



Just a Bang to the Head?

Core Concepts

- Concussions are blows to the head that damage delicate brain tissues.
- Diagnosis of a concussion is difficult and usually based on symptoms.
- Repeated concussions, before the brain has a chance to recover, may pose serious health risks.

Class time required:

- Approximately 2 forty minute class periods for Parts 1-3
- Optional: Approximately 40 minutes for Part 4

Teacher Provides:

For Parts 1-3 you will need to provide the following handouts.

NOTE: The CDC offers a variety of free resources for use with your students. Visit www.cdc.gov/Concussion to order free classroom resources. Allow 6-8 weeks for delivery.

For each student

- Copy of student handout entitled **Just a Bang to the Head?**
- Copy of **A Factsheet for Athletes** on page iv used for Part 2. (Laminate or put in sheet protectors for reuse). Free color copies be ordered from the CDC website www.cdc.gov/Concussion
Note: Pages v-vii provides additional concussion information sheets. Consider increasing student interest by giving different information sheets to each member of a group.
- Color copy of **Concussions: What Happens to the Brain?** on pages viii and ix used for Part 3. (Laminate or put in sheet protectors for reuse)

For each team

- Access to the Internet

Additional materials for Part 4 for each team:

- Envelope containing 1 set of player cards (1-9) for each team (Laminate or cover cards with clear packing tape and provide dry erase markers if you want to reuse)
- 1 S100B color chart (Laminate or cover with clear packing tape for reuse)
- Bag labeled S100B test paper containing at least 9 pieces of pH 1 to 12 paper strips ordered from www.microessentiallab.com (catalog # 4800) or other science suppliers.

- Set of labeled small tubes (Players 1-9) containing 2 mL of the following simulated blood plasma samples prepared with the appropriate buffer solutions. Two mL microtubes are ideal for this.

Label on tube	Contents of tube (2 mL)
Player 1	pH 7
Player 2	pH 11
Player 3	pH 4
Player 4	pH 4
Player 5	pH 9
Player 6	pH 11
Player 7	pH 4
Player 8	pH 7
Player 9	pH 9

Answer key for simulated S100B tests:

Player	S100B Level
Player 1	4
Player 2	10
Player 3	0
Player 4	0
Player 5	8
Player 6	10
Player 7	0
Player 8	4
Player 9	8

Supplementary Resources:

- For a great cartoon to introduce this activity, see **Battered Brains** at <http://www.scientificamerican.com/article.cfm?id=how-head-injuries-damage-brain>
- For further information on concussions and S100B levels, see research article “Consequences of Repeated Blood-Brain Barrier Disruption in Football Players” available for free download at <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0056805>

Suggested Class Procedure:

1. Homework. Distribute a copy of **Just a Bang to the Head? Part 1** (one page) to each student. Ask students to complete for homework. Part 1 is used to engage students and assess their prior knowledge of concussions.
2. Begin class by asking several students to read their answers to the questions for Part 1 and the stories that they have written. Consider asking students to create a class list of things that can cause concussions to help them understand that many activities can result in concussions.
3. Distribute the **Part 2: Concussion Quiz** to each student. Students work individually to take the concussion quiz.
4. Then distribute the **Fact Sheet for Athletes** (and other information sheets if available). Group students in teams (2-4 students). Ask students to work with their team to check their answers using the information in the Fact Sheet(s). *Note: Use 2 additional handouts if you would like each student to have a different handout.*
5. Distribute **Part 3: Concussion Awareness Campaign** and **Concussion: What Happens to the Brain and Nerve Cells?** to each student.
6. Assign students to work in teams of 2-4 students to complete the Concussion Awareness Campaign activity. *Emphasize the importance of referring to the scoring guide and including the information indicated in the product.* Explain the scoring guide that will be used to grade their work.
 - The Concussion Awareness Campaign activity may be completed in class, for homework, or as a combination of in class and out of class work. If done in class, consider limiting the amount of time for students to complete the products to eighty minutes.
 - Students present their Concussion Awareness Campaign with their classmates. Allow approximately 2-3 minutes for presentation by each student in the group.
7. For **Part 4: Blood Test for Concussions?** Distribute to each team of 2-4 students:
 - 1 copy of **A Blood Test for Concussions?**
 - 1 copy of **S100B Color Chart**
 - Envelope containing a set of Player cards (1-9)
 - 1 set of Player blood plasma samples (1-9)
 - 1 bag of S100B Test Paper

Students work in teams to design and conduct the experiments.

HEADS+UP

CONCUSSION IN HIGH SCHOOL SPORTS

A FACT SHEET FOR **ATHLETES**

What is a concussion?

A concussion is a brain injury that:

- Is caused by a bump, blow, or jolt to the head or body.
- Can change the way your brain normally works.
- Can occur during practices or games in any sport or recreational activity.
- Can happen even if you haven't been knocked out.
- Can be serious even if you've just been "dinged" or "had your bell rung."

All concussions are serious. A concussion can affect your ability to do schoolwork and other activities (such as playing video games, working on a computer, studying, driving, or exercising). Most people with a concussion get better, but it is important to give your brain time to heal.

What are the symptoms of a concussion?

You can't see a concussion, but you might notice **one or more** of the symptoms listed below or that you "don't feel right" soon after, a few days after, or even weeks after the injury.

- Headache or "pressure" in head
- Nausea or vomiting
- Balance problems or dizziness
- Double or blurry vision
- Bothered by light or noise
- Feeling sluggish, hazy, foggy, or groggy
- Difficulty paying attention
- Memory problems
- Confusion

What should I do if I think I have a concussion?

- **Tell your coaches and your parents.** Never ignore a bump or blow to the head even if you feel fine. Also, tell your coach right away if you think you have a concussion or if one of your teammates might have a concussion.
- **Get a medical check-up.** A doctor or other health care professional can tell if you have a concussion and when it is OK to return to play.
- **Give yourself time to get better.** If you have a concussion, your brain needs time to heal. While your brain is still healing, you are much more likely to have another concussion. Repeat concussions can increase the time it takes for you to recover and may cause more damage to your brain. It is important to rest and not return to play until you get the OK from your health care professional that you are symptom-free.

How can I prevent a concussion?

Every sport is different, but there are steps you can take to protect yourself.

- Use the proper sports equipment, including personal protective equipment. In order for equipment to protect you, it must be:
 - The right equipment for the game, position, or activity
 - Worn correctly and the correct size and fit
 - Used every time you play or practice
- Follow your coach's rules for safety and the rules of the sport.
- Practice good sportsmanship at all times.

If you think you have a concussion:
Don't hide it. Report it. Take time to recover.

It's better to miss one game than the whole season.

For more information and to order additional materials *free-of-charge*, visit: www.cdc.gov/Concussion.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION





A Fact Sheet for **ATHLETES**

WHAT IS A CONCUSSION?

A concussion is a brain injury that:

- Is caused by a bump or blow to the head
- Can change the way your brain normally works
- Can occur during practices or games in any sport
- Can happen even if you haven't been knocked out
- Can be serious even if you've just been "dinged"

WHAT ARE THE SYMPTOMS OF A CONCUSSION?

- Headache or "pressure" in head
- Nausea or vomiting
- Balance problems or dizziness
- Double or blurry vision
- Bothered by light
- Bothered by noise
- Feeling sluggish, hazy, foggy, or groggy
- Difficulty paying attention
- Memory problems
- Confusion
- Does not "feel right"

WHAT SHOULD I DO IF I THINK I HAVE A CONCUSSION?

- **Tell your coaches and your parents.** Never ignore a bump or blow to the head even if you feel fine. Also, tell your coach if one of your teammates might have a concussion.

- **Get a medical check up.** A doctor or health care professional can tell you if you have a concussion and when you are OK to return to play.
- **Give yourself time to get better.** If you have had a concussion, your brain needs time to heal. While your brain is still healing, you are much more likely to have a second concussion. Second or later concussions can cause damage to your brain. It is important to rest until you get approval from a doctor or health care professional to return to play.

HOW CAN I PREVENT A CONCUSSION?

Every sport is different, but there are steps you can take to protect yourself.

- Follow your coach's rules for safety and the rules of the sport.
- Practice good sportsmanship at all times.
- Use the proper sports equipment, including personal protective equipment (such as helmets, padding, shin guards, and eye and mouth guards). In order for equipment to protect you, it must be:
 - > The right equipment for the game, position, or activity
 - > Worn correctly and fit well
 - > Used every time you play

It's better to miss one game than the whole season.

For more information and to order additional materials free-of-charge, visit:
www.cdc.gov/ConcussionInYouthSports

For more detailed information on concussion and traumatic brain injury, visit:
www.cdc.gov/injury



Parent/Athlete Concussion Information Sheet

A concussion is a type of traumatic brain injury that changes the way the brain normally works. A concussion is caused by bump, blow, or jolt to the head or body that causes the head and brain to move rapidly back and forth. Even a “ding,” “getting your bell rung,” or what seems to be a mild bump or blow to the head can be serious.

WHAT ARE THE SIGNS AND SYMPTOMS OF CONCUSSION?

Signs and symptoms of concussion can show up right after the injury or may not appear or be noticed until days or weeks after the injury.

If an athlete reports **one or more** symptoms of concussion listed below after a bump, blow, or jolt to

Did You Know?

- Most concussions occur *without* loss of consciousness.
- Athletes who have, at any point in their lives, had a concussion have an increased risk for another concussion.
- Young children and teens are more likely to get a concussion and take longer to recover than adults.

the head or body, s/he should be kept out of play the day of the injury and until a health care professional, experienced in evaluating for concussion, says s/he is symptom-free and it’s OK to return to play.

SIGNS OBSERVED BY COACHING STAFF	SYMPTOMS REPORTED BY ATHLETES
Appears dazed or stunned	Headache or “pressure” in head
Is confused about assignment or position	Nausea or vomiting
Forgets an instruction	Balance problems or dizziness
Is unsure of game, score, or opponent	Double or blurry vision
Moves clumsily	Sensitivity to light
Answers questions slowly	Sensitivity to noise
Loses consciousness (<i>even briefly</i>)	Feeling sluggish, hazy, foggy, or groggy
Shows mood, behavior, or personality changes	Concentration or memory problems
Can’t recall events <i>prior</i> to hit or fall	Confusion
Can’t recall events <i>after</i> hit or fall	Just not “feeling right” or “feeling down”

CONCUSSION DANGER SIGNS

In rare cases, a dangerous blood clot may form on the brain in a person with a concussion and crowd the brain against the skull. An athlete should receive immediate medical attention if after a bump, blow, or jolt to the head or body s/he exhibits any of the following danger signs:

- One pupil larger than the other
- Is drowsy or cannot be awakened
- A headache that not only does not diminish, but gets worse
- Weakness, numbness, or decreased coordination
- Repeated vomiting or nausea
- Slurred speech
- Convulsions or seizures
- Cannot recognize people or places
- Becomes increasingly confused, restless, or agitated
- Has unusual behavior
- Loses consciousness (*even a brief loss of consciousness should be taken seriously*)

WHY SHOULD AN ATHLETE REPORT THEIR SYMPTOMS?

If an athlete has a concussion, his/her brain needs time to heal. While an athlete's brain is still healing, s/he is much more likely to have another concussion. Repeat concussions can increase the time it takes to recover. In rare cases, repeat concussions in young athletes can result in brain swelling or permanent damage to their brain. *They can even be fatal.*

It's better to miss one game than the whole season. For more information on concussions, visit: www.cdc.gov/Concussion.

Remember

Concussions affect people differently. While most athletes with a concussion recover quickly and fully, some will have symptoms that last for days, or even weeks. A more serious concussion can last for months or longer.

WHAT SHOULD YOU DO IF YOU THINK YOUR ATHLETE HAS A CONCUSSION?

If you suspect that an athlete has a concussion, remove the athlete from play and seek medical attention. Do not try to judge the severity of the injury yourself. Keep the athlete out of play the day of the injury and until a health care professional, experienced in evaluating for concussion, says s/he is symptom-free and it's OK to return to play.

Rest is key to helping an athlete recover from a concussion. Exercising or activities that involve a lot of concentration, such as studying, working on the computer, or playing video games, may cause concussion symptoms to reappear or get worse.

After a concussion, returning to sports and school is a gradual process that should be carefully managed and monitored by a health care professional.

Student-Athlete Name Printed

Student-Athlete Signature

Date

Parent or Legal Guardian Printed

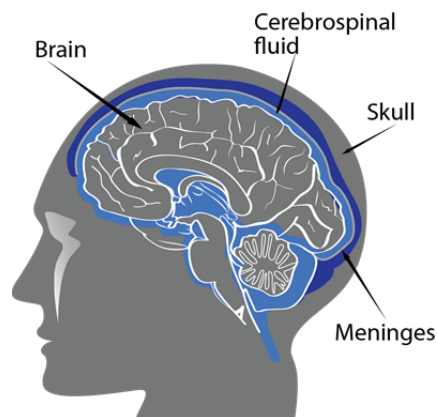
Parent or Legal Guardian Signature

Date

Concussion: What Happens to the Brain and Nerve Cells?

Many people think that concussions are just minor blows to the head. But scientific research has shown that concussions may lead to serious and possibly long-term damage to the brain. The human brain is not perfectly protected from the kinds of injuries that may occur. Collisions with objects or someone else's body create forces that can severely damage the brain's delicate tissues and disrupt its intricate circuitry.

The human brain is protected by cranial (skull) bones that form a hard protective covering around the brain. On the inside of the skull, tough connective tissues called meninges line the skull and cover the brain. Your brain also floats in cerebrospinal fluid that bathes and supports the brain while acting as a shock absorber during head movements.



Concussions occur when the head abruptly stops after being in motion. This causes the brain to bounce back and forth against the bones of the skull. Brain tissue is violently jostled within the skull and this can directly damage both brain cells and the blood vessels that feed them.

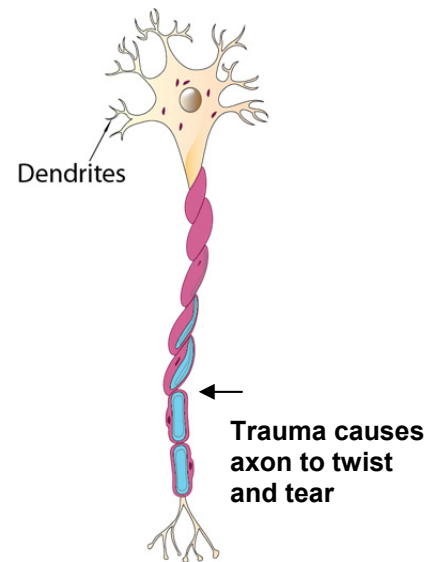
The forehead region, where most concussions occur, is where the most fragile and important parts of the human brain are located. Behind the forehead, is the prefrontal cortex that is the center for processing information, solving problems, concentrating, remembering, and learning. Damage to the prefrontal region can lead to personality changes including depression, violence, or socially inappropriate behavior.



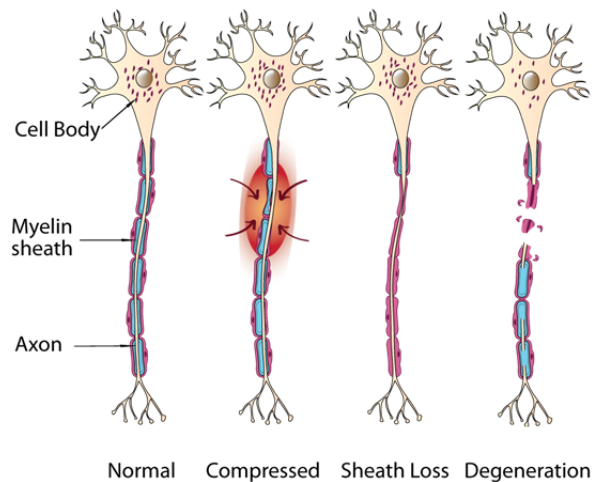
A blow to the head may cause the brain to suffer two separate hits: first at the point of impact, and second as it is thrown against the opposite side of the skull.

For Part 3

Axons are the microscopic conducting fibers of neurons (brain cells) that communicate with each other. The shifting and rotation of the brain inside the skull during a concussion, twists, stretches, and possibly tears the axons. This damage to the brain's axons may occur in localized areas or throughout the brain. Axon damage is often followed by swelling. This swelling quickly reduces impulse conduction in neurons, but some neuron functions may be restored later when the swelling is reduced. Axon damage can also lead to scarring that can take weeks, months, or even years, to heal completely. Axon scars interfere with conduction of nerve impulses (messages) and cause neuron death. This explains why the symptoms of concussions may worsen with time.



Myelin is a fatty substance that coats and protects the axons. A myelin sheath insulates individual axons and is important for the speed and accuracy of impulse conduction. If the myelin sheath is damaged, the information being conducted by the axons will be scrambled or cut off. Brain injury in children and teens may be more damaging because the development of the myelin sheaths continues as late as the mid-twenties.



A concussion also triggers biochemical reactions that flood the brain with ions (such as calcium and potassium ions) that cause blood vessels in the brain to constrict (get smaller). After a concussion, the brain needs to work overtime trying to restore a chemical balance and repair damaged neurons. However, because blood flow to the brain is reduced, there is less oxygen and glucose to use as an energy source. It may take 5 to 10 days until blood flow to the brain returns to normal and the brain can begin to heal itself.

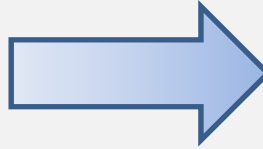
Energy-starved nerve cells are particularly vulnerable to further damage or death. A second concussive episode before total recovery from a first concussion is particularly bad. Second-impact syndrome (SIS) describes a life-threatening condition in which a second brain injury occurs before the brain is fully recovered from an earlier injury, no matter how "mild" the first may have been. Second-impact syndrome (SIS) is fatal in up to 50% of the individuals who suffer it, and can cause major long-term brain damage and disability in the rest. Adolescent and young adult adults are more at risk for second-impact syndrome.

Player # 1

Hits and intensity (SI = Severity Index) of hits recorded during game:

- Hit 1 intensity SI = 5
- Hit 2 intensity SI = 1
- Hit 3 intensity SI = 6

SI Index = 1
Hit Intensity
LOW (mild)



SI Index =15
Hit Intensity
HIGH (Severe)

Symptoms reported by player: Mild confusion for a few minutes, mild headache at end of game

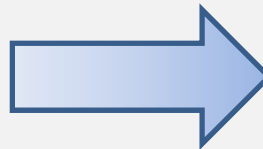
S100B level: Before game = 0 At end of game _____

Player # 2

Hits and intensity (SI = Severity Index) of hits recorded during game:

- Hit 1 intensity SI = 5
- Hit 2 intensity SI = 7
- Hit 3 intensity SI = 12

SI Index = 1
Hit Intensity
LOW (mild)



SI Index =15
Hit Intensity
HIGH (Severe)

Symptoms reported by player: Mild confusion after one hit, feels fine at end of game

S100B level: Before game = 0 At end of game _____

Player # 3

Hits and intensity (SI = Severity Index) of hits recorded during game:

- Hit 1 intensity SI = 1
- Hit 2 intensity SI = 1
- Hit 3 intensity SI = 1

SI Index = 1
Hit Intensity
LOW (mild)



SI Index =15
Hit Intensity
HIGH (Severe)

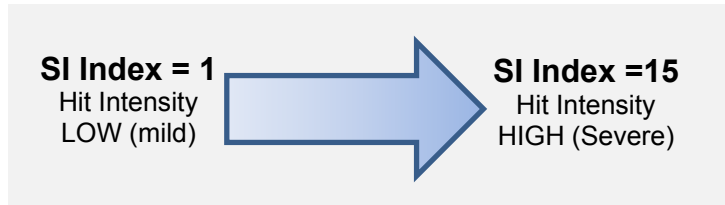
Symptoms reported by player: Headache at end of game

S100B level: Before game = 0 At end of game _____

Player # 4

Hits and intensity (SI = Severity Index)
of hits recorded during game:

- Hit 1 intensity SI = 3
- Hit 2 intensity SI = 1
- Hit 3 intensity SI = 2



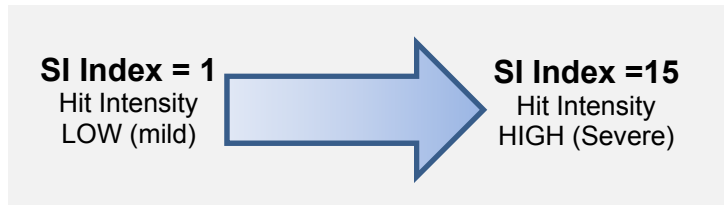
Symptoms reported by player: No symptoms

S100B level: Before game = 0 At end of game _____

Player # 5

Hits and intensity (SI = Severity Index)
of hits recorded during game:

- Hit 1 intensity SI = 10
- Hit 2 intensity SI = 2



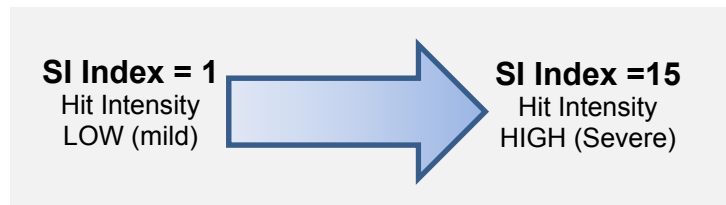
Symptoms reported by player: Saw "stars" with one hit, confused for five minutes after the hit

S100B level: Before game = 0 At end of game _____

Player # 6

Hits and intensity (SI = Severity Index)
of hits recorded during game:

- Hit 1 intensity SI = 11
- Hit 2 intensity SI = 7



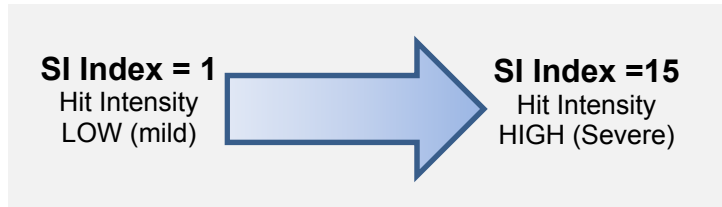
Symptoms reported by player: Brief period of unconsciousness after hit. Benched for remainder of game

S100B level: Before game = 0 At end of game _____

Player # 7

Hits and intensity (SI = Severity Index) of hits recorded during game:

- No hits



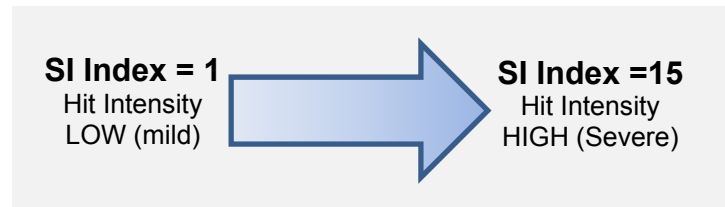
Symptoms reported by player: Feels fine

S100B level: Before game = 0 At end of game _____

Player # 8

Hits and intensity (SI = Severity Index) of hits recorded during game:

- Hit 1 intensity SI = 2
- Hit 2 intensity SI = 4



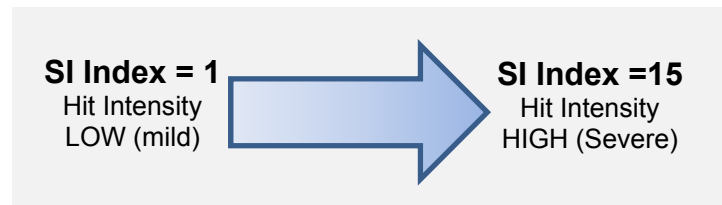
Symptoms reported by player: Feels fine

S100B level: Before game = 0 At end of game _____

Player # 9

Hits and intensity (SI = Severity Index) of hits recorded during game:

- Hit 1 intensity SI = 2
- Hit 2 intensity SI = 14



Symptoms reported by player: Feels fine

S100B level: Before game = 0 At end of game _____

S100B Levels (micrograms/mL blood)

0	2	4	6	8	10	12

S100B Levels (micrograms/mL blood)

0	2	4	6	8	10	12

S100B Levels (micrograms/mL blood)

0	2	4	6	8	10	12

S100B Levels (micrograms/mL blood)

0	2	4	6	8	10	12