Pediatric Traumatic Brain Injury: Understanding the Challenges

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Day 1
(Understanding the Challenges)
► A primer in brain structure and function
► TBI definitional issues
► Scope of the problem
► Types of brain injuries
► Mechanisms
► Outcomes
► Training Models (Me and Brenda)
► Questions

Day 2
(Advanced Assessment)
► Definitions and models
► Specific assessment constructs and associated measurement tools
► Assessment-treatment linkages
► Case presentations
► Questions
Learning Goals

► To increase your knowledge of the definition of TBI and the scope of the problem.
► To increase your understanding of the various mechanisms that can contribute to TBI in children and adolescents.
► To expand your awareness of the range of outcomes that can be seen following a TBI.
► To provide information pertaining to an evolving evidence-based model (BrainSteps) that can facilitate school transition following a TBI.

The Brain: A Primer
The Brain

- About 3.5 pounds
- 3 day-old Jello
- Bony case surrounded by less than ¼ cup of spinal fluid

The Primary Foundation:
The Neuron

- The brain contains approximately 180 billion cells, 50 billion of which transmit and receive sensory-motor signals in the central nervous system via about 15,000 direct physical connections.
- The neuron is the basic cellular structure which transmits nerve impulses throughout a complex network of interconnecting brain cells.
- 10 billion neurons
  - Each neuron connects with others
    - average of 10,000-15,000 synapses
The Primary Foundation: The Neuron

- Neurons can be modified by experience, and they are said to learn, remember, and forget as a result of experiences.
Subcortical Structures

Limbic System

Hemispheric Specialization
Hemispheric Specialization

► The lobules are combined to form the left hemisphere and the right hemisphere.
► Despite the relative contributions to function of each lobule, there is a distinct functional specialization tied to each hemisphere.
► Although the hemispheres appear to be mirror images of each other, they are structurally and functionally distinct.

Hemispheric Specialization

► Neuroanatomically, there are key differences:
  ▪ The right frontal region is wider than the left.
  ▪ The left occipital lobe is wider than the right.
  ▪ The left planum temporale is larger than the right by as much as 10 times.
  ▪ The angular gyrus in the left hemisphere is larger than in the right.
► The shape of the sulci and gyri also may be different on the two sides of the brain.

Hemispheric Specialization

► Neurochemically, there also are key differences:
  ▪ More norepinephrine receptors in the right thalamus than the left (perhaps responsible for orienting the individual).
  ▪ More dopamine receptors in the left globus pallidus than in the right (perhaps responsible for action readiness).
Hemispheric Specialization

► Broca's case studies (circa 1860) suggesting that language processing (e.g., speech) was localized to the left hemisphere.
  ▪ “Tan-Tan”
► Wernicke had similar cases documenting receptive language problems.
► John Hughlings Jackson (circa 1860) introduced the concept of the “cerebral dominance, related to language being housed in the left hemisphere.

Hemispheric Specialization

► Split-Brain Syndrome
  ▪ Roger Sperry (1974) surgical cases for epilepsy control.
► Utilizing the split-brain procedure, wherein the corpus callosum was severed to control for severely uncontrolled seizures, the communication between the hemispheres was terminated at the cortical level.

Hemispheric Specialization

► These commissurotomies offered the opportunity to study the functional significance of each hemisphere separately.
► Discovered the left hemisphere to be specialized for language functioning, particularly speech output.
► Discovered the right hemisphere to be specialized for visual-spatial/nonverbal functions.
Left Hemisphere Specialization

- Expressive speech
- Receptive language
- Language (general)
- Complex motor
- Vigilance
- Paired associate learning
- Analysis of detail
- Reading
- Writing
- Arithmetic
- Finger naming
- Sequential processing
- Temporal analysis

Right Hemisphere Specialization

- Spatial orientation
- Simple language comprehension
- Nonverbal ideation
- Spatial processing
- Creative thinking
- Face recognition
- Nonverbal perception
- Nonverbal paired associate learning
- Simultaneous processing
- Intuition
- Humor
- Affect recognition
- Affect production

Hemispheric Specialization

- 95% of right handers have speech in left hemisphere.
- 70% of left handers have speech in left hemisphere.
- Lateralization does not develop.
- Lateralization of function may provide clues to information processing organization and difficulties (e.g., dichotic listening).
Lurian Theory

Three major units of the brain:
- Unit 1 - Comprises the brain stem and largely concerned with basic arousal.
- Unit 2 - Comprises the temporal, parietal, and occipital lobes and largely concerned with information input.
- Unit 3 - Comprises the frontal lobes and largely concerned with information output.

Lurian Theory

Functional systems
- Complex human functions cannot be reduced to specific brain structures

Zones of proximal development
- Primary, Secondary, and Tertiary
  - Primary and Secondary zones are unimodal
  - Tertiary zones are multimodal

Developmental features to the zones:
- Primary (birth to 12 months), Secondary (birth to 5 years), and Tertiary (5 through adulthood)
- Rehabilitation guidance
Definitional Issues:

What is a TBI?

National Brain Injury Association

Traumatic Brain Injury (TBI) is defined as 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 or physical functioning. It also can result in the disturbance of behavioral or emotional functioning. These impairments may be either temporary or permanent and cause partial or total functional disability or psychosocial maladjustment. Acquired Brain Injury (ABI) is an injury to the brain that is not hereditary, congenital or degenerative (e.g. stroke, anoxia).

National Institutes of Health

► Traumatic Brain Injury (TBI) occurs when a sudden physical assault on the head causes damage to the brain. The damage can be focal–confined to one area of the brain, or diffuse–involving more than one area of the brain.
Pennsylvania special education definition mirrors federal definition (as do most states)

Traumatic brain injury is:
- An acquired injury to the brain;
- Caused by an external physical force;
- Resulting in total/partial disability or psychological impairment, or both, that adversely affects a child’s educational performance;

The term applies to open or closed head injuries, resulting in impairments in one or more areas such as:
- Cognition, language, memory, attention, reasoning, abstract thinking, judgment, problem solving, sensory, perceptual, and motor abilities, psychological behavior, physical functions, information process, and speech.
- The term does not apply to brain injuries that are congenital or degenerative, or brain injuries induced by birth trauma.

A Note in the NC Guidelines:
“Those students with non-traumatic brain injury (e.g., tumor, vascular/circulatory disorders, degenerative diseases, etc.) should be considered for assessment as outlined above.”
Scope of the Problem

► Individuals who have sustained a TBI face many challenges as they attempt to reintegrate into their communities.

► These challenges can include:
  - Physical problems (e.g., mobility)
  - Cognitive problems (e.g., memory)
  - Social difficulties (e.g., problems with regulation of affect)
  - Family adjustment issues

Scope of the Problem

► With approximately 75-80% of TBIs being relatively mild in nature, these challenges also can include:
  - Lack of appropriate screening or recognition of the potential problems associated with TBI.
  - Lack of understanding of the dynamics of TBI on the part of the caregivers and/or service providers (e.g., schools, vocational settings).
  - Insufficient education and support of the individual and family.
Scope of the Problem

► All of these challenges, if not successfully addressed, can contribute to:
  ▪ Poor outcomes
  ▪ Unnecessary frustrations
  ▪ Potentially increased morbidity for the individual and family.
► Programmatic efforts to address these needs are warranted.

Scope of the Problem

► Approximately 1.7 million people sustain a TBI annually.
► Approximately 1.4 million are treated and released from hospital emergency departments for TBI each year.
► Another 275,000 are hospitalized and survive, with about 80,000 sustaining some type of long-term disability.
► Approximately 52,000 die following a TBI.
► The number of people who sustain a TBI and receive no medical care is unknown.

Scope of the Problem

► Of all pediatric injury cases in the United States, about one-quarter are related to brain injury.
► Approximately 500,000 children, ages birth to 14 years, go to emergency departments for a TBI.
► Traumatic brain injury is the most frequent cause of death and disability in children and adolescents (over 41% of all child deaths).
► Over 30,000 children have permanent disabilities following a TBI.
Scope of the Problem
► There are over 500,000 new child and adolescent cases each year.
► This translates into about 1 in every 500 students.
► Peak incidence is between ages 15-24.
► Mild injuries likely are under-reported, and we are only beginning to establish incidence rates for shaken baby syndrome.

Scope of the Problem
► Falls are the leading causes of brain injury in children and the elderly, accounting for about 50% of all TBI's for children ages birth to 14 years.
► Motor vehicles crashes and traffic related incidents are the second leading causes, and the leading causes of TBI-related deaths.
► About 25% of children also sustained a TBI from colliding with moving or stationary objects
  • Sports related injuries (e.g., amateur boxing, football, soccer, horseback riding).
► Causes of TBI vary by age.
► Outcomes vary greatly depending on the cause (e.g., firearms vs. falls).
Scope of the Problem

► The risk is highest among adolescents, young adults, and those younger than 5 and older than 75.
► Males are more than twice as likely as females to sustain a TBI, with a rate of about 59%.
► If recovery is not allowed to occur after one brain injury, the risk for a second injury is three times greater.
► If recovery is not allowed to occur after the second injury, the risk for a third injury is eight times greater.

Scope of the Problem

► For inflicted TBI or Abusive Head Trauma (e.g., shaken baby syndrome):
  ▪ 53% rate of inflicted vs. non-inflicted TBI
  ▪ 17/100,000 per year resulted in death
  ▪ Children < 1 year of age had a higher rate of inflicted TBI (30/100,000 per year) than children age 1-2 years (4/100,000)
  ▪ Boys 21/100,000) had higher rates of inflicted TBI than girls (13/100,000)
► The leading cause of child abuse deaths in the US.
Scope of the Problem

- Median age of inflicted TBI was 4 months compared to 7.5 months for non-inflicted TBI
- Children with inflicted TBI were more likely:
  - To have young mothers (< 21 yrs. Old)
  - To be non-white
  - To be male
  - To be the product of multiple births

Scope of the Problem

- Estimated health-related costs are nearing $60 billion annually.
- Unstated costs to individuals, families, and society.
- Taken together, TBI is one of the most critical areas for health care in the United States.

Types of TBI and Mechanisms
Different Types of Brain Injuries

**Acquired Brain Injuries**

**Traumatic Brain Injuries**
- Penetrating
- Nonpenetrating

**Other Brain Injuries:**
- Congenital brain injuries
- Strokes
- Hydrocephalus
- Tumors
- Multiple Sclerosis
- Brain infections
- Toxic substances

Penetrating versus Non-Penetrating Brain Injuries

- Penetrating (Open) Head Injuries
  - Depressed skull fractures
  - Crushing Injuries
- Nonpenetrating (Closed) Head Injuries
  - Acceleration injuries (i.e., a stationary brain suddenly accelerates)
  - Deceleration injuries (i.e., a moving brain suddenly stops)
    - Acceleration and deceleration forces also can cause coup-contra coup, contusions (bruising), and hematomas (bleeds).
  - Torquing/Rotational injuries (i.e., a brain is twisted on the brain stem)
  - Diffuse Axonal Injury (shearing and tearing of axons)

Penetrating versus Non-Penetrating Brain Injuries

- One myth is that a penetrating brain injury is worse than a non-penetrating injury.
- The fact are that:
  - One is not necessarily worse than the other.
  - Many non-penetrating injuries may go undetected, especially if there was no loss of consciousness.
  - In many non-penetrating injuries, brain edema (swelling) may occur, perhaps resulting in greater brain damage than what might be expected from some penetrating injuries.
Types of Damage in a Closed Head Injury

Abusive Head Trauma

- aka Shaken Baby Syndrome
- This is an “inflicted” brain injury from shaking a baby excessively
  - Causes include abuse (shaking) or non-abuse actions (e.g., tossing a baby in the air before they are ready, jogging with a baby).
- Three major components to a diagnosis (Shaken Baby Triad):
  - Subdural hematomas
  - Retinal hemorrhages
  - History of injury

PRIMARY INJURIES

Coup-Contra Coup

Coup

Contra-Coup

Compression Fracture

Subdural veins torn at base — rotates forward

Subdural veins torn at base — rotates forward

Swelling of brain stem

Shearing strains throughout the brain

Damage to frontal, temporal lobes

brain convex bones at skull base
TBI Severity

- There are two key components to understanding the severity of a TBI:
  - Altered consciousness
  - Structural damage

Degree of Altered Consciousness

- **Concussion/Coma**
  - Glasgow Coma Scale: This is a quick measure assessing the individual’s best eye, motor, and verbal response shortly after injury.
  - Scores range from 3 to 15.
    - Mild = 13-15
    - Moderate = 8-12
    - Severe < 8

- **Post-Traumatic Amnesia (PTA)** – This is determined by the length of time it requires an individual to regain continuous memories for daily events after they have regained consciousness.
Structural Damage
- Skull fractures (depressed vs. nondepressed)
- Contusions (bruising)
- Hematomas and hemorrhages (bleeding)
- Diffuse Axonal Injury (DAI)
  - Shearing
  - Twisting
  - Tearing

Diffuse Axonal Injury
Rotational forces on the brain cause the stretching and snapping of axons.
Hematoma

Secondary Medical Complications

- Anoxia/Hypoxia/Ischemia
- Cerebral atrophy and ventricular enlargement
- Post-traumatic epilepsy
  - About 5%-7% rate
  - Children more likely to show early post-trauma seizures than adults

More Secondary Injuries

- Hydrocephalus (enlarged ventricles)
- Intracerebral Hemorrhage
- Edema (swollen brain tissue)
Secondary Medical Complications

► In more severely injured patients:
  ▪ Deep Vein Thrombosis
    ▪ Incidence as high as 54%
    ▪ First sign often sudden death
    ▪ Look for swelling in affected limb
  ▪ Neurogenic heterotopic ossification that contributes to joint pain and decreased range of motion in about 10% to 20% of patients, typically those with decreased mobility and/or lengthy coma.
  ▪ GI and GU complications (e.g., bowel and bladder dysfunction)

TBI Severity: Moderate/Severe TBI

► Moderate level of severity
  ▪ Loss of consciousness for < 24 hours
  ▪ Typically associated with skull fractures, contusions, hemorrhage, or focal damage
  ▪ Significant disruption of functioning
► Severe level of severity
  ▪ Loss of consciousness > 24 hours
  ▪ Typically associated with identifiable structural damage
  ▪ Multiple cognitive, communicative, physical, social, emotional problems
  ▪ Most survivors have life long changes

TBI Severity: Mild TBI (mTBI)

► A mild TBI reflects a lesser degree of severity, with a loss of consciousness being brief or non-existent
► Early symptoms of a mild TBI may include:
  ▪ Headaches*, blurred vision, dizziness, nausea, vomiting, agitation, drowsiness, seizures, attention disruption,* increased irritability.
► Many symptoms tend to resolve in most individuals within 6-12 months.
TBI Severity: Mild TBI (mTBI)

► Many go undiagnosed and unrecognized!
► Even in a mild TBI, the symptoms should not be ignored.
► Neuroimaging procedures typically do not find neurological damage, but the multiple microscopic injuries can lead to significant neuropsychological and neurobehavioral impairments.

TBI Severity: Mild TBI (mTBI)

► A mTBI also referred to as a concussion.
► A concussion is a type of mTBI caused by a bump, blow, or jolt to the head, or even a blow to the body that causes the head to move rapidly, that can change the way the brain works.
► Most concussions occur without a loss of consciousness, and typically are not life threatening, but they can cause significant impairment.

TBI Severity: Mild TBI (mTBI)

► Concussion signs and symptoms include ANY changes in behavior such as:
  ▪ Cognitive impairments (e.g., reduced attention, sluggish processing speed, diminished memory).
  ▪ Physical symptoms (e.g., headaches, blurry vision, diplopia, dizziness, balance problems, sensory sensitivity, fatigue).
  ▪ Emotional symptoms (e.g., irritability, anxiety, more volatility).
  ▪ Sleep difficulties (e.g., more or less sleep, trouble falling asleep).
  ▪ Not “feeling like themselves.”
TBI Severity: Mild TBI (mTBI)

- Persistent symptoms following the concussion is often referred to as Post-Concussive Syndrome.
- There are raising concerns that cumulative neurological damage will occur from subsequent concussions even if separated by months or years.
  - Pugilistic dementias
  - Reports of aging professional football players

Grades of Concussion

- Grade 1:
  - Transient confusion;
  - NO loss of consciousness;
  - Concussion symptoms clear in less than 15 minutes
- Grade 2:
  - Transient confusion;
  - NO loss of consciousness;
  - Concussion symptoms or mental status abnormalities last longer than 15 minutes
- Grade 3:
  - Any loss of consciousness, either brief (seconds) or prolonged (minutes).
  - Permanent brain injury can occur with either Grade 2 or Grade 3 concussions. It is suspected that subtle brain injury can have permanent consequences if the acute symptoms of the concussion continue for more than 15 minutes.

TBI Severity: Mild TBI (mTBI)

- Another condition associated with mTBI is Second Impact Syndrome.
- Second Impact Syndrome refers to the situation in which an individual sustains a second concussion before the symptoms from the first have resolved.
  - This results from acute brain swelling that occurs when the second concussion is sustained and causes vascular congestion and increased intracranial pressure that may be difficult to control.
- A second brain injury, or cumulative concussions, can be more dangerous than the first one and potentially life threatening.
  - It also may take less of a blow to the head to cause a subsequent concussion AND it may take longer to recover.
TBI Severity: Mild TBI (mTBI)

▶ A mTBI can occur from any type of blow to the head, but there is a strong relationship to sports-related injuries.
▶ There are an estimated 300,000 sports-related mTBIs.
▶ Although a mTBI can occur in any sport, they tend to occur more frequently in contact sports such as football, hockey, soccer, boxing, etc., but they also can occur in non-contact sports (e.g., horseback riding).
  ▪ 10% of all high school athletes in contact sports will sustain a concussion each year.
  ▪ 2nd leading cause of TBI in ages 15-24 behind motor vehicle crashes

TBI Severity: Mild TBI (mTBI)

▶ The relationship of mTBI to sports injuries has contributed to significant policy changes in how athletes are managed at all levels of play from preschool to professionals.
▶ These policy changes have included how medical management occurs on the field of play, examination of return to play guidelines, prevention strategies and improvements in equipment, and public laws to govern high school sporting activities.

TBI Severity: Mild TBI (mTBI)

▶ At present, there are 35 states that have enacted youth sports concussion-related laws and 8 more are pending.
▶ These laws typically address:
  ▪ TBI education for coaches
  ▪ Removal from play guidelines
  ▪ Return to play guidelines that include evaluation from an appropriate health care professional
  ▪ Development of tracking mechanisms to monitor symptoms
  ▪ Increase awareness of concussions for parents and student athletes
▶ Important to note that few, if any of these plans provide direct linkages back to the classroom setting.
TBI Severity: Mild TBI (mTBI)

- The Pennsylvania Safety in Youth Sports Act was passed this fall and will go into effect on July 1, 2012.
- This Act establishes standards for managing concussions and traumatic brain injuries to student athletes, with assigned responsibilities to the Departments of Health and Education.
- Three major areas of focus in the law:
  - Educational materials for athlete, parents, and coaches;
  - Annual informational meetings;
  - Emergency action and removal of play;
  - Postconcussion protocol implementation, and clearance/return to play or practice guidelines;
  - Annual concussion training for all interscholastic coaches.

Brain Functions Disrupted by TBI

Simplified Brain Behavior Relationships
Neurocognitive Functions and Related Domains

- Motor
- Sensory perceptual
- Attention
- Language
- Visual processing
- Memory and learning
- Executive functions
- Related domains
  - Intellectual
  - Achievement
  - Adaptive behaviors
  - Social-emotional
  - Family
  - School environment

Medical/Physical Outcomes

- Physical stamina can be less
- Motor dysfunction or deficits (hemiplegia)
- Endocrine Disorders
  - Hormonal
  - Pituitary
  - Thyroid
- Speech impairments
- Headaches
- Seizures (within 2 years of injury)

Medical/Physical Outcomes

- Vision problems
  - Diplopia (i.e., double vision)
  - Reduced visual acuity/blindness
  - Field cuts
  - Field neglect
- Hearing
  - Sensorineural hearing loss
  - Conductive hearing loss
  - Loss of smell or taste
**A Note on Smell and Taste**

- Smell disorders occur at about an 8% rate following a TBI, but the rate increases with severity.
  - The loss of smell can be partial, complete, lateralized, or specific.
- Taste disorders are rare. Typically, if a taste disorder is reported, it is usually related to an olfactory disorder.
  - The loss of taste can be ipsilateral or bilateral, depending on the injury.
  - These disruptions can lead to a total loss of taste (ageusia), diminished taste (hypogeusia), or various types of disorted tastes (e.g., dysgeusia).

**Medical/Physical Outcomes**

- May require specialized equipment that will be foreign to schools, friends, work sites, etc.
- May require pharmacological agents for problems with behavior, attention, seizures, bowel/bladder, headaches, spaticity, and emotions.
- These medications also may create negative synergistic effects.

**Neurocognitive Outcomes**

- Declines in general intelligence—especially nonverbal abilities.
- Slowed response speed and processing.
- Cognitive fatigue and attention/concentration deficits.
- Language and visual deficits.
- Deficits in memory and new learning.
- Problems with executive functions.
School/Vocational Outcomes
► Problems initiating and completing work
► Slowed work pace
► Increased impulsivity
► Trouble navigating physical surroundings, especially in new settings (e.g., motor limitations, spatial deficits)
► Decreased productivity

School/Vocational Outcomes
► Confusion and increased stress
► Resistance to change—even if routine
► Trouble with maintenance and generalization, especially new learning
► Distractible and poor task persistence
► May resent special assistance—even if in denial

Social-Behavioral Outcomes
► In general, the presence of an acquired brain injury places individuals at greater risk for developing a new psychiatric disorder (about 5 times expectancies)
► Loss of friends and social circles
► Increased affective problems and their regulation
► Increased impulsivity
► Increased agitation
Social-Behavioral Outcomes

► Denial, poor perspective taking, or increased awareness of deficits
► Secondary problems (e.g., family, lowered self-esteem)
► At-risk for substance use/abuse (which, in turn, will slow the neurological recovery process)

Social-Behavioral Outcomes

► Comparison by survivor/others to preinjury level of functioning
► Poor understanding of TBI and recovery
► Premature return to school/work.
► Unrealistic predictions
► Tendency to use disability

Predictors of Outcome

► Key variables for recovery include:
  ▪ Premorbid functioning levels
  ▪ Nature and severity of TBI
  ▪ Degree of Post-Traumatic Amnesia (PTA)
  ▪ Chronological age at time of injury
► Constant medical, developmental, psychological, vocational, and academic vigilance is required over the course of recovery (i.e., recovery curves)
Factors Influencing Outcome

► Age at Time of Injury
  ▪ Younger children may be at greater risk for subsequent learning difficulties
  ▪ These difficulties may be seen in the loss/change of functions, but also in recovery
  ▪ Recovery depends on the capacity of the developing brain to evolve alternate coping strategies

Factors Influencing Outcome

► Type of injury (penetrating versus nonpenetrating; localized versus generalized damage)
► Medical complications (brain edema, post-traumatic seizures, intracranial pressure)
► Injury severity (duration of PTA, depth of coma)—seems to hold the most weight with respect to prognosis for recovery

Factors Influencing Outcome

► Rate of Recovery—generally, the faster the better; however...
  ▪ early rapid recovery is not a clear indication that long-term recovery will continue rapidly and be complete
► Premorbid functioning (e.g., the presence of pre-injury difficulties in the child and/or family)
► Demographic features
  ▪ Gender does not influence recovery
  ▪ SES does not influence recovery (directly), although clinical intuition may suggest otherwise
  ▪ Family functioning is critical
Rates of New Psychiatric Disorder

Long-Term Outcomes

- **Mild TBI 1 year post injury:**
  - Frequent headaches of varying severity
  - Attention disruption
  - Inconsistent regulatory functions

- **Moderate/Severe TBI 2 years post injury, one-half to three-quarters showed:**
  - Memory problems
  - Fatigue (physical and cognitive)
  - Word-finding difficulties
  - Impaired speed of processing
  - Impaired attention and concentration
  - Depressed mood
  - Irritability

Recovery Mechanisms

- Recovery of brain function is thought to occur by several mechanisms:
  - **Diaschisis** - Depressed areas of the brain that are not injured, but linked to injured areas begin functioning again, perhaps secondary to resolving edema
  - **Plasticity** - The function is taken over by a part of the brain that does not usually perform that task
  - **Overlearning** - Redundancy in the function performed so another area of the brain takes over
  - **Behavioral substitution** - The individual learns new strategies to compensate for deficits
Prognosis: General Principles
► Although depth of coma is the best predictor of mortality, length of coma and PTA are better predictors of outcome.
► The severity of damage also is correlated with outcome (e.g., bilateral damage is more likely to result in impairment than unilateral damage).

Prognosis: General Principles
► The age of injury also appears critical.
► There is tremendous variability in recovery patterns.
► Consequently, early prognosis always must be viewed as tentative!

Summary
► TBI is one of the leading health problems in our country, particularly for children.
► Need to know about the dynamic nature of TBI, particularly in acute cases.
► While recovery can and does occur, developmental trajectories and associated functions can be significantly altered.
► Requires knowledge of TBI mechanisms, the range of problems, and a detailed assessment to identify ongoing issues and needs.
  • 90% of school psychologists did not feel adequately trained to assess or intervene with students with a TBI.
Training in North Carolina

► Three didactic workshops
  ▪ 12 hours of training devoted to an introduction to mechanisms, characteristics, and issues
  ▪ 12 hours of advanced assessment strategies
  ▪ 12 hours of treatment issues and techniques
► Case supervision by a neuropsychologist
  ▪ 30 hours of group and/or individual case work
► Registry of Approved Providers and CEUs

BrainSTEPS