

SPECIAL REPORT: **CONCUSSION**

HEAD GAMES



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As more pro athletes go public about the impact of concussion on their lives, doctors, patients, researchers, and caregivers are all starting to take head injury more seriously. Here's what you need to know.

BY LISA PHILLIPS

In his years as a Harvard University defensive tackle and a professional wrestler, Chris Nowinski has been leveled by a helmet-to-helmet collision, bashed in the chin, and kicked in the head. He's been knocked unconscious, seen double, and forgotten where he was or what he was supposed to be doing.

Nowinski always took the blows in stride, getting back into play as soon as he could, sometimes within minutes of the injury. He handled it the way he'd handle any other injury.

"Guys work through all sorts of pain," Nowinski says. "If everyone took a day off because of pain, no one would show up to work. I just considered it like a normal bruise."

But concussions, he would find out later, aren't like any other injury. The cumulative effect of six concussions ended his career with World Wrestling Entertainment and left him struggling with chronic headaches and memory problems.

Today, Nowinski is a crusader, raising awareness about the dangers of concussions through the Boston-based Sports Legacy Institute.

As a former professional athlete with lasting effects from multiple concussions, Nowinski isn't alone. Concussions have ended the careers of Dallas Cowboys quarterback Troy Aikman and Giants catcher Mike Matheny. Former Patriots linebacker Ted Johnson struggles with depression, fatigue, and memory problems. Former NFL players Andre Waters and Terry Long ended their own lives, having suffered chronic depression that researchers have linked to multiple concussions.

Keeping pace with the increasing numbers of high-profile stories about head injury is a growing body of research on the dangers of repeat concussions. As a result, the way concussions are treated, from the professional sports world to the battlefield to the schoolyard, is starting to change. More and more, even minor concussions are taken seriously, to keep a first concussion from leading to a second or, far worse, a lifetime of struggle.



MR. HARVARD, CHRIS NOWINSKI

After playing defensive tackle in college, Chris Nowinski became the first graduate of Harvard University to become a professional wrestler with World Wrestling Entertainment. During a match in 2003, Nowinski sustained a concussion, wrestled for another three weeks, and then suffered a full year of post-concussion symptoms before retiring in 2004.

JODI HILTON / CORBIS; INSET: MSHAKES

A second concussion suffered while a person is recovering from the first could be disabling or fatal.

WHAT IS A CONCUSSION?

Each year in the United States, about a million people are hospitalized or seen in an emergency department for a concussion, according to the Centers for Disease Control and Prevention (CDC). Because many concussions are not treated, the CDC estimates the actual number of concussions is much higher: 1.6 to 3.8 million a year.

An estimated 300,000 of these occur in sports or recreation-related activities. Contact sports, such as football and boxing, are among those most likely to lead to concussion, but so too are falls and collisions sustained in bicycling, skiing, horseback riding, soccer, basketball, and other non- or low-impact contact sports. Many concussions are also caused by falls and motor vehicle accidents.

A concussion, also known as a mild traumatic brain injury, is caused by a blow to the head or body, an impact against a hard surface, shaking, or spinning. Concussion occurs because the body suddenly stops, causing the brain, which floats in cerebrospinal fluid, to be jarred against the skull.

Symptoms of concussion include loss of consciousness, headache, nausea, blurred vision, confusion, dizziness, loss of balance, lightheadedness, ringing in the ears, fatigue, a feeling of “fogginess,” memory problems, and the inability to think straight or see straight. Concussions may cause emotional or behavioral changes; for example, victims may throw a temper tantrum or cry for an extended period.

With more severe concussions, symptoms can also include worsening headaches, convulsions, seizures, vomiting, dilation of the pupils, weakness, numbness, and the inability to wake up.

Concussions literally cause changes in how the cells of the brain function. James Kelly, M.D., professor of neurosurgery and rehabilitation medicine at the University of Colorado Health Sciences Center in Denver, CO, describes the impact of a concussion as a biomechanical force that causes “random and highly disruptive” electrical discharge from nerve cells. The nerve cells cause a chemical imbalance, revving up the

metabolism of other nerve cells. “The physiological demand on the cells can damage them, and some of them die,” Dr. Kelly says. “It’s like blowing the engine of a car.”

In addition, the axons—the long, slender fibers connecting one nerve cell to the next—can tear and swell from the force. This condition, called diffuse axonal injury, can lead to persistent cognitive problems with learning, memory, and attention as well as to paralysis or coma. Symptoms from most mild concussions go away within a few days with rest.

The situation can take a more serious turn, though, if a patient suffers another concussion before recovering from the first one.

“A second concussion may fall on the brain at a vulnerable time, when the cell’s metabolism—the way cells make and use energy—is disturbed,” says Julian Bailes, M.D., the chair of the department of neurosurgery at the West Virginia University School of Medicine in Morgantown, WV. “So a repeat head injury can lead to damage in cell structure and connections in the brain, which could lead to long term consequences, such as headaches, depression, or other problems in mental functioning,” Dr. Bailes says.

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GROWING CONCERN OVER REPEAT CONCUSSIONS

Meredith Auerbach-Levine, a physical therapist in Saugerties, NY, got her first concussion during a skiing accident. She fell backwards and hit her head on a patch of ice. Her symptoms—a headache, blurred vision, and nausea—went away in a couple of days.

She then suffered a second concussion a week later when she fell off a high stone wall. At first, she thought she was fine, but a few days later, she found she had trouble writing. “My brain just didn’t feel like it was working right,” she says.

The symptoms eventually went away, though not as quickly as the first time. Auerbach-Levine had experienced a phenomenon researchers have identified in athletes, in which a first concussion significantly increases the possibility of getting a second one.

HOW CONCUSSION HURTS

A normal brain neuron, such as pictured on the left, can become severely damaged by trauma. A concussion causes the neuronal axon to twist and tear, as shown in the center illustration. The picture on the right depicts the post-trauma death of the brain cell.

The diagram illustrates the progression of axonal injury in three stages:

- Normal Axon:** Shows a healthy neuron with a cell body containing a nucleus and nucleolus, surrounded by neuroglial cells. A long axon extends from the cell body, covered by a myelin sheath, ending in an axon terminal. Labels include: Cell body, Nucleus in cell body, Neuroglial cells, Dendrites, Axon, Myelin sheath, and Axon terminal.
- Shearing of the Axon:** A blue arrow indicates a force applied to the axon, causing it to twist and tear. Label: A. Trauma causes the axon to twist and tear.
- Post-trauma Condition:** The axon is completely severed, and the neuron is shown as dead. Label: B. The result is permanent death of the brain cell.

The way concussions are treated, from the professional sports world to the battlefield to the schoolyard, is starting to change.

A 2000 study of college football players, led by Kevin M. Guskierwicz, Ph.D., A.T.C., professor and director of the Sports Medicine Research Laboratory at the University of North Carolina at Chapel Hill, found that 92 percent of repeat concussions occurred within 10 days of the first injury, and 75 percent occurred within seven days. The study also found that suffering one concussion triples a player's chance of suffering a second concussion in the same season.

Michael McCrea, Ph.D., a neuropsychologist at the Neuroscience Center at Waukesha Memorial Hospital in Wisconsin, calls the 7- to 10-day recovery period after a concussion the "window of cerebral vulnerability." The symptoms of a concussion, which can include loss of coordination and delayed reaction times, make staying out of harm's way challenging.

The recovering brain is also more susceptible to additional damage when a second concussion occurs. "Even if the first is mild, the second can result in poor or even catastrophic outcomes," says Dr. McCrea.

Doctors call this phenomenon second-impact syndrome. A second concussion suffered while a player is recovering from the first could be disabling or fatal, according to the American Association of Neurological Surgeons. The second concussion, even if it's not severe, can cause vascular congestion and increased intracranial pressure, leading to acute brain swelling.

Dr. McCrea advises athletes to stay off the field at least during the 7- to 10-day recovery period and until all symptoms are resolved.

ATHLETES AND MULTIPLE CONCUSSIONS

National Football League Hall of Famer Warren Moon got his first concussion at age 11, during Pop Warner football practice. The team nurse diagnosed the injury right away and took him off the field.

Moon went back to practice two days later. He was feeling good and wanted to prove himself in a sport that was all about being tough and resilient and shaking off obstacles.

Moon got five more concussions during his professional football career, and he wasn't always able to recover as quickly. Once, while he was playing for the Houston Oilers, he returned to the

field a few days after getting a concussion, thinking he was fine. "But my thought process wasn't coming fast enough," he recalls. "As a quarterback, you have to make decisions quickly."

The incident was one of many signs that "getting dinged"—one of many football terms for getting knocked on the head—was no minor matter. Moon, 50, says he's not suffering

any long-term effects from his concussions, but plenty of other former NFL players are. "I'm looking for signs, changes all the time," he says. "A lot of guys I know are really struggling with depression, dementia, and headaches."

Researchers are beginning to understand how multiple concussions over the course of a sports career can affect college and professional athletes.

A study by the Center for the Study of Retired Athletes (CSRA) at University of North Carolina found that 20.2 percent of the players who said they had suffered three or more concussions on the football field were diagnosed with depression. The findings, published in May in the *Journal of the American College of Sports Medicine*, were based on a general health mail survey of 2,552 retired NFL players.

A 2005 study by the Center showed retired NFL players who had three or more concussions were five times more likely to report mild cognitive impairment and three times more likely to have memory problems

than retired players without a history of concussion.

Another set of findings by Pittsburgh neuropathologist Bennet Omalu, M.D., M.P.H., described evidence of chronic traumatic encephalopathy, a type of brain damage commonly found in boxers, in the brain tissue of four deceased former NFL players. Dr. Omalu links the damage to depression, dementia, and other neurological problems. Two of the players, former Philadelphia Eagles safety Andre Waters and former Steelers lineman Terry Long, committed suicide.

The NFL questions the validity of these reports. Ira Casson, M.D., a neurologist at the Long Island Jewish Medical Center in New Hyde Park, NY and the co-chair of the NFL's concussion committee, notes that the CSRA reports are based on the players' own accounts of being diagnosed with depression, dementia, and other neurological problems, and that Dr. Omalu's research depends on interviews with family members.

"There's no objective report from any physician, psychia-

CONCUSSION SIGNS AND SYMPTOMS

- Confusion
- Lethargy
- Vacant staring
- Disorientation
- Slowed reaction time
- Slurred speech
- Imbalance/incoordination
- Weakness
- Memory loss/amnesia
- Mood swings
- Blurred vision
- Headache
- Dizziness
- Nausea/vomiting
- Loss of consciousness



ON THE FOOTBALL FIELD AND THE BATTLE FIELD

Left: Troy Aikman, who led the Dallas Cowboys to three Super Bowl championships, retired in 2001 after at least 10 concussions on the field. Right: An injured soldier is helped from the wreckage of a humvee after it was destroyed by an improvised explosive device (IED). A few of the soldiers suffered concussions.

trist, or psychologist who might have examined the patients,” says Dr. Casson.

He also points out that the 20.2 percent rate of depression among retired football players who have suffered three concussions was not much higher than the rate of people in the general population who have suffered bouts of major depression: 16.2 percent, according to a Harvard Medical School study published in 2003.

Dr. Bailes, the Center for the Study of Retired Athletes’ medical director, concedes that there are “natural limitations” to survey or self-reported data. “We suggest that more detailed studies be done,” he says. “But roughly a third of the medical literature out there is based on surveys and self-reports—epidemiological-type papers. The link between smoking and lung cancer was first discovered that way. The evidence should not be dismissed.”

Leigh Steinberg, a sports agent who represents Troy Aikman, Steve Young, and other current and former NFL players, suspects the number of players who have suffered multiple concussions on the field and depression and other cognitive problems later in life is actually higher than the CSRA study indicates.

“I think we have a largely undiagnosed health epidemic,”

Steinberg says. “Players aren’t enthusiastic about responding to surveys and admitting they’re depressed. The results may be only the tip of the iceberg.”

Steinberg began to get concerned about repeated concussions more than a decade ago, when he saw a number of his clients struggling with memory loss and other signs of brain damage after repeated blows to the head.

Yet, Steinberg says, players who suffered concussions still faced pressure to get back in the game as soon as possible. “Professional athletes are in a state of denial,” he claims. “From the time they were in Pop Warner and Little League, they were taught to ignore pain, be stoic, because to be injured is to be shunned and kept separate.”

Only recently has this attitude begun to change, Steinberg says. This year, the NFL started to give players baseline tests during training-camp physicals that can be used to diagnose concussions. The NFL and the union representing players have also created a program to provide assistance to retired players with dementia and Alzheimer’s disease.

In August, the NFL issued new guidelines for managing concussions, clarifying exactly when a player who has had a con-



THE RISKS OF PLAYING HARD

Center: Biker Russell Smith, 16, recovers from a mild concussion while riding at Camp Woodward in Woodward, PA.



The old “tough-it-out” attitude that can drive professional athletes back onto the field too soon after a concussion affects young people as well.

conclusion should be allowed to return to the field. The guidelines also include a telephone hotline to make it easier to let the league know when a player with a head injury is being pushed to play or practice and a booklet to help players and their families identify concussion symptoms.

Steinberg would like to see more changes, including safer field turf and better helmets, but he’s hopeful about the progress so far. “Only three years ago, *Monday Night Football*’s logo was two helmets crashing together,” he says. “I think people are more conscious now. They’re beginning to realize that someone’s brain is part of that clash.”

CONCUSSIONS ON THE BATTLEFIELD

The battlefields of Iraq and Afghanistan may seem a world away from the playing fields of America, but the U.S. military is also taking new steps to protect soldiers with concussions, a common injury in wartime.

The phenomenon of “shell shock,” familiar to soldiers since the Civil War, is getting renewed attention with the prevalence of improvised explosive devices, or IEDs, in roadside bombings and suicide attacks in Iraq and Afghanistan.

During an IED explosion, concussion may result when a soldier is thrown by the force of the blast or hit by flying debris. Military doctors also suspect that concussions may result from the blast waves of extremely high pressure from the explosions, says Colonel Jonathan Jaffin, M.D., the acting commander of the U.S. Army Medical Research and Materiel Command.

Concussions, which Col. Jaffin estimates affect about 12 percent of soldiers in combat units, may seem to be the least of the problems caused by IEDs, which have maimed and killed thousands of troops. But the U.S. army is spreading the word to line commanders about the importance of diagnosing and treating concussions. Col. Jaffin says while soldiers with life and limb-threatening injuries are evacuated from the battlefield for medical care, soldiers with mild concussions end up back in their units. Unit commanders are being told to make sure concussed soldiers stay out of the action until they’re fully recovered.

The reasons are twofold, Col. Jaffin says. Going back into battle means risking a second concussion, which can present complications if it follows a first concussion too closely. And a soldier with a concussion may not be at the top of his game.

“Some of the symptoms of a mild head injury are poor judgment and slower reaction time,” he says. “We don’t want to put a guy back out in a very dangerous situation who’s not good at making decisions or has trouble reading maps. It’s un-



HEADS-UP ON CONCUSSION: WHAT PARENTS SHOULD KNOW

Athletes often return to competition too soon following concussions. Repeated concussions that occur without full recovery from one to the next can result in potentially fatal brain swelling, called second-impact syndrome. Repeated concussions over time can also result in permanently impaired thought processes and slowed reaction times.

A major misconception is that a concussion only occurs when an athlete is “knocked out.” However, the hallmarks of concussion are confusion and amnesia, usually without a preceding loss of consciousness. The signs and symptoms of concussion may be immediate or may gradually evolve over several minutes after the head trauma (See Concussion Signs & Symptoms).

Due to the possibility for serious medical complications, any athlete who loses consciousness or has persistent confusion should be evaluated in an emergency department. Those athletes whose symptoms seem to have resolved may be observed at home by a parent, but the athlete should be awakened from sleep every two hours and should

avoid strenuous activity for at least 24 hours (See Emergency Symptoms).

Athletes may experience physical, emotional or cognitive symptoms that gradually taper in severity over hours, days, weeks, or even months after a concussion. These “post-concussion symptoms” can include:

- ✓ Headache
- ✓ Dizziness
- ✓ Problems sleeping
- ✓ Imbalance/incoordination
- ✓ Fatigue
- ✓ Sensitivity to light or noise
- ✓ Difficulty remembering or concentrating
- ✓ Difficulty thinking clearly
- ✓ Word-finding difficulty
- ✓ Irritability/moodiness/impulsiveness
- ✓ Feeling depressed or anxious

Any athlete having post-concussion symptoms should be evaluated and followed by a physician until all the symptoms resolve.

Anyone who continues to have symptoms of a concussion should not

be allowed to return to play until all the symptoms have cleared. Sideline evaluations may be performed on players who are briefly symptomatic but not “knocked out” following a concussion to determine if they are safe to return to play. In 1997, the American Academy of Neurology (AAN) published recommendations regarding sideline evaluation and guidelines for return to play in contact sports following a concussion. The AAN guideline scores a concussion based on severity from grade 1 (least severe) to grade 3 (most severe). Specific sideline management recommendations are given based on the concussion grade. Recommendations on return to play are also given based on the frequency of concussions. These AAN guidelines have been available for use by professional sports organizations and school athletic departments since 1997. — *David Kushner, M.D.*

David Kushner, M.D., is associate professor of rehabilitation medicine and neurology at the University of Miami School of Medicine, Miami, FL.

“We have a largely undiagnosed health epidemic,” sports agent Leigh Steinberg says. “Players aren’t enthusiastic about responding to surveys and admitting they’re depressed. The results may be only the tip of the iceberg.”

fair and dangerous to him and unfair to the troops depending on him, so those are reasons from an operational standpoint to protect soldiers.”

The military has begun to use a key tool developed to assess concussion in sports. The Standardized Assessment of Concussion, known as SAC, was developed by Dr. McCrea, Dr. Kelly, and Christopher Randolph, Ph.D., clinical neuropsychologist and professor of neurology at Loyola University Medical Center in Chicago, IL. The SAC gives clinicians a standardized tool to assess memory, level of consciousness, strength, sensation, and attention on a scale of 30 points. The military has imbedded the SAC into the Military Acute Concussion Evaluation, known as MACE.

The SAC is most effective, Dr. McCrea says, when baseline testing is done—that is, when players or soldiers are given the test at the start of the season, before potential injuries occur. “So when the SAC is administered again, post injury, you can compare,” Dr. McCrea says.

For more on traumatic brain injury among veterans of war, see “War on the Brain” from September/October 2006, available free at neurologynow.com.

CONCUSSIONS, YOUTH SPORTS, AND SCHOOL

The old “tough-it-out” attitude that can drive soldiers back into combat and professional athletes back into the field too soon after a concussion affects young people as well.

Though schools are starting to use baseline testing and concussion-awareness programs to prevent and treat concussions, children still may not know they need to take a bad bump on the head seriously—especially when the consequences of a second bump can be grave.

“Concussions are a joke in cartoons,” says Dr. Kelly. “Characters get stars around their heads. The issue is made fun of, trivialized.”

The result? Some kids—especially boys—won’t admit they’ve been injured because they don’t want to appear weak or be taken out of games. Other kids, sometimes along with the adults supervising them, don’t even realize they have had a concussion. “They don’t understand the connection between Sally’s

fall off the horse and the fact that she’s having trouble in school,” Dr. Kelly says. “No one says, ‘My God, this is a brain injury.’”

Recognizing concussions is crucial to identifying the causes of sudden learning or memory problems, which can hold children back in school. Repeat concussions, Dr. Kelly says, can be more serious in children because their skulls are “tighter,” meaning there’s less room between the brain and the skull, a dangerous situation if brain swelling occurs.

PREVENTION STRATEGIES

Safety comes first. Make sure you’re wearing the proper helmets and equipment for the activity you’re doing.

If you think you might have a concussion, don’t be macho and stoic. Seek treatment and encourage others to do the same.

Once a first concussion is diagnosed, don’t return to the activity that caused it until the symptoms go away and a doctor has given the okay.

Children should not be sent back to school until they’re symptom free, according to Dr. Kelly. “Mental activity creates metabolic demand,” he says. “Kids will struggle in school. It’s like working on seven out of eight cylinders. You have to wait until the eighth is working right.”

Keep in mind that there are many different symptoms of concussion, not just loss of consciousness (see “Concussion Signs and Symptoms”). Dr. Kelly advises that coaches, teachers, health care professionals, and other observers should take seriously both the symptoms they notice and those the person who experienced the concussion describes.

NFL agent Leigh Steinberg remembers the days when people laughed about drunk driving. “They’d watch someone get into a car and joke, ‘boy, did he tie one

on!’” he says. “Then Mothers Against Drunk Driving came along and made that kind of thing unacceptable. That’s the kind of attitude change I want to see in professional sports about concussion.”

Lisa Phillips is a freelance writer and the author of Public Radio: Behind the Voices (CDS Books/Perseus, 2006).



EMERGENCY SYMPTOMS

Go to the emergency department if concussion is accompanied by:

- Loss of consciousness
- Vomiting
- Severe or worsening headache
- Inability to be awakened
- Somnolence
- Persistent confusion
- Urinary or bowel incontinence
- Restlessness/nervousness
- Convulsions
- New visual impairment
- New weakness or numbness