

Heads Up!

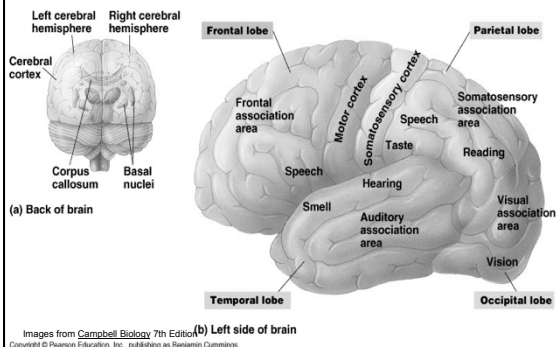
Richard Beebe MS RN NRP
MedicThink LLC

Fall of a Teton

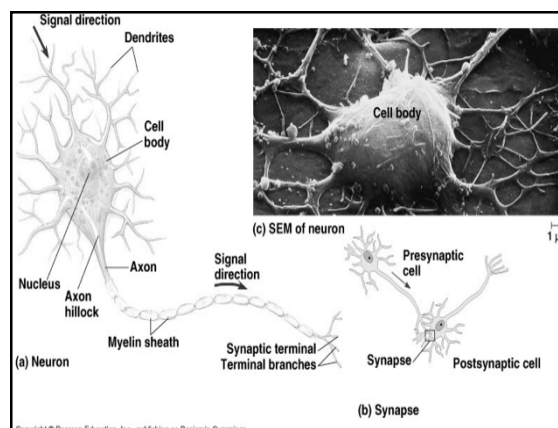


Cerebrum has different areas for different functions

Four lobes: Frontal, Parietal, Temporal, Occipital
Left & right hemispheres: connected by the Corpus callosum



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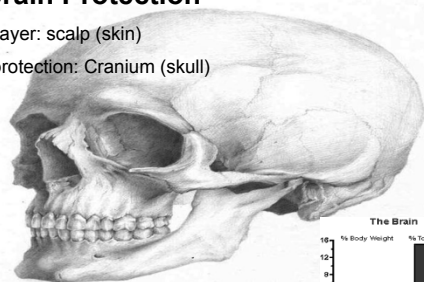


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The Brain Needs lots of TLC: Protection and Nutrition

Brain Protection

1. Outer layer: scalp (skin)
2. Bony protection: Cranium (skull)



3 Specialized coverings called Meninges:

- Dura Mater- outermost
- Arachnoid Layer- middle
- Pia Mater- innermost



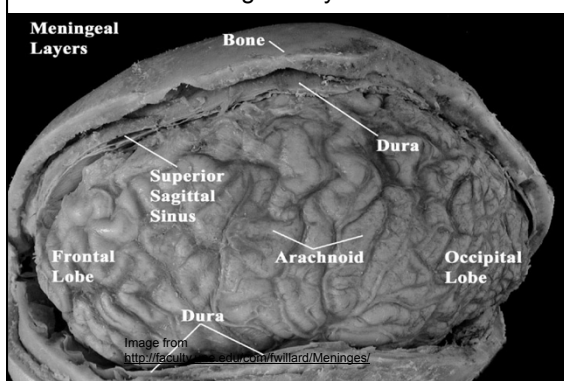
Here's a good way to remember the order of the meninges (innermost to outermost): The meninges PAD the brain.
www.washington.edu/chudler/meninges.html

Foramen magnum:

Opening at base of cranium (occipital bone) where the medulla oblongata extends, and nerves & blood pass into and out of the brain.

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Check out the Meningeal Layers in a REAL brain!

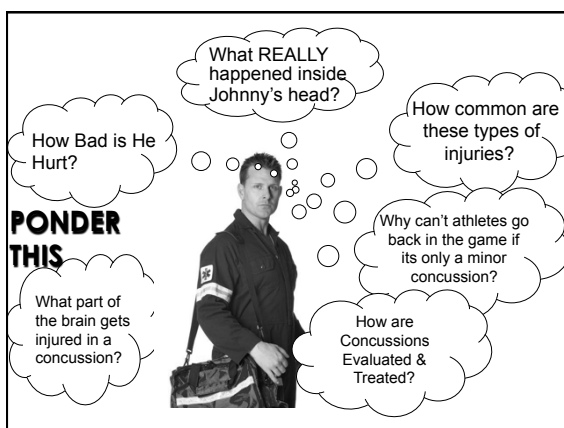


Brain Nutrition

The diagram shows a heart connected to the brain and the rest of the body. A bar graph titled 'The Brain' compares the brain's weight and blood supply to the rest of the body. The y-axis is labeled '% Body Weight' and '% Total Blood'. The x-axis has two categories: 'Body' and 'Brain'. The 'Body' bar is at 2% for both weight and blood supply. The 'Brain' bar is at 2% for weight and 15-20% for blood supply.

- Deep and superficial blood vessels → BRAIN
- Brain is 2% of the total body weight in humans
- Brain receives 15-20% of body's blood supply
- Brain's blood supply stops = brain cell death
- Brain has top "blood priority" over all organs
- Blood vessels reach the brain through the cranial foramina (labeled with red arrows).

Images and information from www.faculty.washington.edu/chudler/vessel



What Is Mild Traumatic Head Injury?

The term, *mild traumatic head injury (MTHI)* has been applied to patients with certain types of head injuries for many years.

MTHI is commonly referred to as *concussion or mild traumatic brain injury* - the terms are used interchangeably.

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Common Features of MTHI

Most definitions of MTHI include the following elements:

- Involves an impact to, or forceful motion of, the head that results in a brief alteration of mental status such as:
 - confusion or disorientation
 - memory loss immediately before/after injury
 - brief loss of consciousness (if any) less than 20 minutes
- Glasgow Coma Scale score of 13 – 15
- If hospitalized, admission is brief
 - (e.g., less than 48 hours)
- Possible amnesia – while amnesia does not need to be present, it is a good predictor of brain injury

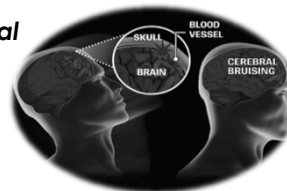
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MTHI vs. Traumatic Brain Injury (TBI)

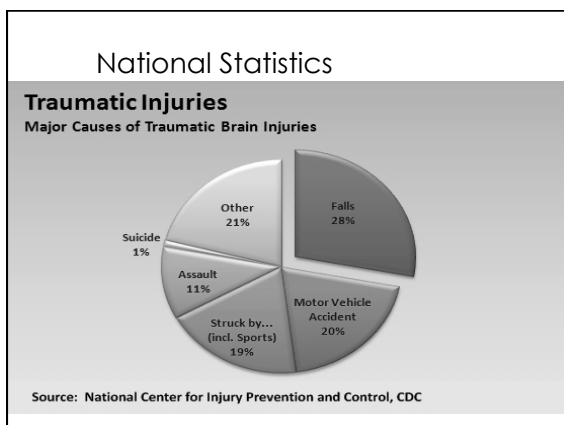
In MTHI, the brain temporarily becomes functionally impaired

without structural damage.

TBI, there is structural damage to the brain.



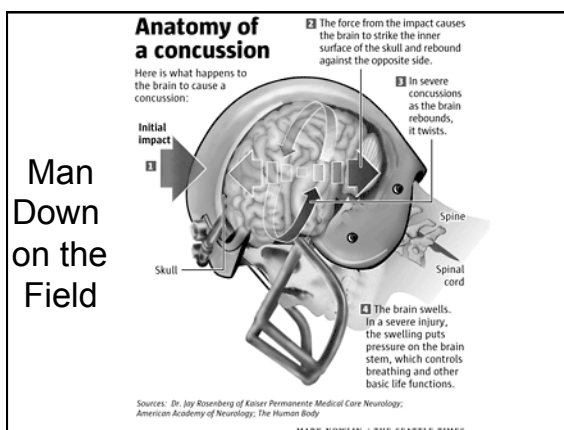
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Epidemiology

Sports rate of concussions/1000 athlete-exposures

Ice hockey	0.27
Football	0.25
Men's soccer	0.25
Women's soccer	0.24
Field hockey	0.20
Wrestling	0.20
Men's lacrosse	0.19
Women's softball	0.11



Focal/Diffuse Injuries

Brain injuries can be classified as focal or diffuse

When an injury occurs at a specific location, it is called a **focal** injury (e.g., being struck on the head with a bat). A focal neurologic deficit is a problem in a nerve function that affects a specific location or function. Examples: Numbness, decrease in sensation, Paralysis, weakness, loss of muscle control

In **diffuse** injury, the impact is spread over a wide area, such as being tackled in a game of football that results in a general loss of consciousness

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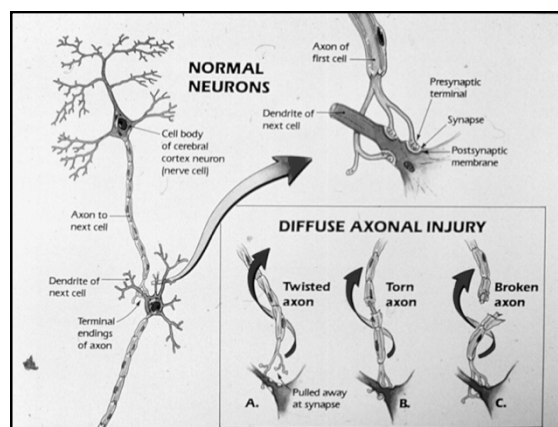
Simple and Complex Injury

Brain injury can be classified as simple or complex based on clinical presentation.

- o Simple: symptoms resolve in 7-10 days
- o Complex:
 - Symptoms persist longer than 10 days
 - Multiple concussions
 - Convulsions, coma or loss of consciousness (LOC) greater than 1 minute
 - Prolonged cognitive impairment

Meehan 2009

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Acceleration/Deceleration

Forces causing abrupt changes in the speed or motion of the brain within the skull are called acceleration or deceleration.

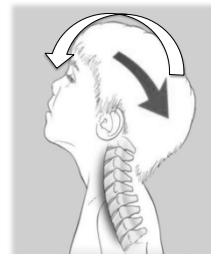
- o The movement of the skull through space (acceleration) and the rapid discontinuation of this action when the skull meets a stationary object (deceleration) causes the brain to move at a different rate than the skull.
- o Different parts of the brain move at different speeds because of their relative lightness or heaviness.
- o The differential movement of the skull and the brain when the head is struck results in direct brain injury.
- o Acceleration - Deceleration injuries can be caused by linear as well as rotational impact. Traumatic Brain Injury.com

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Acceleration

- o Direct blow to the head
- o Skull moves away from force
- o Brain rapidly accelerates from stationary to in - motion state causing cellular damage

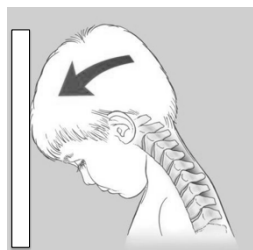
*Newtonian Law
For every action there is an
equal and opposite reaction*



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- o Head impacts a stationary object (e.g., car windshield)
- o Moving skull stops motion almost immediately
- o However, brain, floating in cerebral spinal fluid (CSF), briefly continues moving in skull towards direction of impact, resulting in significant forces that damage cells

Deceleration



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Children vs. Adults

Children have greater disposition to head trauma:

- o Greater head mass relative to body weight ratio making them top-heavy
- Neck musculature has not been developed to handle relatively heavier structure
- Increased head weight results in increased momentum during falls or injuries
- o Brain area has more fluid: more susceptible to wave-like forces
- o Less myelination
- o Thinner cranial bones more easily shattered

Fuchs 2001

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Short Vertical Falls: Incidence

Frequently, parents/caregivers bring their young children to the ED for an evaluation with a history of a short vertical fall (defined as 1.5 meters/5 feet in height).

An extensive review of the literature showed that short falls account for **less than 0.48 deaths per 1 million** young children (0-5 years of age) per year.

Remember: Suspect and evaluate for child maltreatment if a short vertical fall history does not match the severity of the injuries.

Chadwick 2008

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Infants & Toddlers



- o Limited head control
- o Open fontanels mean less brain protection
- o More susceptible to seizures than older children
- o Emerging motor and expressive language skills at risk for regression
- o Synaptic connections become interrupted resulting in decreased functional processing
- o Focal injuries may have better outcome
- o **Common mechanisms include: falls, child maltreatment, and motor vehicle collisions.**

Sellers 1997; National Research Council 2000; Savage 1994¹

Elementary & Middle School Students



- o Functional and developmental risk
- o Connections between the two hemispheres of the brain and within each hemisphere may become less efficient
- o Brain injury during this time period may interrupt development of critical cognitive and communication skills

Common mechanisms include: falls, sports, child maltreatment, bicycle injuries, motor vehicle collisions, and pedestrian-motor vehicle collisions.

Sellers 1997; National Research Council 2000; Savage 1994

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High School Students



- o Functional and developmental risk
 - o Damage to cellular myelination of the frontal lobes may reduce creation of efficient connections that facilitate development of logical thinking and ability to solve complex problems
 - o Psychosocial effects of brain injury such as slower response to stimuli threaten adolescent's sense of self (Bubba syndrome)
- Common causes include: motor vehicle collisions (due to lack of driving experience) and sports injuries (due to increased participation). A marked increase in alcohol and/or substance abuse, predisposition to greater risk-taking behaviors, and greater exposure to violence can lead to more injuries.

In all age groups, child maltreatment is a potential cause. Sellers 1997; National Research Council 2000; Savage 1994

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School of hard knocks

A concussion occurs when a violent blow to the head causes the brain to slam against the skull beyond the ability of the cerebrospinal fluid to cushion the impact. Between 1996 and 2001, NFL teams reported nearly 900 concussions.

- 1 When a football player takes a hit to the head, speeds range from 17 to 25 miles per hour with a force averaging 90 times the force of gravity.
- 2 The shock wave passes through the brain and bounces back off the skull. The concussion usually occurs at the opposite side from the point of impact.
- 3 The impact can cause tearing of the brain, tearing of blood vessels and nerve damage.

A study commissioned by the NFL revealed most hits occurred from a blow to the side of the head, often on the lower half of the face.

Symptoms

Immediate

Confusion

Amnesia

Loss of consciousness

Ringing in the ears

Nausea and vomiting

Convulsions

Delayed

Irritability

Headaches

Depression

Sleep disorders

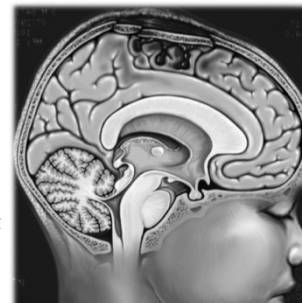
Poor concentration

Trouble with memory

Source: MayoClinic.com; Biomedicine; Washington Post, Science Daily; KidHealth.org; Author Permission

Andrew Lucas, Jeff Gortman | The Denver Post

Assessment of the Pediatric Head Injury (with a Pediatric GCS Primer)



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Primary Assessment

- o Begin your immediate assessment by following the ABCs:
 - ✓ LOC
 - ✓ Airway
 - ✓ Breathing
 - ✓ Circulation
- o Always consider the possibility of cervical spinal injury.
- o Determine the child's orientation to people, place, and time.
- o Perform a test of recent memory - does the child remember events just before injury?

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History

A detailed history is critical in assessing MTHI. Consider:

- o Symptoms
 - o Severity and Mechanism of Injury
 - o Was injury witnessed by a reliable person?
- o Medical history:
 - ✓ Allergies
 - ✓ Medications (SHOPS)
 - ✓ Past illnesses /hospitalizations
 - ✓ Last head injuries
- o Events preceding
 - ✓ Time of injury
 - ✓ Emesis
 - ✓ Loss of consciousness / Amnesia

Fuchs 2001



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Mental Status is AVPU!!

AVPU is a quick test used to determine level of consciousness. It measures the reaction of the eyes, voice and motor activity in response to stimuli. In the scale, **A**lert represents the level of least injury and **U**nresponsive the most severe.

Alert: fully conscious; may be *mildly* disoriented

Voice: responds to verbal stimuli

Pain: responds only to pain stimulus

Unresponsive: unconscious

AVPU is *not* a replacement for the Glasgow Coma Scale.

McNarry 2005

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Glasgow Coma Scale (GCS)

An accurate, commonly used, and easily reproducible tool

- o Commonly used neurologic assessment tool for trauma patients since its development by *Jennett and Teasdale* in the early 1970s
- o Is an accurate measure for trauma care practitioners to document level of consciousness over time
- o Commonly used in adults - more recently used in children (Pediatric GCS score)

Sternbach 2000

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Pediatric GCS Score Scenario 1

A 3-month-old female is brought to the emergency department by her father with a history of "not acting right" since falling out of her crib two days ago. You note multiple bruises are on the child's face and rapidly complete the assessment and treatment in the trauma room.

Eyes: The child's eyes remain closed during painful stimuli.

Motor: The child withdraws both arms during IV access.

Verbal: The child is grunting.

What PGCS score you would assign for each component for this patient?

Click the Answer button below to see how we scored the patient.

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Eyes	1
Motor	4
Verbal	2
Total	7

Answer

33

Pediatric GCS Score Scenario 2

A 6-year-old male is brought into the emergency department fully immobilized by paramedics who report that he was a restrained front seat passenger. There was intrusion into the driver's side of the car only. His left forearm is swollen.

Eyes: The child opens eyes to his name being called.

Motor: The child withdraws his right arm when his blood pressure is taken.

Verbal: The child cries when his swollen forearm is touched.

What PGCS score would you assign for each component for this patient?

Click the Answer button below to see how we scored the patient.

34

Eyes	3
Motor	4
Verbal	3
Total	10

Answer

34

Pediatric GCS Score Scenario 3

A 3-year-old female is brought to the emergency department by her mother who claims that her child is lethargic after being pushed down by her 5-year-old brother (fighting over a toy). The mother states the red mark on her daughter's forehead is where she landed head first on the tile floor.

Eyes: The child is sitting on her mother's lap curiously looking at you.

Motor: The child accidentally drops her favorite toy so she quickly jumps off her mother's lap crawls under the chair and grabs her toy.

Verbal: The child states "Mine" clutching her favorite toy. She says, "I am this many" as she proudly tries to hold up three fingers.

What PGCS score you would assign for each component for this patient?

Click the Answer button below to see how we scored the patient.

35

Eyes	4
Motor	6
Verbal	5
Total	15

Answer

35

Loss Of Consciousness (LOC)

o LOC is not a reliable predictor of concussion or length of recovery.

o LOC is not as definitive a predictor of severity as the Pediatric Glasgow Coma Scale.

o Cognitive symptoms such as confusion and disturbance of memory **can** occur without LOC.

o However, when the patient **does** experience LOC, confusion and memory disturbance almost **always** occur.

Gray 2009; Meehan 2009

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Amnesia

Post traumatic amnesia (PTA) is more accurate than loss of consciousness in predicting functional recovery. Patients suffering from MTHI may have amnesia of events occurring immediately after injury.

Classification of the severity of amnesia is measured by length of time it occurs:

- Very mild: Less than 5 minutes
- Mild: Less than 1 hour
- Moderate: 1-24 hours
- Severe: Greater than 24 hours
- Very severe: Greater than 1 week

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Sideline evaluation and return to play conscious athlete:

- Athlete should be evaluated for 15 minutes minimum
- If asymptomatic at rest, provocative testing should be performed
- Any symptoms with this testing precludes return to play



Concussion Management: Acute injury

- ANY signs or symptoms of a concussion:
 - Should not be allowed to return to play in the current game or practice
 - Should not be left alone; regular monitoring for deterioration
 - Should be medically evaluated
 - Return to play must follow a medically supervised stepwise process
- "When in doubt, sit them out!"

Return To Play Guidelines

- o **Simple** – an injury that progressively resolves without complication for 7-10 days. Management based on a step-wise approach until all symptoms resolve.
- o **Complex** – persistent symptoms, specific sequelae (e.g., prolonged LOC), or prolonged cognitive impairment. Consider formal neuropsychological testing beyond return to play guidelines.

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EMSC - Return To Play Guidelines Brochure

McCrary 2005

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Return To Play:

A Step Wise Approach

Athletes are **NOT** be returned to play the same day of injury.

Recommended stages of progression:

- Step #1. Rest until asymptomatic (physical and mental rest)
- Step #2. Light aerobic exercise
- Step #3. Sport-specific exercise
- Step #4. Non-contact training drills (light resistance training)
- Step #5. Full contact training

ONLY AFTER MEDICAL CLEARANCE

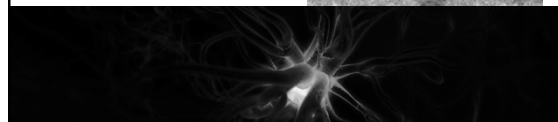
Step #6. Return to competition (game play)
There should be approximately 24 hours (or longer) for each stage and the athlete should return to previous step if symptoms reoccur.

McCrary 2005

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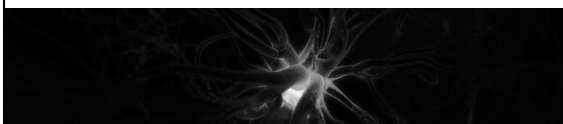
Sequelae of concussions

- Second impact syndrome
- Post-concussive syndrome



Second impact syndrome

- Second injury to the brain during the vulnerable metabolic cascade
- May be a minor / incidental injury
- Can lead to severe worsening of mental status and even death



Second Impact Syndrome

The effects of multiple injuries to the head are cumulative and potentially more damaging than a single incident. A second blow is more damaging than the "sum" of the two blows.

Second Impact Syndrome should be suspected in all children involved in high-risk situations (i.e., contact sports) and with a history of previous head injuries.

Patients experiencing Second Impact Syndrome are:

- o More likely to experience post-traumatic amnesia
- o More likely to experience mental status disturbance after each new injury
- o Often score lower on memory tests

Second Impact Syndrome can result in fatal brain swelling.



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Post Concussive Syndrome

One potential complication of MTHI is **Post Concussive Syndrome**. Clinical indications include:

- o Dizziness, trouble concentrating
- o Changes in sleep pattern
- o Any deviation from normal behavior in the days or even weeks following the injury.

Over time, the symptoms may eventually lessen. However, parents/caregivers must report any new, continuing, or worsening symptoms to their physician immediately.

It is critical that parents / caregivers are made aware of this complication at time of discharge.

Emotional

- o Irritability
- o Sadness
- o Increased demonstration of emotions
- o Nervousness
- o Loss of impulse control
- o Difficult to console
- o Shows lack of interest in favorite toys/activities
- o Any deviation from normal/baseline as per parent/caregiver

CDC's Heads Up Facts for Physicians

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Cognitive

- o Feeling mentally "foggy"
- o Feeling slowed down
- o Difficulty concentrating
- o Difficulty remembering
- o Forgetful of recent information or conversations
- o Confused about recent events
- o Answers questions slowly
- o Repeats questions
- o Any deviation from normal/baseline as per parent/caregiver

CDC's Heads Up Facts for Physicians

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Sleep

- o Drowsiness
- o Sleeping less than usual
- o Sleeping more than usual
- o Trouble falling asleep
- o Any deviation from normal/baseline as per parent/caregiver

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Computerized Test

ImPACT®

- **Immediate Post Concussion Assessment & Cognitive Testing**





UPMC HEALTH SYSTEM
PITTSBURGH, PENNSYLVANIA
affiliated with the University of Pittsburgh schools of the health sciences

ImPACT®

MODULES	DOMAIN
Symptom Inventory	Self-report of symptoms
Word Learning	Verbal memory
X's and O's	Visual working memory
Number tracking	Attention
Visual span	Visual attention span
Symbol Matching	Processing speed
	memory
	Word/color discrimination
Reaction time	3 letters (trigrams)
	Working memory/processing speed

The Return of the Teton




Test Your Knowledge

2. Which of the following is a common mechanism of injury for all developmental levels?

- A. Motor vehicle collisions
- B. Bicycle riding
- C. Risk-taking behaviors
- D. Contact sports

Click the Answer button below to see the correct response.

A. Motor vehicle collisions are a common mechanism of injury for children of all ages.

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Test Your Knowledge

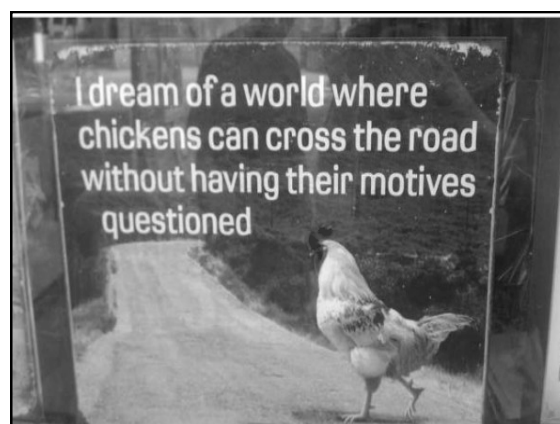
1. Which of the following symptoms is an example of a focal neurological deficit?

- A. Loss of consciousness
- B. Amnesia
- C. Numbness
- D. Polydipsia

Click the Answer button below to see the correct response.

C. Numbness is evidence of a focal rather than a diffuse injury.

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