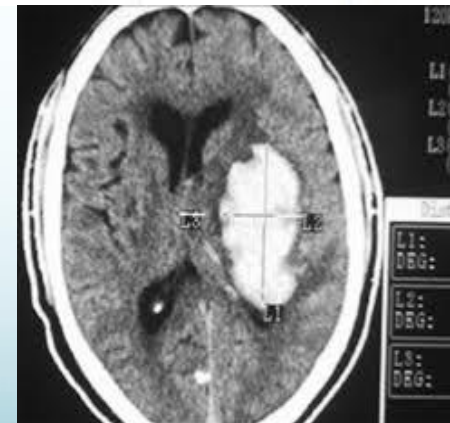
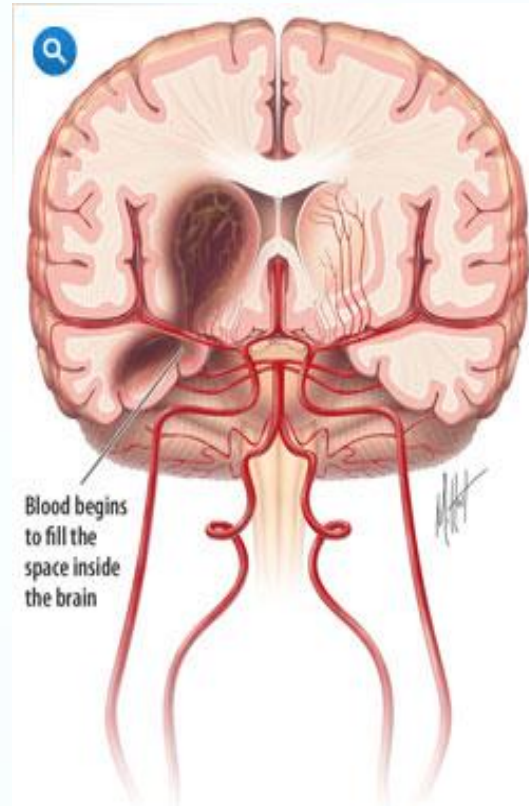
The Internet Stroke Center

Stroke

- Intracerebral Hemorrhage →
- Subarachnoid Hemorrhage



The Internet Stroke Center



Anoxic / Hypoxic

- Anoxic brain injury is a result of a lack of oxygen
- Hypoxia is the term used to describe *low* oxygen
- Brain cells without oxygen will begin to die in about 4 minutes



Anoxic / Hypoxic

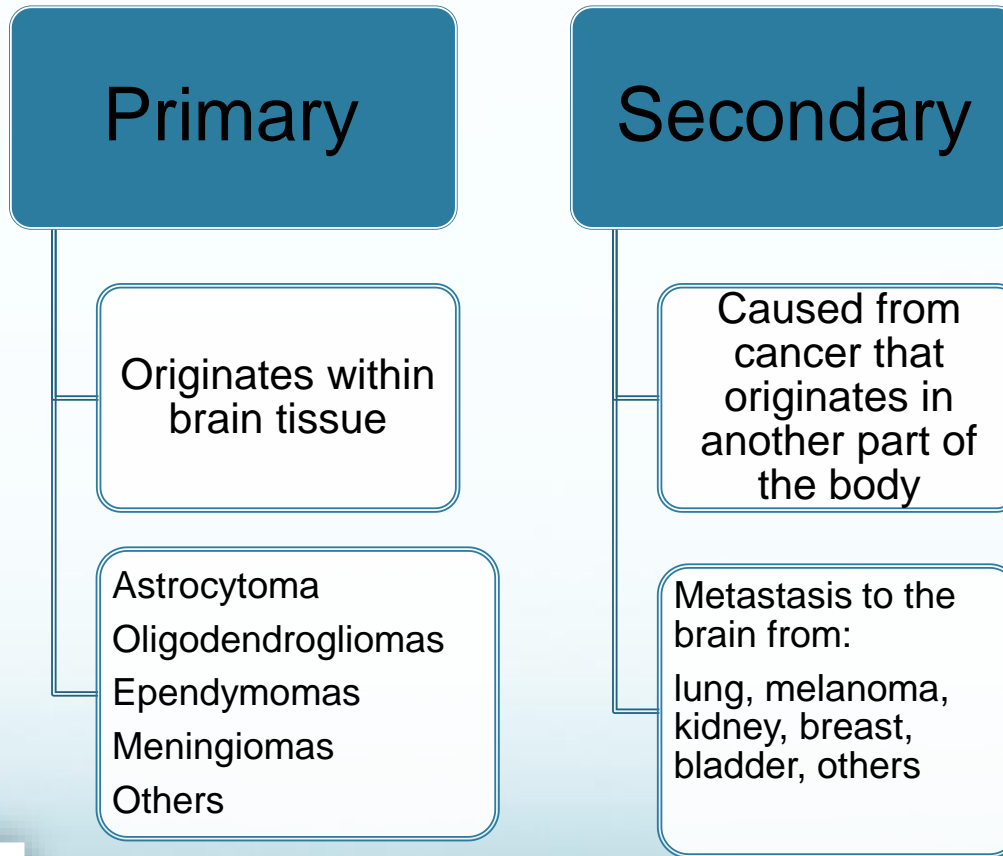
Causes

- Oxygen is carried to the brain in the blood. Anoxic brain damage may occur if:
 - Blood flow to the brain is blocked or slowed. This can happen with:
 - Blood clot or stroke
 - Shock and heart problems, like heart attack
- The blood flow is normal but the blood is not carrying enough oxygen. This may happen if:
 - The individual has lung disease
 - There is a lack of oxygen in the air, which may occur at high altitudes
 - The individual experiences prolonged exposure to certain poisons or other toxins, such as carbon monoxide
 - The individual experiences an event that stops them from breathing normally, such as drowning, choking, or suffocation

Icahn School of Medicine at Mount Sinai 2015

Brain Tumor

Classified into 2 categories



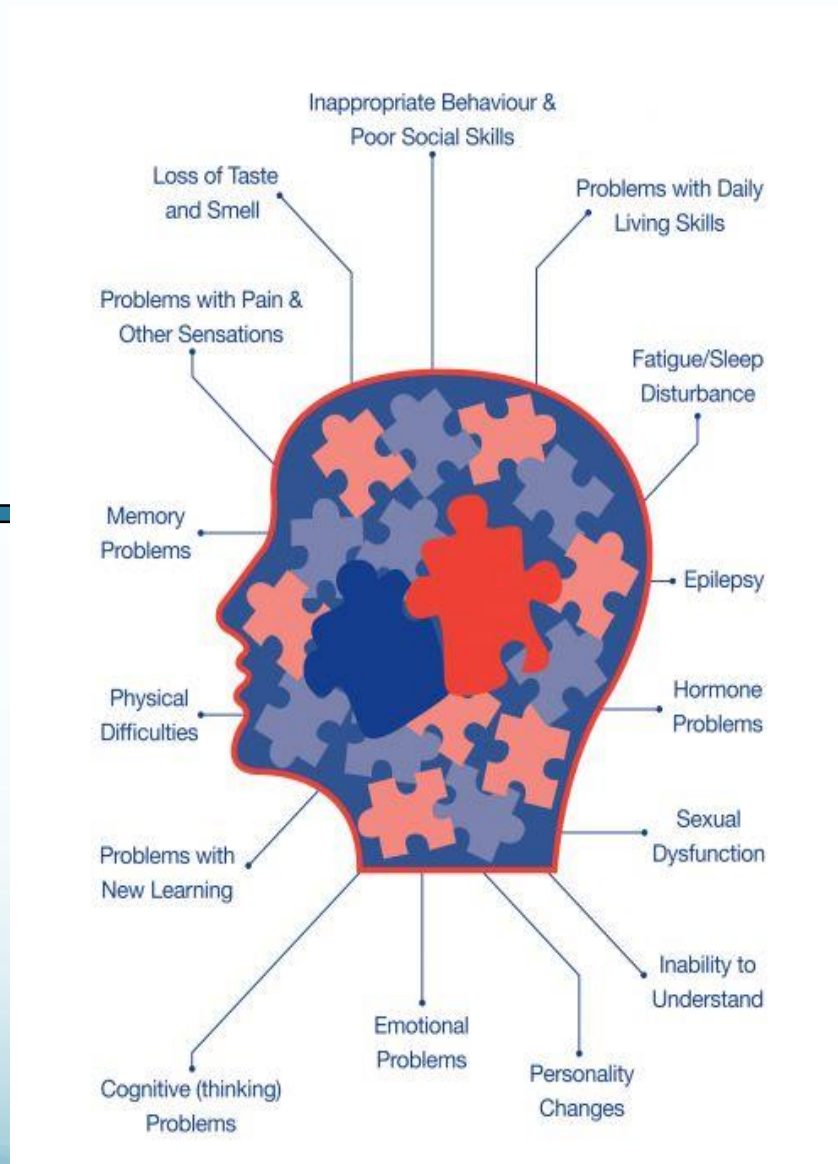
Brain Surgery

- Brain surgery usually involves a procedure called a craniotomy
 - *A craniotomy* is an operation to open the skull
- The main types of brain conditions that may require brain surgery include:
 - **Alterations of the brain tissue** – such as brain cancer, infections and swelling
 - **Alterations in brain blood flow** – such as subdural hematoma, subarachnoid hemorrhage and intraventricular bleed
 - **Alterations in cerebrospinal fluid** – such as infection or hydrocephalus (e.g., shunt placement)
- Brain surgery is also sometimes used to treat epilepsy

Infection

- CNS can become vulnerable to infection most commonly by bacteria and viruses, but also parasites, fungi, and other organisms (more rarely)
- Infection → Inflammation
- Depending on the location of the infection, different names are given to the diseases
 - Meningitis
 - Encephalitis
 - Abscess

Encephalitis



The Encephalitis Society

Toxic / Metabolic Injury

- ~ 1,000 substances identified as possibly neurotoxic
- Categories of substances:

Metals – e.g., lead, mercury, manganese

Pesticides – many types

Solvents & Fuels – e.g., glues, paints, thinners

Carbon Monoxide

Electrocution / Struck by Lightning

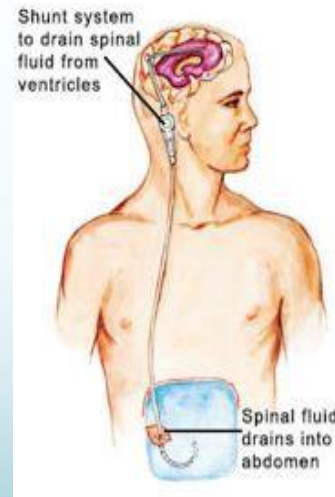
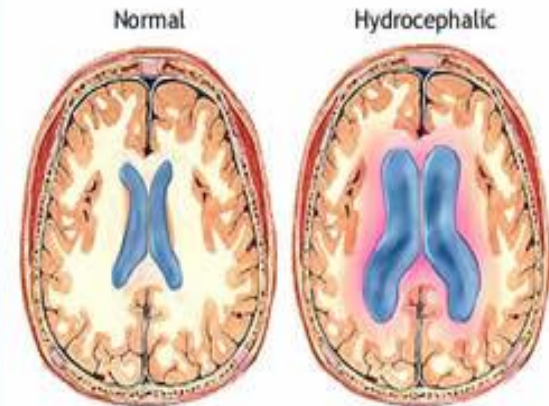
- High voltage electric shock or lightning strike can cause damage to the CNS, including the brain
- Immediate effects are usually obvious
 - E.g., burns, cardiac arrhythmias, paresthesias, seizures, sensory and motor deficits
- Sometimes there is a delayed onset of symptoms
 - Due to progressive cellular damage and death
 - Can occur days to years post-injury
- Long-term effects might be more subtle, pervasive, and less well-defined



Wesner & Hickie, 2013

Hydrocephalus

- A result of excessive accumulation of fluid in the brain
 - A.K.A. – “water on the brain”
- “Water” = Cerebrospinal fluid (CSF)
- Most commonly treated by inserting a shunt system



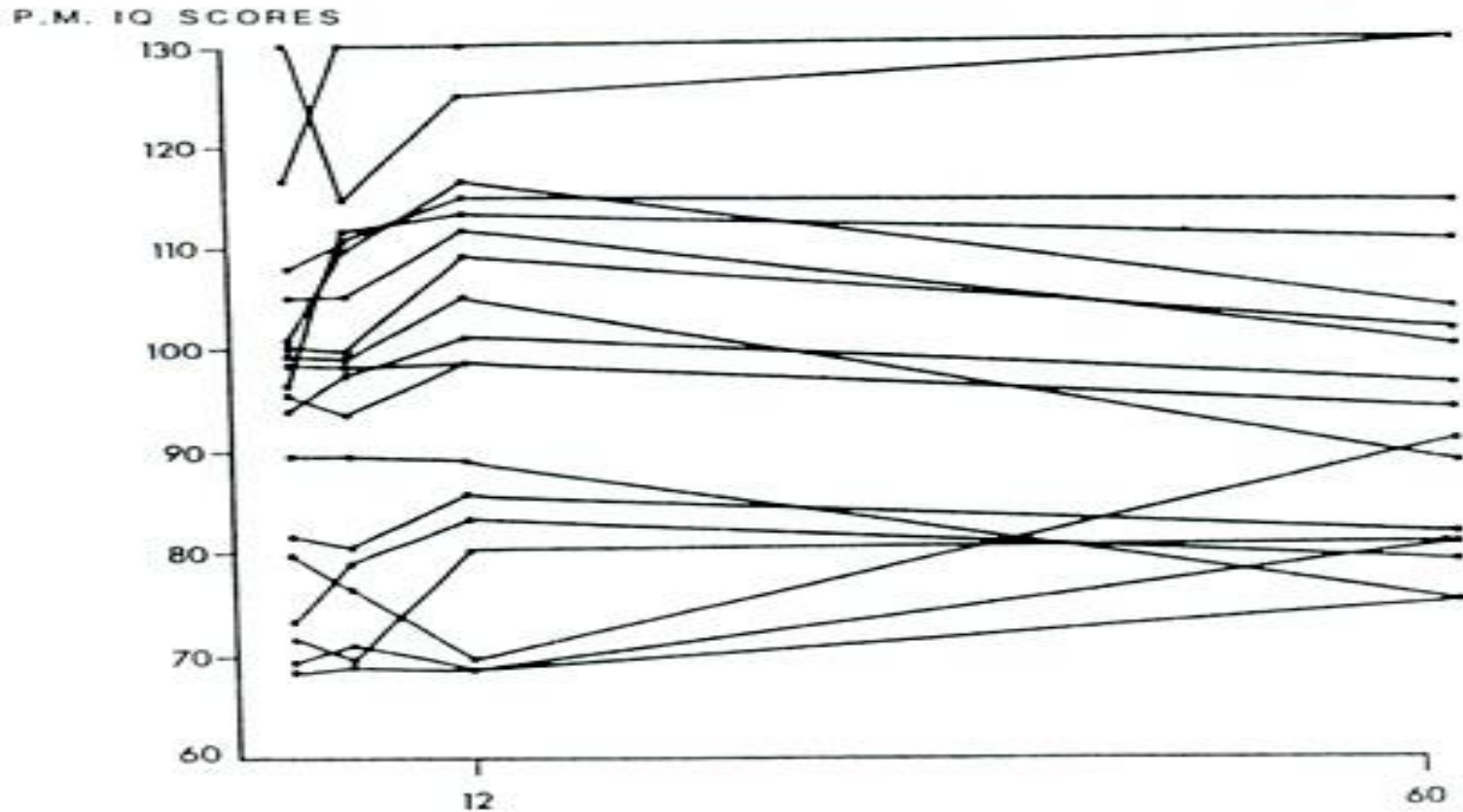
Recovery Post-Brain Injury

Myth or Fact?

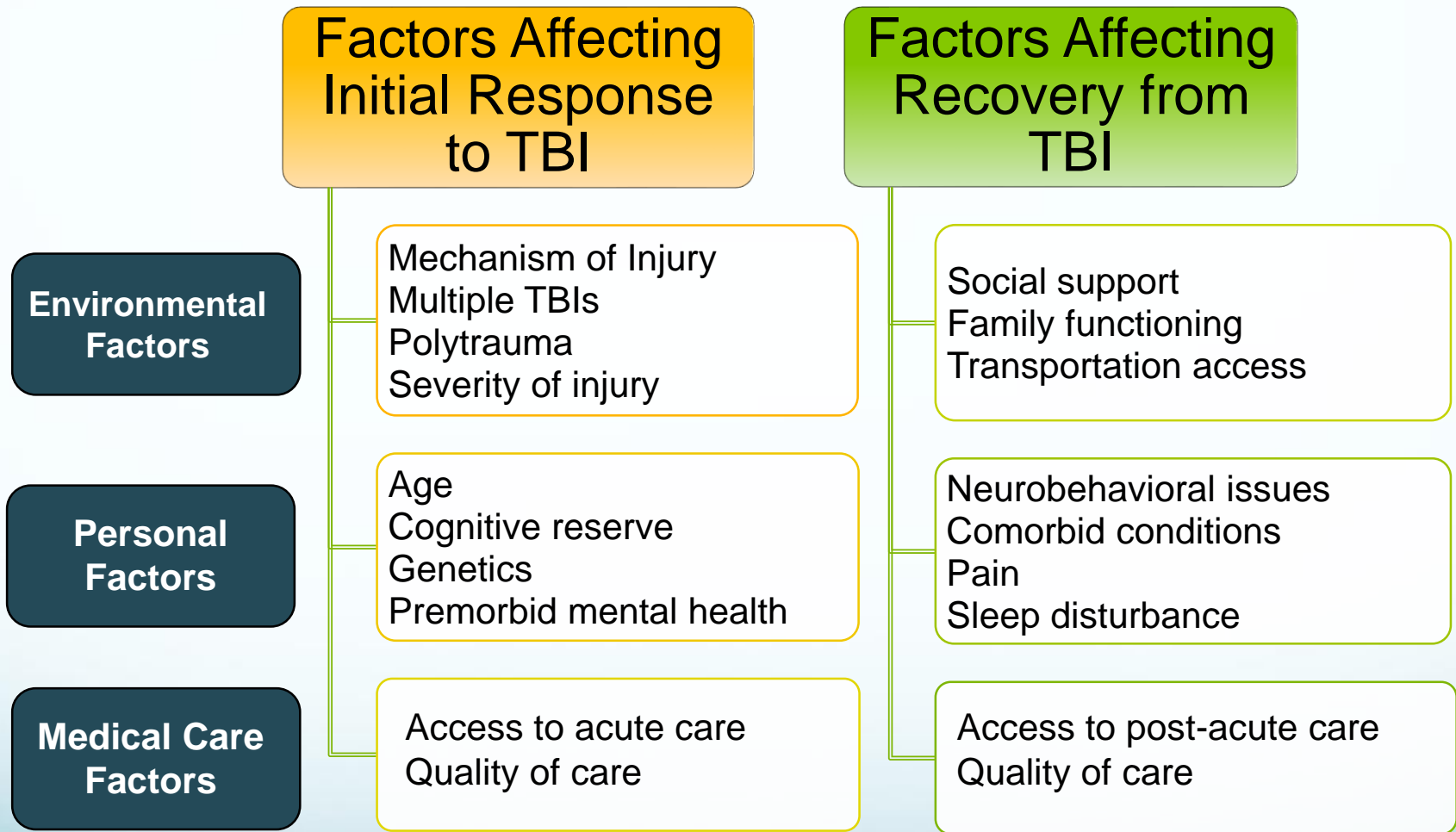
1. Acute severity can accurately predict post-acute severity. **MYTH**
2. The amount of time the person with a brain injury remains in a coma is one of the factors that affects recovery. **FACT**
3. Knowing which parts of the brain have been injured will tell you the specific challenges to expect. **MYTH**
4. Most recoveries for brain injury show steady improvement up until 2 years when recovery is complete. **MYTH**
5. With support, many people can change their behavior after a brain injury. **FACT**

“Recovery” after TBI

(Brooks, 1984)



Determinants of Recovery



Determinants of Recovery

- Factors affecting cognitive and functional recovery from TBI:
 - Premorbid Conditions
 - Comorbidities
 - Contextual Factors

<https://www.nap.edu/read/13220/chapter/6>

Determinants of Recovery

Premorbid Conditions

- ADHD, learning disabilities, developmental disabilities, syndrome on the Autism spectrum
- Pre-injury psychiatric conditions including personality and substance use disorders
- Lack of social support systems
- Low socioeconomic status
 - Uninsured / Underinsured
 - Low educational status
 - Low IQ

Determinants of Recovery

Comorbidities

- Can include behavioral, psychiatric, physical, or cognitive disorders – mostly causal associations
- E.g.
 - Depression and anxiety related to the effects of the injury
 - Post-traumatic seizure disorder
 - Neurobehavioral syndromes
 - Vision impairment
 - Fatigue
 - Headache / pain
 - Sleep disturbance
- Co-occurring injuries may include multi-trauma such as broken bones

Determinants of Recovery

Contextual Factors

- Family and social support play a key role in recovery post-TBI
- The dynamic of family functioning (poor and good) can directly affect one's potential for optimal recovery
- Access to appropriate rehabilitation resources may be limited due to geographical restrictions and/or limited funding