Traumatic Brain Injury
The Silent Epidemic
Training Objectives

- Know the names of the lobes of the brain and understand their corresponding functions.
- Comprehend how coup-contra coup and axonal shearing injuries occur.
- Recognize the Glasgow Coma Scale and Ranchos Los Amigos Scale measures and understand how their measurements are recorded.
- Know the hierarchy of cognitive functions and their corresponding characteristics.
- Understand how neurofatigue, adynamia and disinhibition affect someone with a traumatic brain injury.
"Traumatic Brain Injury (TBI) is an important public health problem in the United States. Because the problems that result from TBI, such as those of thinking and memory, are often not visible, and because awareness about TBI among the general public is limited, it is frequently referred to as the “silent epidemic.”

Centers for Disease Control (CDC) report on Traumatic Brain Injury in the U.S.: Emergency Department Visits, Hospitalizations, and Deaths (Langlois, Rutland-Brown & Thomas, 2006, page3).
TBI Statistics

- 5.3 million Americans, about 2% of the U.S. population, currently have a long-term or lifelong need for help to perform activities of daily living as a result of a TBI. ¹

- 75% of TBIs that occur each year are concussions or mild TBI. ²

- 1.4 million people sustain a TBI each year in the U.S. ³
  - Of those:
    - 50,000 die;
    - 235,000 are hospitalized; and
    - 1.1 million are treated and released from an emergency department.

Motor Vehicle Accidents - result in the greatest number of TBI related hospitalizations. Rate highest among ages 16-19 years of age. ³
EPIDEMIOLOGY:
* Every 21 seconds, 1 person in the U.S. sustains a TBI
* 1.4 million Americans survive a brain injury each year
* After 1\textsuperscript{st} TBI the risk for a second brain injury is 3x greater
* After a 2\textsuperscript{nd} TBI, the risk is 8x greater

SEVERITY:
* 80% - Mild TBI
* 10 - 30% - Moderate TBI
* 5 - 25% - Severe TBI

GENDER:
* Men sustain 3x as many brain injuries as women  \textit{CDC, 2007}
Definitions

**Traumatic Brain Injury (TBI)** is an insult to the brain, not of a degenerative or congenital nature but caused by an external physical force, that may produce a diminished or altered state of consciousness, which results in an impairment of:

- Cognitive abilities and/or physical functioning and
- Disturbance of behavioral or emotional functioning.
- Impairments may be either temporary or permanent and
- May cause partial or total functional disability or psychological maladjustment.

Brain Injury Association, 2007
The leading causes of TBI:
Falls – 28%
Motor Vehicle Accidents (MVA) - 20%
Struck By/Against events - 19%
Assaults – 11%
Other TBI Causes (cont.)

- Gunshot Wounds
- Sports Injuries
- Workplace Injuries
- Shaken Baby Syndrome
- Child Abuse
- Domestic Violence
- Military Actions
- Other injuries caused by trauma
Definitions (cont.)

• Acquired Brain Injury (ABI) is an injury to the brain that has occurred after birth and is not hereditary, congenital or degenerative. The injury commonly results in a change in the neuronal activity, which affects the physical integrity, the metabolic activity or the functional ability of the cell. The term does not refer to brain injuries induced by birth trauma.

Brain Injury Association, 2007
Causes of Acquired Brain Injury

- TBI
- Tumors
- Blood Clots
- Strokes
- Seizures
- Toxic Exposure
- Infections
- Metabolic Disorders
- Neurotoxic Poisoning
- Lack of oxygen to the brain
Shaping of the Brain

- A person has the most neurons when they are born. As they grow and learn, neurons are shed and new dendrite connections are formed.
- The first lobes of the brain that shape are the occipital lobes, as a baby perfects their visual skills.
- The last lobes of the brain that shape are the frontal lobes, about 18 for females and about 21 for males (reason for the drinking age of 21).
The Neuron
How long is a neuron?
Some neurons are very short...less than a millimeter in length. Some neurons are very long...a meter or more! The axon of a motor neuron in the spinal cord that innervates a muscle in the foot can be about 3 feet in length.

How big is the brain compared to the rest of the body?
If you assume the average person is 150 pounds and the average brain weighs 3 lbs., then the brain is 2% of the total body weight.

How fast does information travel in the nervous system?
Information travels at different speeds within different types of neurons. Transmission can be as slow as 0.5 meters/sec or as fast as 120 meters/sec (268 miles/hr!!!)
Brain Function

- **Frontal Lobe**
  - Motivation
  - Controlling attention
  - Emotional control
  - Guide/Control social behavior
  - Judgment and problem-solving
  - Decision making
  - Expressive language
  - Abstract thinking
  - Motor integration
  - Voluntary movement

- **Parietal Lobe**
  - Tactile perception (touch)
  - Awareness of spatial relationships
  - Academic skills (reading)
  - Using information from body senses

- **Occipital Lobe**
  - Visual perception and Input
  - Reading (perception and recognition of printed words)

- **Temporal Lobe**
  - Memory
  - Expressive and receptive language
  - Comprehension of language
  - Musical awareness
  - Sequencing skills

- **Cerebellum**
  - Coordination and balance

- **Brain Stem**
  - Regulates:
    - Blood pressure
    - Heartbeat
    - Respiration
    - Reflexes
    - Gateway for information to and from the body
Hemispheric Specialization

**LEFT HEMISPHERE**
Controls right side of body

**RIGHT HEMISPHERE**
Controls left side of body
Perceptual Abilities of the Brain

The senses bring information into the brain
Taste and Smell
SPEECH AND LANGUAGE

Broca's Area
Speech production and articulation

Wernicke's Area
Language comprehension
Learning and Memory
Types of Brain Injury

- **Penetrating Injuries:** A foreign object (e.g., a bullet) enters the brain and causes damage to specific brain parts.

- **Closed Head Injuries:** A blow to the head occurs, for example, in a car accident when the head strikes the windshield or dashboard.
  - **skull fracture:** Breaking of the bony skull
  - **contusions/bruises:** Often occur right under the location of impact or at points where the force of the blow has driven the brain against the bony ridges inside the skull
Types of Brain Injury (cont.)

- **Hematomas/blood clots**: occur between the skull and the brain or inside the brain itself.

- **Lacerations**: tearing of the frontal (front) and temporal (on the side) lobes or blood vessels of the brain (the force of the blow causes the brain to rotate across the hard ridges of the skull, causing the tears).

- **Nerve damage (diffuse axonal injury)**: arises from a cutting, or shearing, force from the blow that damages nerve cells in the brain's connecting nerve fibers.
Specific sites of bruising and contusion can occur at the site of the blow to the head (“coup”) and the site directly opposite to where the blow was struck on the head (“contracoup”).
Axonal Shearing & Swelling

**Axonal Shearing**
When axons are stretched until they are torn. If this happens, the neuron dies.

**Brain Swelling**
Can lead to neuron damage by squeezing the cells or from anoxia caused by disrupting the flow of blood and oxygen to the brain.
Contusion & Hematomas

Contusion
Bruising and bleeding from violent impact.

Hematoma
A pool of blood
Anoxia & Hypovolemic Shock

**Anoxia**

A lack of oxygen to the brain which causes subsequent further damage to brain cells.

**Hypovolemic Shock**

Loss of blood volume that further compromises healthy brain tissue.
Seizures

**Generalized Seizures**
Generalized seizures happen when an electrical disturbance sweeps through the whole brain at once.

**Partial Seizures**
Partial seizures happen when the disturbance occurs in just one part of the brain.
Glasgow Coma Scale

**Eye Opening Response**
- Spontaneous--open with blinking at baseline 4 points
- To verbal stimuli, command, speech 3 points
- To pain only (not applied to face) 2 points
- No response 1 point

**Verbal Response**
- Oriented 5 points
- Confused conversation, but able to answer questions 4 points
- Inappropriate words 3 points
- Incomprehensible speech 2 points
- No response 1 point

**Motor Response**
- Obeys commands for movement 6 points
- Purposeful movement to painful stimulus 5 points
- Withdraws in response to pain 4 points
- Flexion in response to pain (decorticate posturing) 3 points
- Extension response in response to pain (decerebrate posturing) 2 points
- No response 1 point

\[ E + V + M = 3 \text{ to } 15 \]
- 90% less than or equal to 8 are in coma
- Greater than or equal to 9 not in coma
- 8 is the critical score
- Less than or equal to 8 at 6 hours - 50% die
- 9-11 = moderate severity
- Greater than or equal to 12 = minor injury
Rancho Los Amigos Scale

Level I - No Response: Total Assistance
Level II - Generalized Response: Total Assistance
Level III - Localized Response: Total Assistance
Level IV - Confused/Agitated: Maximal Assistance
Level V - Confused, Inappropriate Non-Agitated: Maximal Assistance
Level VI - Confused, Appropriate: Moderate Assistance
Level VII - Automatic, Appropriate: Minimal Assistance for Daily Living
Level VIII - Purposeful, Appropriate: Stand-By Assistance
Level IX - Purposeful, Appropriate: Stand-By Assistance on Request
Level X - Purposeful, Appropriate: Modified Independent
# Brain Injury Severity

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>GCS</th>
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<tbody>
<tr>
<td><strong>Mild</strong></td>
<td>Loss of Consciousness &lt; 20 minutes</td>
<td>13-15</td>
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<tr>
<td></td>
<td>Post-Traumatic Amnesia &lt; 24 hours</td>
<td></td>
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<tr>
<td></td>
<td>GCS = 13-15</td>
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<tr>
<td><strong>Moderate</strong></td>
<td>Loss of Consciousness ≥ 20 minutes and ≤ 36 hours</td>
<td>9-12</td>
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<tr>
<td></td>
<td>Post-Traumatic Amnesia ≥ 24 hours and ≤ 7 days</td>
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<tr>
<td><strong>Severe</strong></td>
<td>Loss of Consciousness &gt; 36 hours</td>
<td>3-8</td>
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<tr>
<td></td>
<td>Post-Traumatic Amnesia &gt; 7 days</td>
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Neurophysiology of Mild Traumatic Brain Injury (MTBI)

- “MTBI renders neurons dysfunctional, not destroyed”
- Dysfunction of brain metabolism- **Neurometabolic Cascade**
  - Sequential neuronal dysfunction due to:
    - Ionic Shifts
    - Altered metabolism
    - Impaired connectivity
    - Changes in neurotransmission

Iverson, G.L., 2005. Outcome from MTBI. Curr Opin Psychiatry, 18:301-17
Physical Consequences of Brain Injury

- **Motor** – paralysis, poor balance, lowered endurance, ataxia, abnormal tone, muscle stiffness
- **Oral and Speech Movement** – Slowed, slurred speech, difficulty chewing & swallowing, choking
- **Perceptual** – all senses may be affected – vision, hearing, smell, taste, touch
- **Regulatory** – fatigue, difficulty regulating body temperature, difficulty regulating consumption of food and liquids, loss of bowel and bladder control
- **Traumatic Epilepsy** – seizures – generalized or focal motor
Cognitive Consequences of Brain Injury

- Difficulties with Arousal/Alertness – Neurofatigue
- Poor Initiation of activity or communication
- Poor Attention/Concentration
- Poor processing of information – slowed, distortions
- Memory deficits
- Difficulties with comprehension
- Difficulties with language production
- Poor problem solving and reasoning
- Sequencing difficulties
- Poor planning and organization skills
- Difficulty with self monitoring
Behavioral and Emotional Consequences of Brain Injury

- Restlessness and Agitation
- Emotional Lability and Irritability
- Confabulation
- Diminished Insight – Poor Awareness of Deficits
- Impulsivity
- Socially Inappropriate Behavior
- Lack of Emotional Response
- Paranoia and blaming others for negative events
- Depression
- Anxiety
How does brain injury affect children/adolescents?

- It is often difficult to diagnose a TBI in children and adolescents due to several of the symptoms mimicking “normal” childhood behavior.
- Often, a TBI early in life becomes a part of the child’s personality, and can be missed by professionals.
- It is important for family and schools to be educated regarding the signs and symptoms of TBI.
- IEP=Individual Educational Plan-Developed between child, parent, rehab staff, special educators, and teachers to ensure success in school.
Systems of Care for Brain Injured Individuals / Treatment Options

- Acute Care Hospitals
- Acute Rehabilitation
- Skilled Nursing Facility (Sub-Acute)
- Post Acute Rehabilitation
- Outpatient Services
- Supported Living
Providers of Care

- Physical Medicine and Rehabilitation Physician
- Neurologist
- Neuropsychologist/Psychologist
- Psychiatrist
- Physical Therapist
- Speech Language Pathologist
- Occupational Therapist
- Social Worker
- Care Coordinator
- Vocational Services Specialist
- Recreation Specialist
- Direct Care Providers - Living Skills Staff
Other Issues Related to Brain Injury

- Life Changes – acceptance – moving on
- Behavioral Issues – need for plan and intervention
- Social Interactions/Support
- Vocational – losses and changes
- Family Adjustment
- Guardianship
- Legal Rights
Embracing person-centered planning, family participation, and an interdisciplinary approach, we provide rehabilitation in a manner that respects the dignity of the individual.