Learning Objectives

- Know the symptoms clusters of neurologic disorders, neuroendocrine disorders, sexual dysfunction, and musculoskeletal dysfunctions resulting from brain injury
- Gain an understanding of the causes of brain injuries, both traumatic and non-traumatic
- Be able to distinguish between primary and secondary injury
- Be able to articulate the effects of brain injury and injury severity
- Be able to describe the different patterns of brain injury observed in specific age groups

Brain Injury as Silent Epidemic

- The effects of brain injury (BI), such as changes in thinking, may not be readily apparent to an outside observer
- Negative consequences occur when the general public and medical providers do not recognize the effects of BI
  - Problems at work or school
  - Changes in personal relationships
  - Legal problems
  - Homelessness

Risk Factors for Developing Disability

- Brain injury is a major public health problem in the United States
- Brain injury is often called a silent epidemic because many of the problems that result from a brain injury are not always readily apparent
- Brain injury is frequently not identified
- Appropriate treatment at the right time, at the right dose and the right frequency is not readily available
Acquired Brain Injury

- An injury to the brain that is not hereditary, congenital, degenerative, or induced by birth trauma
- Occurs after birth with presumed normal brain development preceding the injury
- Results in a change in neuronal activity affecting physical integrity, the metabolic activity, or the functional ability of nerve cells
- Acquired brain injury is an umbrella definition as it includes injuries caused by external physical forces applied to the head, as well as internal insults to the brain.

Traumatic Brain Injury (TBI)

- A TBI is an alteration in brain function, or other evidence of brain pathology, caused by an external force
- With traumatic impact injuries the head is struck by an object or an object strikes the head resulting in either a:
  - Closed injury
  - Open (penetrating) injury

Closed Head Injury

- Coup Contrecoup Injury

Open Head Injury

- A penetrating brain injury involving:
  - Breach of the skull or breach of the meninges
  - Often results in focal injuries
  - Infection can be a secondary factor

Rainbow Rehabilitation Centers
**Traumatic Inertial Injuries**
- Non-impact injuries resulting from inertial forces
- Example: Acceleration-deceleration forces which can result in coup-contrecoup injuries
- There may be rotational or angular forces that create diffuse axonal injury

**Non-traumatic Brain Injury**
- Brain damage caused by internal factors such as:
  - Lack of oxygen or nutrients to the nerve cells of the brain
  - Exposure to toxins
  - Pressure from a tumor or blockage
  - Other neurological disorder

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**Acquired Brain Injury Causes - Traumatic and Non-traumatic**

<table>
<thead>
<tr>
<th>Causes of Traumatic Brain Injury</th>
<th>Causes of Non-Traumatic Brain Injury</th>
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</thead>
<tbody>
<tr>
<td>Falls</td>
<td>Stroke (hemorrhage or blood clots)</td>
</tr>
<tr>
<td>Assaults</td>
<td>Infectious disease (meningitis)</td>
</tr>
<tr>
<td>Motor vehicle crashes</td>
<td>Skull fracture</td>
</tr>
<tr>
<td>Spinal and pelvic injuries</td>
<td>Electric shock or lightning stroke</td>
</tr>
<tr>
<td>Shaken baby syndrome/abusive head trauma</td>
<td>Tumor (surgery, radiation, chemos)</td>
</tr>
<tr>
<td>Gunshot wounds</td>
<td>Toxic exposures (suicide, inhalation of lead, inhalation of volatile agents)</td>
</tr>
<tr>
<td>Workplace injuries</td>
<td>Metabolic disorders (diabetes, coma, liver and kidney disease)</td>
</tr>
<tr>
<td>Child abuse</td>
<td>Neurologic poisoning (sodium imbalanced poisoning, inhalants, lead exposure)</td>
</tr>
<tr>
<td>Domestic violence</td>
<td>Lack of oxygen to the brain (near drowning, asphyxiation, asphyxia, anoxia)</td>
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<td>Military actions (blast injury)</td>
<td></td>
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**Primary Injury**
- The initial injury to the brain defines the injury as either traumatic or non-traumatic.
- Helps determine:
  - Severity of injury
  - Surveillance data
  - Correlates of injury to long-term outcome
- The mechanism of injury is mechanical - for example, neurons damaged from a penetrating injury or from a stroke

**Secondary Injury**
- The primary injury causes a cascade of adverse events leading to secondary brain injury including:
  - The release of excitatory amino acids
  - Oxidative free-radical production
  - Release of arachidonic acid metabolites
  - Disruption of neurotransmitters
- Other secondary injuries include:
  - Hypoxia
  - Anemia
  - Metabolic abnormalities
  - Hydrocephalus
  - Intracranial hypertension
  - Hemorrhagic activity
Brain Injury Severity

- **Mild TBI**: Can have either brief or no loss of consciousness and its presentation may demonstrate vomiting, lethargy, dizziness, and inability to recall what just happened.

- **Moderate TBI**: Will be marked by unconsciousness for any period of time up to 24 hours, will have neurological signs of brain trauma, including skull fractures with contusion or bleeding, and may have focal findings on an electroencephalograph (EEG) or computed tomography (CT) scan.

- **Severe TBI**: Marked by a period of loss of consciousness of 24 hours or greater.

Concussion

- Is a trauma-induced alteration in mental status (dazed, disoriented, confused)
- May or may not involve loss of consciousness (LOC)
- Can result in loss of memory for events immediately before or after trauma
- Can result in local neurological deficits that may or may not be transient
- Most are not treated in the hospital or emergency department and therefore may not be diagnosed or under-diagnosed in studies.

The Importance of Understanding the Epidemiology of Brain Injury

- Assists with prevention of brain injury
- Development of training programs
- Passing legislation
- Lobbying and planning for effective resources and services, including improving the quality of care

Incidence of TBI

- Young children, adolescents, young adults, and older adults disproportionately affected
- Contributing factor to a third (30.5%) of all injury-related deaths in the US
- 75% of TBI's that occur each year are mild TBI
- An estimated 2.5 million people sustain a TBI yearly
  - 2,214,000 emergency department visits (81%)
  - 284,000 hospitalizations (16%)
  - 53,000 deaths (3%)

Prevalence of Brain Injury

- Second most prevalent disability in the U.S.
- An estimated 13.5 million Americans are living with brain injury
- 4.5% of the U.S. population is living with a brain injury
- Overall rates of TBI have gone up gradually from 2001 through 2010
  - Rates of death related to TBI have dropped during the same time frame
What Determines the Effects of Brain Injury?

- Risk Factors
- Injury severity
- Age at injury
- Alcohol misuse
- Domestic violence
- Service in the military
- Participation in sports

What Determines the Effects of Brain Injury?

- Number of brain injuries a person experiences
- After multiple concussions, there is an association with developing chronic traumatic encephalopathy (CTE) and other neurodegenerative disorders

Age Groups to Most Likely to Sustain a TBI

- Adolescents age 15 to 19 years (via motor vehicles)
- Young adults age 20-24 (via firearms)
- Adults age 65 years and older
- Adults age 75 years and older have the highest rates of TBI-related hospitalization and death
- Falls and firearms

Age and Mechanism of Injury

- Highest Rates of TBI due to Falls by Age Group
  - Children 0-4 (50% of all TBIs)
  - Adults 65 or older (65% of all TBIs)

- Highest Rates of Death from TBI due to Falls
  - Adults aged 75 or older

- Highest Rates of Death from TBI (All Causes)
  - Adults aged 75 or older

- Highest Rates of Death from TBI (Firearms)
  - Adults 20-24

- Highest Rates of Death from TBI Related Death from Motor Vehicle Crashes
  - Adults 75 or older

- Percentage of Children with TBI from Physical Abuse
  - Children 0-2 years old (57%)

- Highest Rates of TBI from Motor Vehicle Crashes
  - Adults 20-24 years of age

- At any age, males have a higher rate of TBI-related death than females

Children and TBI

- Non-accidental trauma is the cause of at least 80% of deaths from head trauma in children under 2
- 2/3 of the children under three-years-old who are physically abused have TBIs
- Approximately 18% of all TBI-related emergency department visits involved children aged 0 to 4 years
- Falls cause half of the TBIs among children aged 0 to 14 years

Sports Related TBI

- Bicycling, football, playground activities, basketball, soccer, horseback riding, and all-terrain vehicle (ATV) riding result in the greatest number of TBIs
- Among children 9 or younger, the most injuries are from bicycling and playground injuries
- Public health campaigns are working to create greater awareness of how to recognize a TBI and how to treat it
Domestic Violence
A study found that 67% of women victims of domestic violence also had symptoms associated with brain injury.

Brain Injury in Prisons
A high proportion of the 2 million people currently in U.S. prisons have a brain injury. These injuries are not necessarily recognized, diagnosed, or treated. Many state correctional systems and the CDC are now recognizing TBI in prisons and jails as a significant factor in recidivism.

Between 25 and 87 percent of inmates report having experienced a TBI, compared with a report rate of 8.5 percent in the general population.

They experience mental health problems including severe depression, anxiety, substance abuse disorders, anger management disorders, and suicidal ideation/attempts.

Female inmates who are convicted of a violent crime are more likely to have sustained a pre-crime TBI or some other form of physical abuse.

Male prisoners with a history of TBI are highly associated with perpetration of domestic and other kinds of violence.

Screening for TBI
- Brain injury is often undetected in children, sports, the military, and prisons.
- Thorough screening is important so that appropriate services can be provided.
- The comprehensiveness of tools varies. Most are self-report.
- The Acute Concussion Evaluation (ACE)
- HELPS
- Warrior Administered Retrospective Casualty Assessment Tool (WARCAT)
- Traumatic Brain Injury Questionnaire (TBIQ)
- ImPACT
- OSU TBI-ID

Continuum of Care
- Developed over the past 30 years in response to:
  - The unique needs of the population
  - Efforts to develop less costly treatment options that were not hospital-based
  - The failure of existing options to demonstrate functional improvement or prevent complications
  - Progression along the continuum is not linear or unidirectional

Rehabilitation Accreditation & Licensure
- Goal: to ensure that the organization has the capacity to meet the needs of persons with disabilities
- Compliance with quality and performance standards
- Survey sites periodically
- Look for evidence of currently accepted standards of practice
- Consult with the organization to improve delivery of services
National Accreditation Agencies

- Commission for the Accreditation of Rehabilitation Facilities (CARF)
  - For post-acute BI programs
  - Residential
  - Outpatient
  - Vocational
  - Home and community programs
  - Stroke & pediatrics
- Joint Commission on the Accreditation of Healthcare Organizations (JCAHO)
  - For most hospital-based programs
  - May also have CARF accreditation

Costs of TBI

- Costs to society are two-fold:
  - Lost productivity
  - Those related to insufficient or inappropriate diagnosis, treatment, and care
- Annual costs of TBI (medical and lost productivity) are estimated at $76.5 billion
- Most families are unprepared and underinsured

Funding

Funding TBI Care

- Medical advances mean many more individuals with TBI survive
- BIAA estimates that only 5% of persons with severe brain injuries have adequate funding for long-term treatment and supports
- Funding that exists is fragmented, is not accessible by all, and is difficult to obtain
- That which is available offers time-limited treatment

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Funding

Private Funding

- Auto insurance
- Workmen’s compensation insurance
- Commercial health insurance
  - HMOs
  - PPOs
  - POS
  - HDP

Public Funding

- Medicare provides healthcare for more than 49 million low-income people
- Medicaid provides healthcare to 44 million Americans who are blind, aged 65 and older, or who have disabilities
- Patient Protection and Affordable Care Act (PPACA) of 2010

Home and Community-Based Waiver Programs (HCBS)

- Case management
- Homemaker service
- Home health aide services
- Personal care
- Adult day health
- Respite care
- Habilitation services
- Services for chronic mental illness
- Other services that help avoid institutionalization (such as assistive technology, etc.)
The Rehabilitation Act of 1973

- Set the foundation for the state vocational rehabilitation system (VR), a federal/state supported system of services, which assists persons with disabilities who are pursuing meaningful careers.
- Typically contract with private brain injury service providers for:
  - Evaluation services
  - Job development, job placement, and job coaching services.

The Olmstead Decision

- In July 1999, the Supreme Court ruled that the plaintiffs must be granted the option to live in the community.
- Uses Title II of the American Disabilities Act (ADA) to assert that states must administer their services, programs, and activities “in the most integrated setting appropriate to the needs of qualifies individuals with disabilities.”
- The decision has resulted in multiple federal and state initiatives.

Centers for Medicare and Medicaid (CMS) Waiver Renewal Requirements:

- Person-centered planning (PCP)/person-directed as an integral part of the delivery process
- PCP that supports individuals to be as independent as possible based on comprehensive assessments by professionals with experience in brain injury, and conducted as much as possible in real-life settings
- Age-appropriate services and supports
- Freedom to move about in the community
- A home-like residential setting in the community with privacy
- Services that are integrated and accessible to other public services, such as transportation and recreational venues (i.e., parks, YMCA, walking trails, church/synagogues, shopping, and adult learning classes)
- PCP that involves vocational and integrated employment goals, including volunteer work, when appropriate, or other meaningful daytime activities

Advances in Care

- 1970s: improvements in emergency medical services, medical technology, and improved auto safety
- 1980s: specialized models of brain injury rehabilitation care were initiated

Brain Injury Association of America (BIAA)

- The National Head Injury Foundation was founded in 1980.
- Evolved into the BIAA in 1995.

BIAA’s Academy of Certified Brain Injury Specialists offers training and certification to thousands of individual brain injury service providers around the world.

ADVOCACY

- Provides information and resource referrals
- Has active Media, Government Affairs, and Public Policy departments
**TBI Act of 1996**

- Single most important piece of federal legislation for persons with brain injury
- Acknowledged the incidence and prevalence of TBI nationally
- Set the stage for funding of surveillance research on TBI, effect of TBI research, and improving systems of care
- Aim: "expand efforts to identify methods of preventing traumatic brain injury, to expand biomedical research efforts, to minimize the severity of dysfunction as a result of such an injury, and to improve the delivery and quality of services"

**Gave the authority to:**

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**TBI State Grants**

- Provides federal dollars for states so that they may:
  - Strengthen the state infrastructure
  - Improve community support and services
  - Develop and evaluate model approaches to the myriad challenges in integrating TBI services into the broader service delivery system
  - Generate support from local and private sources for sustaining their efforts after the grant's completion
  - States that receive grants must use them to build infrastructure and core capacity to provide comprehensive and coordinated TBI services

**Centers for Disease Control (CDC)**

- Carries out projects to reduce the incidence of TBI
- Published TBI surveillance methods and guidelines
- Created a uniform reporting system to provide nationally representative data
- Established public education programs

**TBI Model Systems of Care (TBIMS)**

- Established in 1987 by the U.S. Department of Education’s National Institute on Disability and Rehabilitation Research (NIDILRR)
- TBIMS conducts prospective, longitudinal research to demonstrate the course of recovery and outcomes following TBI at 16 centers
- Maintains the Model Systems Knowledge Translation Center (www.msktc.org)

**Center for Outcome Measurement in Brain Injury (COMBI)**

- An online resource for outcome measures used with individuals with TBI
- NIDILRR also provided the initial funds for COMBI

**Reversing the Silent Epidemic**

- Current advances have not yet resulted in dramatically increased funding for services, basic research or prevention of brain injury
- There is continued need for:
  - Public health education
  - Funding to ensure ongoing support and services
  - Awareness about concussion
  - Epidemiological data collection
  - Brain injury screening

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Rainbow Rehabilitation Centers  9
TBI is the beginning of a chronic process which:
- Impacts multiple organ systems
- Can cause disease
- Can accelerate disease

Mortality
- Persons with a TBI have a life expectancy reduction of approximately 7 years, as compared to peers without a TBI.
- Individuals surviving a TBI are at increased risk of death (as compared to a non brain injured persons) due to multiple conditions, including:
  - Aspiration Pneumonia: 49x
  - Seizures: 22x
  - Septicemia: 12x
  - Circulatory problems: 29x

Morbidity
- Neurological conditions associated with TBI:
  - Epilepsy
  - Sleep disturbances
  - Alzheimer’s Disease
  - Chronic traumatic encephalopathy (CTE)

Neuroendocrine Disorders
- Dysfunction of the pituitary gland
  - Found in approximately 30% of persons with moderate-to-severe TBI over a year post injury

Musculoskeletal Dysfunction
- Spasticity
  - Increase in muscle tone that results in abnormal motor patterns
  - Negatively affects general functioning, mobility, and independence in Activities of Daily Living (ADL)
- Skeletal dysfunction
  - Approximately 30% of persons with TBI have post-injury fractures
  - Fractures are at risk for heterotopic ossification
Disorders Associated With TBI

- Incontinence
- Psychiatric disease
  - Psychiatric and psychological deficits are among the most disabling consequences of a TBI
- Significant long-term neurobehavioral sequelae
- Sexual dysfunction

Possible Etiologies

- Unclear if chronic damage is due to initial traumatic insult or progressive secondary injury
  - TBI may reset the cellular timer and cause early degeneration and death of cells
- Post-traumatic immune paralysis
  - In the acute period after TBI, the immune response is significantly impaired

Learning Objectives

- Be able to distinguish between treatments for migraines and those appropriate for headache secondary to head injury
- Be able to identify the specific risk to patients with depression, chronic pain, and anxiety
- Be able to describe common symptoms of concussion and the physiologic processes that underlie them

Background

Since the 1990s, mild traumatic brain injury (mTBI) has been the focus of increased study due to the prevalence of mTBI in:
- Military conflicts, specifically the wars in Iraq and Afghanistan
- Contact sports
- All states have introduced concussion laws designed to protect student-athletes

mTBI-Controversies & Challenges

- mTBI is distinct from moderate-severe TBI and should be managed accordingly
- The symptoms ascribed to mTBI may be caused by or maintained by non-brain injury phenomena
- Increased attention must be paid to these factors
History of Concussion

- First described by Hippocrates as a commotion of the brain.
- The term concussion was coined in the 16th century.
- In 1839, mTBI's physiological impact on the brain was described.
- Concussion is mild TBI or mTBI.

mTBI-Incidence

- mTBI represents 75% of all TBIs that occur in the U.S.
- The true incidence may be higher as 16-25% of those injured do not seek medical care.
- Mild/moderate/severe provides a gross description of the severity of injury at the time of injury, but does not provide a reliable prediction of future outcomes.

Definition of mTBI

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<tr>
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Definition of mTBI

- Defined by the American Congress of Rehabilitation Medicine (ACRM) as a traumatically induced physiological disruption of brain function.
- Alteration of mental state (Department of Defense).
  - Feeling dazed or confused.
  - Difficulty answering simple questions.
  - Unclear thinking.
  - Unable to describe what happened prior to or after injury.

Processes of mTBI

- After the primary cause, the following processes occur:
  - The transfer of kinetic energy into brain tissues causes metabolic alterations or direct damage to physical structures.
  - Diffuse axonal injury is the most common form of damage.
  - Axonal shearing occurs, disrupting neuronal communication.
  - Difficult to visualize with neuroimaging.
  - Massive release of the neurotransmitter glutamate.
  - High levels become toxic, impacting the amount of fuel available to the brain.
  - Constricted blood flow also impacts neurological function.

mTBI-Causes

- Primary causes:
  - Acceleration-deceleration.
  - Balking head against hard surface.
  - Blasts or explosions.

mTBI-Incidence

- mTBI represents 75% of all TBIs that occur in the U.S.
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mTBI-Second Impact Syndrome
- A rare but possibly fatal condition
- After one mTBI, the brain is significantly more affected by the neurochemical cascade of each successive injury
- Athletes younger than 24 are at the greatest risk if they return to play while still at risk neurologically

mTBI-Initial Symptoms
- Most symptoms resolve in 2-4 weeks
- Only 10-15% of people experience persistent problems after that
- Symptoms are considered non-specific
- Cognitive changes may be subtle

mTBI-Symptoms

<table>
<thead>
<tr>
<th>Physical/Somatic</th>
<th>Cognitive</th>
<th>Behavioral/Emotional</th>
</tr>
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<tbody>
<tr>
<td>Headache</td>
<td>Light sensitivity</td>
<td>Insomnia</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Noise sensitivity</td>
<td>Diminished concentration</td>
</tr>
<tr>
<td>Seizure</td>
<td>Impaired hearing</td>
<td>Poor memory</td>
</tr>
<tr>
<td>Nausea</td>
<td>Blurred vision</td>
<td>Impaired judgement</td>
</tr>
<tr>
<td>Numbness</td>
<td>Disorientation of balance</td>
<td>Slowed processing speed</td>
</tr>
<tr>
<td>Poor sleep</td>
<td>Neurological abnormalities</td>
<td>Executive dysfunction</td>
</tr>
</tbody>
</table>

mTBI-Frontal Release
- Damage to the frontal lobe can result in disinhibition and changes in behavior
- Reduced self-awareness
- Disinhibition
- Lability
- Social inappropriateness
- Physically acting out
- Depression
- Apathy

Fatigue
- Common symptom after mTBI
- Typically arises due to mental rather than physical overexertion
- Worsened by sleep difficulties
- Difficulty falling asleep or waking through the night
- Lack of restorative sleep
- Fatigue worsens memory and behavioral disturbances

mTBI-Changes in Vision
- Blurred vision due to difficulty with subtle eye movements or motor control
- Convergence insufficiency
- Eyes cannot focus effectively together
Immediately after a TBI, a rapidly progressing severe headache signals a need for medical attention.

- Most common complaint after mTBI
- Primary reason for patients seeking medical attention
- Typically occur with exertion rather than at rest

**mTBI-Headaches**

- Treated similarly to migraine, except in the acute phase of post-traumatic headache
- Felt at the top or front of head
- Hypersensitivity to light and sound
- Extra-cranial causes:
  - Occipital neuralgia
  - Trigeminal nucleus
  - Cervicalgia

**mTBI-Changes in Balance**

- Causes of Balance Issues:
  - Disorders of the inner ear, central nervous system, or musculoskeletal systems
  - Psychological issues
  - Orthostatic hypotension
  - Medication side effects
- Most common inner ear disorder after mTBI: benign paroxysmal positional vertigo (BPPV)

**mTBI-Symptom Overlap**

- Reported symptoms cannot be treated in isolation
- Prompt treatment is beneficial
  - Symptom overlap can be a significant issue after mTBI
  - Lack of sleep can trigger headache pain
  - Headache pain can interfere with sleep
  - When this becomes a never ending cycle, the individual may be at risk for depression and, in some cases, suicide

**mTBI-Education**

- Research shows that early intervention and management of mTBI is the most effective means of reducing disability
- Provide information that promotes expectations of a positive recovery and normalizes the experience
  - Promote physical safety and psychological well-being
- Guides are available
- Teach relaxation techniques to reduce emotional reactivity and improve sleep
mTBI-Physical & Mental Activity
- Standard practice calls for rest and slow resumption of normal activities as long as symptoms do not recur
- If symptoms recur, return to rest and then advance activity when symptoms have abated

mTBI-Sleep Disturbance
- Comes in many forms
- Intervention is important as good sleep can accelerate recovery
- Includes education on sleep hygiene and relaxation techniques and medications
- If warranted, a sleep study may be helpful

mTBI-Headaches and Fatigue
- Management of headaches should be done with a provider familiar with mTBI
- Treatment should be diagnosis-dependent
- Ensure the causes of fatigue are addressed
- Gradual return to normal activity and restful sleep are beneficial

mTBI-Dizziness & Poor Balance
- Physical therapy for specialized testing and vestibular rehabilitation
  - Focus on: Gaze instability, Motion sensitivity, Postural instability, Epley maneuver

mTBI-Sensory Sensitivity
- Overstimulation is common due to the brain’s slower processing (particularly vision and hearing)
- Reduce exposure to overstimulating environments
- Typically resolves shortly after injury
  - If symptoms persist, rule out optic or auditory nerve damage
**CONTROVERSY & mTBI**

**mTBI-Syndrome vs. Symptoms**

- The current preferred term is persistent post-concussive symptoms (PPCS)
- Change brought about by the unclear link of post-concussion syndrome (PCS) symptoms to brain injury and inconsistent definitions of PCS in authoritative sources
- Both PCS and PPCS refer to the persistence of symptoms weeks to months after mTBI

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**mTBI-Persistent Post-Concussive Symptoms**

- The symptoms are non-specific
- The reason for incomplete recovery from mTBI is still debated
  - Poor early intervention
  - Delay in seeking treatment, allowing other factors to influence behavior
  - Risk factors

---

**PPCS Risk Factors**

- Over age 40
- Female
- Traumatically injured
- Low socioeconomic status
- History of substance abuse
- Positive mental health history
- Pending litigation

---

**mTBI-PPCS Post-Injury Risk Factors**

- Persistent headache
- Persistent dizziness
- Persistent nausea
- Post-traumatic amnesia greater than 1 hour
- GCS of 13 or 14

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**Psychological Features and mTBI**

- Psychological conditions can create mTBI-like symptoms or worsen them in individuals who had a concussion
### Psychological Features and mTBI

<table>
<thead>
<tr>
<th>Feature</th>
<th>Common</th>
<th>Rare</th>
<th>New</th>
<th>Rare</th>
<th>Depression</th>
<th>Pain</th>
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<td>Irritability</td>
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<tr>
<td>Nausea</td>
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<td>Worry</td>
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<tr>
<td>Impaired balance</td>
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<tr>
<td>Blurred vision</td>
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### Personality and mTBI

- Somatization and secondary gain may play a role in PPCS
- Somatization is an unconscious process by which psychological distress is expressed as physical symptoms
- Secondary gain and symptom magnification may not be a fully conscious process

### Diagnosing & Treatment of PPCS

**Diagnosing**
- A neuropsychological evaluation is invaluable in determining symptom causation
- Should be considered necessary with complicated PPCS
- Neuropsychologists can:
  - Provide early intervention
  - Make recommendations for therapies
  - Monitor return to work/school
  - Treat emotional problems that arise during recovery

**Treating**
- Treatment should be:
  - Symptom focused
  - Based off careful diagnosis
  - Emphasize both functional resolution and compensatory strategies
  - Provide an optimistic outlook and clear path for the patient to improve
- Teams should be multidisciplinary

### mTBI-Repetitive Concussions

- General consensus is that there is a cumulative effect of multiple concussions
- However, some debate is ongoing
- Possible consequences:
  - Focal seizures
  - Chronic Traumatic Encephalopathy (CTE)

### mTBI-CTE

- Rare and progressive degenerative condition
- DAI causes the release of Tau proteins and chronic inflammation
- Still working to identify who is at risk for CTE after mTBI
- Most who have mTBI will not develop CTE

**THE END**