SPECTRUM HEALTH

Understanding the Brain and Brain Injury

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Learning Objectives

1. Describe brain anatomy and identify related function
2. Identify potential medical complications and functional impacts of TBI
3. Outline the principles of effective treatment planning and rehabilitation following brain injury

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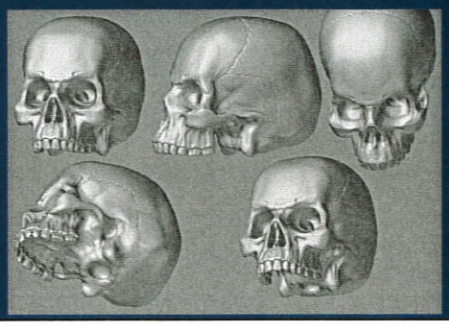
Skull Anatomy-Protection



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The Brain.....

..... is the main organ of learning.

It makes it possible for us to think, communicate, act, behave, move about, and create.

ACBIS Chapter 3

4

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Meninges—Cover the Brain

Three membranes, or meninges, cover the brain:

The outer *dura mater* or hard matter, which is like a heavy plastic covering.

The *arachnoid*, which is like a spider web that bridges the brain's many wrinkles and folds.

The *pia mater* or tender matter, which molds around every tiny crook and crevice on the brain's surface.

Between the pia mater and the arachnoid, there is 145cc of cerebrospinal fluid.

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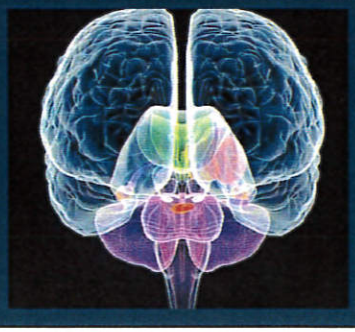
Brain Anatomy



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Lobes of the Brain

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Frontal Lobe Functions

-Problem Solving

-Initiation

-Judgement

-Inhibition of behavior

-Self monitoring

-Motor planning

-Personality, emotions

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Frontal Lobe Functions

-Awareness of abilities, limitations

-Planning, anticipation

-Attention, concentration

-Mental flexibility

-Ability to speak (expressive language)

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Parietal Lobe Functions

Functions:

- Sense of touch
- Differentiation of shape, size, color
- Spatial perception
- Visual perception

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Temporal Lobe Functions

Functions:

- Memory
- Hearing
- Understanding Language (Receptive Language)

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Occipital Lobe

Vision

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Cerebellum

Functions:

- Balance
- Coordination
- Skilled motor activity

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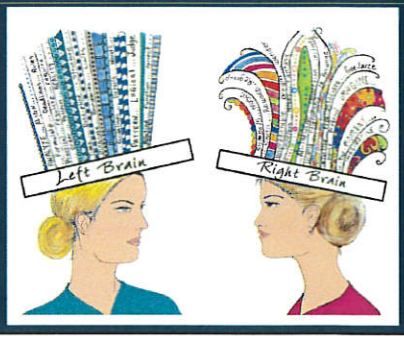
Brain Hemispheres



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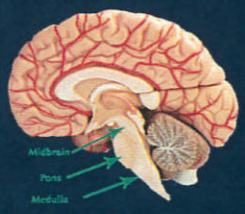
Brain Stem



Midbrain
- Alertness & arousal
- Elementary forms of seeing & hearing

Pons
- Facial movement & sensation, hearing, & coordinating eye movements

Medulla
- Basic living functions
- Vital to life and death
- Controls involuntary functions like breathing, heart-rate, blood pressure, swallowing, vomiting and sneezing.

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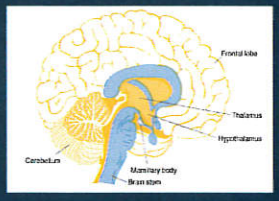
Diencephalon



Thalamus
- Major relay station for incoming and outgoing sensory information
- The input for every sense (except smell) travels through the thalamus

Hypothalamus
- Control center for hunger, thirst, sexual response, endocrine level & temperature regulation.
- Controls complex responses like anger, fatigue, memory and calmness.

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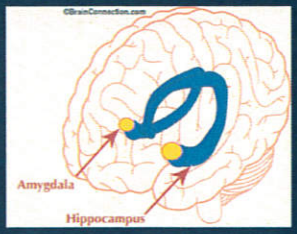
Limbic System



Limbic System
- Houses basic elemental drives, emotions and survival instincts.
- Injury to the limbic system can result in serious problems with basic emotional perceptions, feelings & responses.
- Behavior and mood can be very erratic

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Limbic System

Amygdala
- Fight or flight structure
- The front door to our emotions
- When perceptions reach the cerebral cortex, it is transmitted to the amygdala to be evaluated for emotional content

Hippocampus
- Associated with memory functions
- Injury can result in problems with short term memory, and turning short term memories into long term memories
- Disrupts the encoding and retrieval of long term memory

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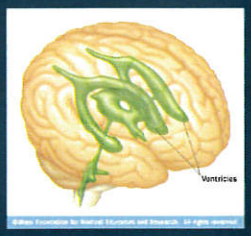
Ventricles



- Make, store and circulate cerebral spinal fluid (CSF)
- CSF ehlps cushion and protect brain tissue when swelling occurs

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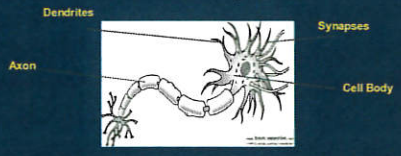
Neurons

Neurons: the billions and billions of tiny brain cells making up the nervous system ***Glial*** ("glue"): non-communicating cells support and nourish the neurons.

Three main parts of the neuron: ***cell body***, ***axon***, ***dendrites***



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Definition of Traumatic Brain Injury

Definition of TBI: *TBI is defined as an alteration in brain function, or other evidence of brain pathology, caused by an external force.*

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Causes of TBI

- Falls
- Motor Vehicle Crashes (20%)
- Struck by/against (19%)
- Assaults (11%)
- Blast injuries are the leading cause of TBI for active military personnel

Source: Brain Injury Association of America

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Primary Injury

Caused by initial blow or insult

- Skull Fracture
- Contusion to brain

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Coup-Contracoup Injury

After a sudden jolt or bang, the result can be…

Coup-Contracoup: Injury at the site of impact and on the opposite side from the movement of the brain against the skull (either front to back or side to side)

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Secondary Injury

After a sudden jolt or bang, the result can be…

Swelling: Brain tissue swells preventing blood and CSF circulation

Increased intracranial pressure

- Hematoma: Accumulation of blood causing pressure
- Hydrocephalus: Blockage of CSF causing pressure

Anoxia & Hypoxia: Oxygen deprivation from suffocation, drowning, blood loss, or cardiac failure that kills brain cells

Seizures

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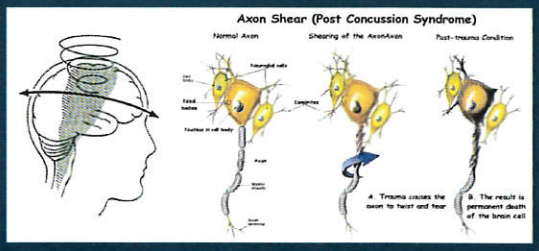
Diffuse Axonal Injury (DAI)



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DAI

- Delicate nerve tissues rip, tear, and stretch
- Injury occurs because the unmoving brain lags behind the movement of the skull, causing brain structures to tear.
- Tearing of the nerve tissue disrupts the brain's regular communication and chemical processes.
- This disturbance in the brain can produce temporary or permanent widespread brain damage, coma, or death.

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Severity of Brain Injuries

The Glasgow Coma Scale (GCS):
A measure of brain injury severity.
Measures *Eye Response + Verbal Response + Motor Response*
= Total Score
Scores range between 3 and 15

The *lower* the score, the more severe the brain injury

Eye Opening	Verbal Response	Motor Response
4 Spontaneous	5 Oriented to person, place, month & year	6 Obeys commands
3 Eye opening to verbal command	4 Confused	5 Localizes pain
2 Eye opening to pain	3 Inappropriate words	4 Withdraws to pain
1 No eye opening	2 Sounds, but words not understandable	3 Abnormal flexion to pain
	1 No verbal response	2 Abnormal extension to pain
		1 No motor response

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Severity of Brain Injuries

Severity Definitions

Mild Brain Injury	Moderate Brain Injury	Severe Brain Injury
Loss of consciousness for less than 30 minutes (possibly no loss of consciousness)	Coma more than 30 minutes, but less than 24 hours	Coma longer than 24 hours, often lasting days or weeks
Glasgow Coma Scale of 13-15	Glasgow Coma Scale of 9-12	Glasgow Coma Scale of 3 to 8
Typically returns to normal in less than 24 hours	Possible skull fracture with bruising & swelling	Bruising/bleeding in brain
Temporary or permanently altered mental or neurological state	Signs on CT, DAI or MRI scans	Signs on CT, DAI or MRI scans
Headaches or symptoms	Some long-term problems in one or more areas of life (like, home, work, community)	Long-term impairments in one or more areas of life (like, home, work, community)

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Severity of Brain Injuries

Post concussion symptoms of cognitive and psychiatric nature that may or may not persist include:

- headache
- dizziness
- vomiting
- sleep disturbance
- irritability
- changes in personality
- memory problems
- depression
- difficulty problem solving
- diminished attention span

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Severe Brain Injury

- Coma (GSC 3-8; coma >24 hours)
- Vegetative State
- Persistently Vegetative State
- Minimally Responsive State
- Locked-in Syndrome

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Functional Impacts of Traumatic Brain Injury

- There may be many changes in how a person thinks, feels, and acts after a brain injury.
- Physical, cognitive, behavioral and emotional changes can greatly affect a person's ability to live independently.
- Most people who have survived moderate to severe brain injury have impairments in several areas, which complicate living independently, working, and relationships with others.

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Potential Impacts of TBI

- Medical Complications
- Musculoskeletal Issues
- Sensorimotor Changes
- Cognitive Changes
- Behavioral and Emotional Changes

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Possible Medical Complications

Cardiovascular

- May be caused by direct trauma to the heart itself, complications from trauma, or damage to parts of the brain that control the functioning of the heart
- Heart Rate and Blood Pressure may be impacted

Respiratory

- Complications include infection, airway obstruction, trauma to the larynx, trachea, chest and lungs, risk of aspiration pneumonia

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Gastrointestinal System

- Injury to the brain directly affects a person's nutritional needs. A person's metabolism may increase after brain injury which causes the body to need increased energy and calories.
- Problems such as poor hand to eye coordination, difficulty swallowing, diminished attention and impaired cognition can further compromise a person's nutritional intake.

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Neurologic Symptoms

Headaches

- most common neurological condition reported after brain injury
- Monitor for changing neuro status
- may be accompanied by memory impairment, dizziness, fatigue, difficulty concentrating and cognitive impairment

Seizures

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Musculoskeletal Issues

- Observe for muscle and skeletal complications and peripheral nerve injuries:
- **Spasticity:** an involuntary increase in muscle tone-tension
- **Paresis or paralysis-**weakness or paralysis of one or more limbs
- **Contractures** - flexion and fixation of a joint due to a wasting away and abnormal shortening of muscle fibers and loss of skin elasticity
- **Heterotopic ossification (HO):** abnormal growth of bone in soft tissues or around joints.

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Sensorimotor Impairments

Vision problems
- Depth perception
- Involuntary eye movements (*nystagmus*)
- Increased sensitivity to light (*photophobia*)

Swallowing difficulties (*dysphagia*)

Impaired hearing
- Ringing in ear (tinnitus)
- Increased sensitivity to sound (sonophobial)

Impaired taste

Impaired ability to smell (*anosmia*)

Chronic pain

Increased sensitivity to touch (tactile defensiveness)

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Sympathetic Storming (Autonomic Dysregulation)

Sometimes seen after acute trauma (severe TBI)

Hypothalamic stimulation of sympathetic nervous system causes increased stress response

Symptoms:
- increased posturing/tone
- diaphoresis
- agitation
- tachycardia/tachypnea
- hyperthermia

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Hierarchy of cognitive abilities

- Arousal/alertness
- Sensory/motor skills
- Attention/concentration
- Language skills/communication
- Spatial/constructional abilities
- Memory abilities
- Reasoning Skills/Ability to solve problems
- Intellectual and Academic Abilities (3 R's)

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Cognitive Impairments

- Lack of awareness of deficits (***anosognosia***)
- Confusion about who one is, where one is, and the time (disorientation to person, place, and time)
- Distractibility, or reduced ability to pay attention
- Difficulty with changes in routine
- Difficulty with sequencing

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Cognitive Impairments

- Impaired ability to evaluate what is important versus trivial
- Impaired ability to think abstractly
- Preservative verbal behavior
- Difficulty understanding cause and effect
- Impaired safety awareness
- Lack of empathy
- Poor insight

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Speech and Language Deficits

Speech and language problems can be either *Receptive* (the ability to understand others), or *Expressive* (the ability to express oneself to others)

Common Deficits:

- Impaired word-finding abilities
- Repetition of words or phrases
- Disorganized spoken or written communication
- Incomplete or incoherent expression of thoughts

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Behavioral and Emotional Changes

- delayed or unresponsiveness to requests
- aggression
- property destruction
- depression
- yelling and angry outbursts
- self-injurious behavior
- decreased frustration tolerance
- impulsivity
- decreased sensitivity to others
- paranoia
- inappropriate sexual behavior
- hyperactivity
- immature self-focused behavior
- hoarding
- emotional swings (affective lability)

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Goal of Brain Injury Rehabilitation:

Return people to their communities

- To help the individual adapt to the expectations of the community
- To help the community accept and respect the differences that people with disabilities may have

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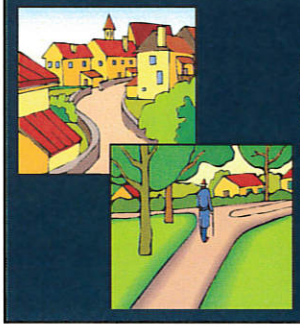
The Goal of Rehabilitation



Rehabilitation is a process to provide the assistance needed to ultimately unite a person to his or her community

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Recovery Principles

- Stabilize
- Rehabilitate
- Compensate
- Anticipate
- Provide support and structure

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Treatment Planning

The most effective treatment plan is:

- tailored to the specific needs of the individual
- developed based on the expected discharge site,
- developed based on the expectations of the individual and family,
- developed based on knowledge about methods to improve performance.

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Levels of Care

- Acute Hospital/Trauma Unit
- Long Term Acute Care Hospital (LTACH)
  - vent wean
- Inpatient Rehabilitation
- Home/Community Based Rehabilitation
- Outpatient Rehabilitation
- Transitional Rehabilitation
- Residential Care

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Summary

- Traumatic Brain Injury can result in functional, cognitive and behavioral impairments.
- Rehabilitation and providing appropriate supports can help persons with TBI function at their best.
- Improving staff knowledge and understanding of brain injury issues can lead to improved planning and improved outcomes for persons following TBI.

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References and Favorite Websites

Family/patient support:
Brain Injury Association
- www.biausa.org (National)
- www.biami.org (Michigan Chapter)
- www.brainline.org

Traumatic Brain Injury and Public Services in Michigan (self-study course)
- www.mitbitraining.org

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Thank You!