

## **Journey Toward Understanding: Concussion & Mild Brain Injury**

### **Introduction**

*Three little monkeys jumping on the bed.  
One fell off and bumped his head.  
Took him to the doctor and the doctor said,  
"That's what you get for jumping on the bed!"*

This nursery rhyme tells a story about concussion--the bumps, bangs and shakings to the brain that many adults and children experience. Unfortunately, just like the monkeys jumping on the bed, professionals may not understand concussion well enough to offer support and to help individuals who sustain concussions. People with concussions may just try and "shake it off" and, thus, not be evaluated and treated properly by professionals. It is not uncommon for individuals to be sent home from emergency rooms (ERs) with no follow-up care or to end up with long-term problems that no one understands. This paper will define concussion, present the common symptoms of concussions and discuss ways to help people who sustain concussions.

Each year, it is estimated that approximately 1.5 million people experience concussions. Vehicular crashes (cars, motorcycles, bicycles), sports/recreational activities (football, hockey, playgrounds), abuse/assault (shaken baby syndrome, beatings), falls (young children and the elderly) and other events all have been implicated. It is easy to see that almost any activity can put a person at risk for a concussion. It is a little surprising that people do so well avoiding concussions and equally not surprising that many of us have had concussions.

It is important to note that concussions clearly are associated with lifestyle and parallel other similar lifestyle injuries. If you are involved actively in sports that put your body at risk for muscle pulls, strains, sprains and broken bones, then your chances of a concussion also are great. The Centers for Disease Control and Prevention (CDC) estimates 300,000 sports-related concussions in the United States each year. The more risk to your body, the more risk of serious harm and permanent damage, and the greater the chances that a concussion or more permanent brain injury can occur.

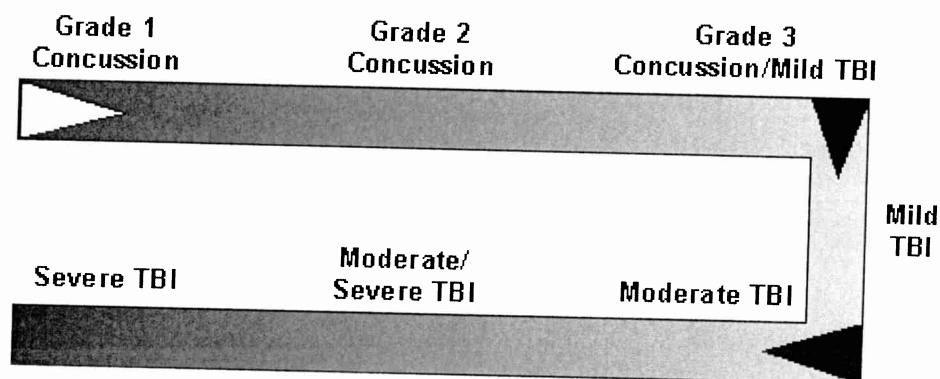
If your job involves heavy labor in farm or construction settings, your chances of physical injury increase and the chances of a concussion increases as well. The use of substances, such as alcohol, that alter your judgment and coordination about everyday activities, like driving or even walking, put you at risk for physical injury and, therefore, at similar risk for a concussion or more serious brain injury. Children--especially younger children--are susceptible to sustaining concussions from falls, play activities and abuse. Lastly, older individuals with balance problems may be prone to falls that can result in not only broken hips, but concussions as well.

### **What is Concussion?**

It is important to understand that a concussion is a physical injury to the brain that causes a disruption of normal functioning just like any other physical injury disrupts your normal functioning. For example, some ankle injuries (i.e., sprains and fractures) are more disruptive

than others, just as some brain injuries are more disruptive than others. The better we understand any injury, the better our chances are for a speedier and healthier recovery.

There is some confusion as to the definition of a concussion and the definition of a mild traumatic brain injury (MTBI). Brain injury can be viewed along a continuum that incorporates concussion, mild brain injury, moderate brain injury and severe brain injury. Each type of brain injury varies depending upon: 1) whether the person was unconscious, 2) how long he/she was unconscious, 3) the length of their amnesia, 4) the resulting cognitive, behavioral and physical problems and 5) the recovery. Viewed as a continuum, the severity of brain injuries can be represented as follows:



As one can see, the definition for a Grade 3 concussion and a MTBI tend to overlap on this continuum.

To further clarify, a concussion is defined as a trauma (i.e., a blow to the head or a serious whiplash) that induces an alteration in mental status (physical or cognitive abilities) that may or may not involve a loss of consciousness.

Concussion as detailed by guidelines developed by the American Academy of Neurology (AAN) and the Brain Injury Association (BIA), commonly is divided into three different types.

#### Grade 1 Concussion

- Person is confused but remains conscious.
- SIGNS: Temporarily confused, dazed, unable to think clearly, has trouble following directions
- TIME: Symptoms clear within 15 minutes

#### Grade 2 Concussion

- Person remains conscious, but develops amnesia .
- SIGNS: Similar to Grade 1
- TIME: Symptoms last more than 15 minutes

#### Grade 3 Concussion

- Person loses consciousness
- SIGNS: Noticeable disruption of brain function exhibited in physical, cognitive and behavioral ways.
- TIME: Unconsciousness for seconds or minutes

It is important to note that a person can sustain a concussion (Grades 1 & 2) without losing consciousness. A Grade 3 concussion involves the loss of consciousness, even if only briefly. As defined by the American Congress of Rehabilitation Medicine, MTBI is a traumatically induced physiological disruption of brain function as manifested by some or all of the following:

- Any period of loss of consciousness
- Any loss of memory for events immediately before or after the incident
- Any alteration in mental state at the time of incident
- Focal neurological deficits that may or may not be transient but does not exceed:
  1. Loss of consciousness of approximately 30 minutes or less
  2. An initial Glasgow Coma Scale score of 13-15 after 30 minutes
  3. Post-traumatic amnesia (PTA) of no more than 24 hours

If concussion and MTBI are seen as part of the brain injury continuum, with Grade 3 concussion and MTBI overlapping, one can get a better understanding of how these definitions compliment each other and enhance our understanding. BIA estimates that approximately 75% of all brain injuries fall in the "concussion-MTBI continuum."

### **The Functional Mechanics of Concussion**

Two mechanisms currently are believed to underlie the changes following concussion. In the first, a sudden movement or direct force applied to the head can set the neural matter of the brain in motion even though the brain is well protected in the skull and very resilient. This motion squeezes, stretches and sometimes tears the neural cells, changing the precise balance and distance the cell's axons and dendrites maintain to transmit or process information.

The second mechanism involves changes that occur in the neuron's ability to produce energy for the cell's vital functions in structures called mitochondria. An initial increase in energy production occurs followed by a dramatic decrease that affects the ability of the cell to produce structural proteins to preserve the diameter of the axon. This change occurs gradually after the time of impact and may be responsible for the delay in symptoms sometimes observed.

The changes that occur affect the electrical or chemical aspects of neural cell functioning and result in unusual processing of normal information. (For this reason, radiologic studies that look at the structure of the brain, such as CT scans and MRI, are most frequently read as normal after concussion/MTBI.) This actually is quite adaptive because the brain cells automatically keep working to reconnect or establish normal impulse transmission. Even the loss of consciousness is adaptive, because the brain shuts down all unnecessary functions until the most important life sustaining neural adjustments are made. Unfortunately, sometimes these neural adjustments cannot be made quickly enough and death can occur.

As a person recovers, the cells re-establish the precise balance needed to ensure effective information processing, but this may mean some compensation or adjustments to the neural cell's original alignments. The more often neural cells must compensate or adjust to injury, the more likely the task takes longer and may not be as complete. For example, when a person sprains or fractures an ankle, professionals recommend cold/heat treatments, rest and supports (i.e., cast, brace) and specific exercises to help the ankle adjust to the injury and recover maximal function. Depending on the severity of the ankle injury (i.e., sprain, fracture) and what is required after recovery (i.e., long distance running, ballet), the severity of the injury to the ankle can disrupt a person's life. Obviously, a human brain is much more complicated than an ankle. Yet similarly, rest, supports (i.e., compensations, modifications) and "exercises" (i.e., therapies, education) for the brain may be recommended to rehabilitate and restore useful

function. Depending on the severity of the concussion and what the person needs to do (i.e., care for a family, return to work or school, manage a large company), a concussion can disrupt a person's life for a short period of time or even longer.

To review, a concussion causes a disruption of normal brain function that may be a temporary inconvenience or result in permanent changes in brain function. Where there are complicating factors, the disturbance in brain function can be fatal. Because of the potential life-threatening danger associated with brain injury, the severity of any brain injury—including concussion—is determined at the time of the injury, based on measures of physical, cognitive and behavioral responsiveness. Again, the three categories commonly used to describe brain injury—mild, moderate and severe—indicate only how seriously impaired the person was at the time of the injury. Thus, on the brain injury scale of severity, a concussion usually is classified as a MTBI because the alterations in brain function are not severe enough or do not last long enough to be classified as moderate or severe brain injury. In the moderate and severe classifications, there appears to be direct damage to the brain's neural network with long-term difficulties related to the sites of the damage. The long-term effects of MTBI on brain cell recovery and functioning and behavior vary across individuals. However, for most individuals, no long-term neuronal changes are noted after three to four months and the cognitive and behavioral adjustments return to normal.

Exceptions to this rule exist. Studies indicate that age (i.e., 40 years or older), the presence of a systemic disease (i.e., diabetes mellitus), and possibly female gender affect the recovery process. Other risk factors for delayed recovery include a history of previous brain injury or when situational and personality factors play a role in recovery. For example, individuals who sustain a second concussion while still symptomatic from the first one may sustain what is termed "second impact syndrome." This condition is very serious and can result in lifelong impairments, coma and even death. Individuals who sustain a series of multiple concussions over time (i.e., boxers, abused children) may be left with permanent impairments and disabilities. People who have mental health issues or other disabilities (i.e., attention deficits, learning disabilities) may find that a concussion further complicates their behavioral and learning challenges. Also, even litigation issues may complicate a person's recovery.

The symptoms of concussions cover a wide range of perceptual, sensory, cognitive, emotional and behavioral features. The TABLE below lists the common early and late symptoms of concussion:

#### Early Symptoms:

- Headache
- Dizziness or vertigo
- Lack of awareness of surroundings
- Nausea with or without memory dysfunction
- Vomiting

#### Later Symptoms:

- Persistent low grade headache
- Lightheadedness
- Poor attention and concentration
- Excessiveness or easy fatigue
- Intolerance of bright light or difficulty focusing vision
- Intolerance of loud noises
- Ringing in the ears

- Anxiety and depressed mood
- Irritability and low frustration tolerance

As you can see, many of the symptoms listed above are common to a variety of other natural human experiences. Feeling scared or anxious can make our vision change and cause dizzy feelings and numerous "fight or flight" reactions. Muscle cramps in the neck can give headaches, just as not having our usual dose of caffeine causes headaches. A virus can make us feel "spaced-out" and affect our balance. Depression can affect our cognitive abilities and memory. Being angry over changes due to an injury such as a broken arm can make us irritable and affect our motivation. And, as with concussion, if everyone else feels you "should be over it by now," being treated unfairly may cause hopelessness that makes it difficult to concentrate and sleep.

## **Recovery Variations after Concussion**

Concussions vary, depending upon the type and the individual, hence, recovery varies as well. Some commonly asked questions by individuals who sustained concussions include:

Why is there so much variation in symptom presentations? This variation can best be explained because people differ and their perceptual experience of sensations such as pain and distress remains subjective. Without a technology (i.e., more sophisticated CT/MRI scanning technology) to measure these individual experiences, it remains difficult to determine when the brain's coping or healing has taken place and when the individual's reaction to the process has left perceptual and learned phenomena. Thus, we need to monitor the symptoms of concussion in order to monitor recovery. The following checklist can help individuals and their families monitor their recovery one to three months after a concussion so they can report this information to their physician or therapist. Symptoms that persist beyond the usual recovery time for concussion need to be evaluated and treated more carefully.

### **Physical Symptoms**

- Headache, dizziness, lightheadedness
- Vomiting or nausea
- Numbness or tingling
- Balance problems, clumsiness, drops things, trips often
- Fatigue, tires easily, needs extra sleep, drowsiness, trouble falling asleep or staying asleep
- Sensitivity to light and noise
- Blurry vision
- Ringing in ears

### **Cognitive Symptoms**

- Confusion, in a "fog," has befuddled expression, gets mixed up about time and place
- Attention or concentration problems, inability to do more than one thing at a time, unable to return to a task if interrupted
- Memory problems, forgets things
- Takes longer to get things done or complete assignments
- Has problems organizing thoughts or words, misunderstands things

### **Behavioral Symptoms**

- Restless, irritable, fussy
- Acts without thinking

- Becomes upset easily, loses temper
- Sadness, depressed mood
- Anxiety, nervousness

Why some people adjust better after a concussion than others? Research in cognitive-behavioral therapy supports the notion that: 1) looking at the positive aspects of recovery, 2) taking steps to gain control of your rehabilitation and 3) knowing that fundamental healthy behavior requires a focused rehearsed plan all can contribute to dealing better with the many sensations and feelings that often follow concussion. Concussion needs to be taken seriously and modifications to a person's life (i.e., home, work, school) need to be made during the recovery period. Just because a person "looks great" does not mean that they are recovered fully. Having a good plan for recovery and knowledge about concussion helps individuals feel more in control and lessens their anxiety.

Why do concussive symptoms change over time? It now appears that during the first months after concussion the brain begins to heal and evidence suggests that there is little trace of brain damage after three to four months. During this period of time, sleep patterns return to normal, sensations mirror the brain's recovery and efforts to return to normal and develop a sense of self are influenced by the rehabilitation process. For example, many strange sensations accompany recovery from a sprained or fractured ankle, including pain from the efforts a person makes to accommodate the recovery time (such as muscle atrophy), as well as sleeping and exercise changes due to limitations. Brain function is much more complex to understand and monitor. Yet, just as an ankle can "return to normal" over time, so can the brain after concussion.

Why can't professionals tell if there is permanent brain injury over time? Without doing an autopsy, brain function can only be estimated. For example, neurological testing can provide information about what a person might be able to do at this point in time, but without the same information from before the concussion, it is only possible to estimate how a concussion affected performance. Many professionals use various tools to help them understand the degree of brain damage (i.e., CAT scans, MRI, neuropsychological batteries, neurolinguistic assessment, functional behavioral analysis), but these tools are only approximations and it is difficult to predict the total impact a brain injury may have on a person's life. The best "predictor" is the person with the injury working with a dedicated team of professionals to identify and compensate for permanent damage.

Is permanent brain damage always bad? This is a trick question because the easy answer is that damage always means a loss of brain cells. Yet, many people can attest that the loss of brain cells does not mean that they themselves are "lost". Rather, many individuals have found the strategies and techniques they have used to cope with brain injury have been helpful in assisting them to become the person they felt they wanted to be all along--happy, loved, productive and important. The experience of coping with a rehabilitation or treatment program has helped them: 1) appreciate their talents, 2) give up bad habits and 3) become more mindful of what they truly wanted out of life. This is not to minimize the tremendous changes brain injury causes for people and their families, but rather to emphasize the importance of good treatment programs and community support to help people re-define their lives.

## **Treatment Recommendations**

The only cure for brain injury is prevention. Obviously, the treatment of concussion starts with prevention. Thoughtful preparation before activities--knowing your limits; minimizing risk to one's head by wearing protective gear such as seat belts, helmets, hard hats; and being

substance free when activities require concentration such as driving, bicycling, swimming, boating and skiing--all will reduce the likelihood of injury. Unfortunately, concussions often are difficult to prevent even with careful preparation and protective gear.

Immediately after a concussion, emergency care may be required. Since life-threatening complications--usually due to brain swelling and bleeding--can occur from any brain injury regardless of the type, all brain injuries must be taken seriously. The proper assessment of concussion by emergency medical professionals and physicians is critical.

AAN and the BIA have developed a clear, scientifically based set of guidelines for the medical management of concussion in sports that is used by team physicians, coaches and athletic trainers and can easily be adapted for all concussions. Thus, after the type of concussion has been determined, management guidelines are implemented. If an adult sustains a Grade 1 or 2 concussion, it may be wise for that person to rest for two or three days before returning to regular activities and not operate a motor vehicle for at least a week. If a child crashes a bicycle and the physician has examined and given them a clean bill of health, it is wise to keep the child off the bicycle for a week. As always with children, the rule should be that if it has wheels, you need a helmet.

The potential danger with concussion is sustaining a second one before allowing the brain time to rest and recovery from the first one (as we would for a broken ankle). The chart below summarizes AAN's management recommendations for athletes returning to play after concussion, but reworded for the general audience. Please remember that all concussions are potentially serious and an individual should be examined by a physician if there is any doubt about their safety.

#### Grade 1 Concussion Management Guidelines

If the person has no symptoms or mental status abnormalities 15 minutes after the injury, he/she can resume normal activities. All symptoms from the concussion must have disappeared, first at rest and then with exertional testing, before the individual can return to regular activities.

#### Grade 2 Concussion Management Guidelines

The individual should refrain from activities for at least one week, again only after the person is asymptomatic at rest and during exertion. Additionally, a physician should perform a neurological exam before the individual is allowed to go back to regular activities. If the individual experiences a worsening in headaches and other concussion symptoms and/or these symptoms last longer than a week, a CT scan or MRI is recommended.

#### Grade 3 Concussion Management Guidelines

One month should be the minimum period for an individual to return to rigorous activity. For an individual with a brief loss of consciousness (i.e., seconds), he/she can return to regular activities only after being asymptomatic for at least one week. For a person who had a prolonged loss of consciousness (i.e., minutes), he/she can resume normal activities no sooner than after two weeks of rest. A thorough neurological examination and a neuro-imaging study (i.e., CT scan, MRI) should be performed on all individuals who have been rendered unconscious for brief periods of time. The individual should be admitted to the hospital if any signs of pathology are detected and/or the mental status of the person remains abnormal.

Recovery after concussion--just like a sprained or fractured ankle--takes time. An individual with a broken ankle would not go out the next day and run a marathon. That individual likely would take time out from work, rest and put the leg up, use crutches, attend therapy, if necessary, and allow the ankle time to recover. Too often after concussion, many individuals immediately return to work or school, push themselves to think as well and as quickly as they did before and expect that in a day or two they are recovered fully. One of the problems with concussion is that people try and "get back on the horse" too quickly. The danger in doing this is that the person could sustain a second concussion (i.e., the athlete returns to the game; the child gets back on his/her bicycle; the person resumes driving a car) that could cause more serious injury to the brain. Or, if individuals push themselves to perform and/or are expected to perform by their colleagues and family too soon after the concussion, the symptoms may become exacerbated.

After a concussion, it is wise for people to modify their lives by: 1) reducing workloads, 2) building in rest periods, 3) giving more time to finishing projects, 4) developing a written plan to refer to when confused or uncertain, 5) using a notebook/calendar to write things down and check-off when completed, 6) writing down schedules with time, place and person and 7) avoiding the use of alcohol or other substances that may slow recovery.

It is also important to monitor symptoms over the next one to three months and report this data to one's physician and other treating professionals. Family members can become more knowledgeable about concussion and help the person make accommodations, monitor symptoms and ensure that--just like with a broken ankle--the person is given ample healing time. The use of other professionals, such as a Neuropsychologist, can help through testing to determine a person's strengths, needs and preferences. Psychologists and counselors may be extremely beneficial in helping people with more serious injuries to understand and adjust to any changes caused by the concussion. BIA, its chartered state affiliates and support groups may provide the person with education about concussion and where to go for additional help.

## **Conclusion**

Concussion is the most common of all brain injuries. It needs to be better understood, evaluated and treated. Individuals who sustain concussions may experience an array of symptoms, both short, and long term. The important thing is to take any concussion seriously and recognize that recovery is dependent on many things.

### **About the Authors...**

William Frey, PhD, maintains a private clinical psychology practice in Rutland, VT, specializing in behavioral medicine with a focus on traumatic brain injury rehabilitation. He received his BA from Villanova University (1967) and his MS (1969) and PhD (1976) from the University of Vermont. In addition to his clinical practice, he has held faculty positions at the University of Vermont, St. Michael's College and Middlebury College and, most recently, had been interim Dean of Student Development at Green Mountain College in Poultney, VT. He has been a President of the Vermont Psychological Association (1985-1987) and a founding board member of the Vermont Head Injury/Stroke Independence Project (1983-1986). He has published articles on mild traumatic brain injury and the impact of brain injury on sense of self and has developed an ecologically-based rehabilitation model for traumatic brain injury.

Ronald C. Savage, EdD, has worked with children, adolescents and young adults with neurological injuries and disabilities for over 25 years. Presently, Dr. Savage is Executive Vice President for Professional Development at Bancroft NeuroHealth in New Jersey. He is the former Senior Vice President of Behavioral Health and Rehabilitative Services at The May



Institute in Massachusetts and the former Director of Clinical Services for Rehabilitative Services of New York and the company's for rehabilitation facilities. In addition, Dr. Savage has taught at the elementary and secondary school level as a classroom teacher and as a special educator, as well as teaching at several colleges and universities. Dr. Savage presently holds academic appointments at Tufts University, Department of Rehabilitation Medicine; Northeastern University, Department of Psychology; The George Washington University School of Education; and the Laboratorio de Neuropsicologia, Universidad de Sevilla, Spain. Dr. Savage has presented at over 200 conferences, training seminars and grand rounds presentations in the past four years. He has published numerous articles, chapters, manuals and books on children, adolescents and adults with traumatic brain injuries and other neurological disabilities.

#### References

- Centers for Disease Control and Prevention: Facts about Concussion and Brain Injury. U.S. Dept of Health and Human Resources, Washington, DC, 2000.
- Frey WF: Psychotherapeutic interventions for mild traumatic brain injury. In: Educational Dimensions of Acquired Brain Injury. RC Savage & GF Wolcott (Eds). Austin, TX: PRO-ED, 1995.
- Kelly J & Savage RC: Concussions in Sports. Brain Injury Source. 3(2): 34-37, 1999.
- Kelly J & Rosenberg J: The development of guidelines for the management of concussion in sports. Journal of Head Trauma Rehabilitation. 13(2): 53-65, 1998.
- McCrea M, Kelly J & Randolph C: The Standardized Assessment of Concussion (SAC) Manual. Alexandria, VA: Brain Injury Association, 1997.
- Savage RC: Bing, Bang, Bong: When your Child has a Concussion. Wake Forest, NC: L&A Publishing, 2000.

#### Content Edited By

Lisa Ward, Director of Communications, Brain Injury Association  
Monique J. Marino, Publications Manager, Brain Injury Association