



# Brain Injury: The Abc Years

## Understanding and Preventing Pediatric Brain Injury

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### Introduction

According to the Centers for Disease Control and Prevention (CDC), **an estimated 5.3 million Americans, a little more than 2 percent of the U.S. population**, currently live with disabilities resulting from brain injuries. The CDC also reports that of the one million people who are treated in and released from hospital emergency rooms each year:

- 230,000 will be hospitalized and survive
- 80,000 will experience an onset of disabilities resulting from their brain injuries
- 50,000 will die

After many years of studies, the following findings have been released about the prevalence of brain injury:

- The risk of having a brain injury is especially high among adolescents and young adults, as well as people older than 75 years (CDC, 1999). In fact, it is males 14 to 24 years of age who are at the highest risk for sustaining a brain injury, followed by infants and the elderly (Kraus, 1993)
- For persons of all ages, the risk of brain injury among males is twice the risk among females, due to differences in risk exposure and lifestyle (CDC, 1999; Kraus, 1993)
- The leading causes of brain injury are motor vehicle crashes, violence and falls (CDC, 1999)
- The leading causes of brain injury vary by age. Falls are the leading cause among persons aged 65 years and older and 5 years of age and under, whereas transportation-related injuries are most frequent among persons ages 5 to 64
- The outcome of these injuries varies greatly depending on the cause: 91% of firearm-related brain injuries resulted in death, but only 11% of fall-related ones proved fatal (CDC, 1999)



## What Is Brain Injury?

**Traumatic brain injury (TBI)** has been defined as a physiological disruption of brain function resulting from trauma both external (an object striking the head or the head striking an object) and/or internal (the rapid acceleration/deceleration of the brain within the skullcap).

There are two basic types of brain injury. Open head injuries are caused by bullets or other penetrating objects. Closed head injuries are the more common of the two and usually are caused by a rapid movement of the head during which the brain is bounced back and forth within the skullcap. Closed head injuries often result from motor vehicle crashes, falls and injuries sustained during sports and other recreational activities (i.e., football, bicycling).

Brain injuries are classified in terms of severity (i.e., mild, moderate, severe):

### Mild Brain Injury

Also known as concussion, a mild brain injury is defined as one in which an individual experiences at least one of the following: 1) any period of loss of consciousness; 2) any loss of memory of events immediately preceding and/or following the injury; 3) any alteration in mental state at the time of the injury and 4) focal neurological deficit(s) that may or may not be transient.

The most common symptoms of mild brain injury fall into the following categories:

- **Physical** (headache, dizziness, nausea, sleep problems, fatigue)
- **Cognitive** (decreased attention span, concentration, mental speed and short-term memory)
- **Behavioral** (irritability, emotional lability, depression, anxiety)

The majority of individuals who sustain a mild brain injury will recover spontaneously and with no residual deficits within one to three months, although some individuals may require a longer length of time. Even with a mild brain injury or concussion, a relatively subtle amount of damage occurs and a small subset of people will be left with permanent disability or deficits.



## Moderate Brain Injury

Although a mild brain injury can be identified and documented easily, distinctions between moderate and severe brain injury are less clear-cut. Generally, a moderate brain injury is one that results in a loss of consciousness lasting only a few minutes to a few hours, followed by days and/or weeks of confusion. Persons sustaining a moderate brain injury usually have physical, cognitive and/or behavioral impairments which can last for many months and even become permanent. Although to a lesser extent, these impairments are similar to those experienced by individuals with severe brain injury. With treatment, however, individuals with moderate brain injuries usually are able to make a complete recovery or successfully learn to compensate for their deficits. (For more information about deficits after brain injury, see the “Consequences” section on page 7.)

## Severe Brain Injury

Severe brain injury almost always results in prolonged unconsciousness or coma lasting days, weeks and even months after the injury. Coma is defined as a state of unconsciousness from which the individual cannot be awakened; in which the individual responds minimally or not at all to stimuli and initiates no voluntary activities. Although persons who sustain a severe brain injury can make significant improvements in the first year after the injury and continue to improve at a much slower rate for many years, these individuals often will be left with permanent physical, cognitive or behavioral impairments.

## Brain Injury And Children

Brain injury is the most frequent cause of disability and death among children and adolescents in the United States (CDC, 1999; Lehr, 1990). Each year, more than one million children sustain brain injuries ranging from mild to severe (Eiben et al., 1984). According to the National Pediatric Trauma Registry, approximately one-third of all pediatric injury cases are related to brain injury (1993). As noted previously, the causes and consequences vary with the child’s age.

## Causes

**Falls**—For children under five years of age, falls are the number one cause of brain injury, accounting for more than 50% (Kraus et al., 1984; Ivan et al., 1983). The severity of brain injury is determined by the distance of the fall and the type of landing surface (i.e., concrete pavement, sand). Because falls are associated with a child’s curiosity and development of motor skills, children under age 10 are at the greatest risk for fall-related brain injury and death (National Safe Kids Campaign, 1999a). During a fall, a child’s brain is at special risk because of the size and weight of his/her head in relation to his/her body.



Infants are at greater risk of falls from changing tables, cribs and other pieces of furniture, stairs and baby walkers. Toddlers and school age children are predominantly at risk for falls from windows, balconies, porches, stairs and playground equipment. In children four years of age and under, more than 89% of fall-related injuries occur in the home (National Safe Kids Campaign, 1999a). Children between the ages of 5 and 14 experience 45% percent of fall-related injuries in the home and 23% in school settings (National Safe Kids Campaign, 1999a).

### ***Preventing Falls***

The following are tips to help prevent infants and children from sustaining a brain injury in a fall:

- Never leave infants unattended on changing tables or other furniture where there is danger of falling
- Never use baby walkers on wheels. Use alternative products such as stationary activity centers
- Use safety gates at the top and bottom of all stairs
- Lock all unopened windows. Open windows from the top, not the bottom. Move chairs and other furniture away from windows. Consider installing window guards in all windows
- Be sure that children are always supervised and do not allow them to sit on ledges

***Motor Vehicle Crashes***—The second major cause of pediatric brain injury is motor vehicle crashes with children as passengers. Among children ages 4 to 14, it is the number one cause of brain injury.

Although 85% of infants (children under age one) were restrained while riding in motor vehicles in 1997, only 60% of children ages one to four were restrained (National Safe Kids Campaign, 1999b). As they grow older, the percentage of children being restrained continues to decrease. Unrestrained children of any age are more likely to incur a brain injury and/or die in motor vehicle crashes than children that are restrained. In fact, among children ages 14 and under who were killed as occupants in motor vehicle crashes in 1997, 63% were not using safety restraints at the time of the collision (National Safe Kids Campaign, 1999b). Misuse of child safety seats is rampant and it is estimated that 80% of children who are placed in child safety seats are being improperly restrained (National Safe Kids Campaign, 1999b).

### ***Preventing Motor Vehicle Crashes***

Correctly installed child safety seats in passenger cars are extremely effective, reducing the risk of death by 77% for infants and by 54% for children ages one to four (National Safe Kids Campaign, 1999b).



Adult safety seat belts do not adequately protect children ages four to eight from sustaining a brain injury during a motor vehicle crash. Car booster seats combined with proper seat belt usage are the best protection, although it is estimated that only 5% of the children in this age group are properly restrained in booster seats. To further prevent the risk of a child sustaining a brain injury during a motor vehicle crash, follow these simple precautions:

- Always place infants and children under 12 in the back seat of the car
- Infants age one and under or children weighing less than 20 pounds should ride in rear facing child safety seats in the back seat
- Never put an infant in the front seat of a car with passenger side airbags
- Children weighing 20 to 40 pounds should ride in approved car seats, facing forward in the back seat
- Children weighing 40 to 80 pounds should ride in approved car booster seats in the back seat

***Pedestrian***—Each year, approximately 50,000 children are hit by motor vehicles, often receiving serious brain injuries (Child Pedestrian Safety Program, Harborview Injury Prevention and Research Center, 1995). Children are particularly vulnerable to pedestrian brain injury and death because they are exposed to traffic threats that exceed their cognitive, developmental, behavioral and physical abilities.

### ***Preventing Pedestrian Injuries***

- When crossing the street, children should hold an adult's hand and cross at designated crossing areas
- Children should never cross between parked cars
- Children should be taught to look left-right-left when crossing and watch for cars that are turning
- Children should always walk on the sidewalk. When there is no sidewalk, children should walk facing traffic
- When outside after dark, children should always wear reflective materials

***Abuse***—Abuse is another leading cause of serious brain injury in children. Approximately two-thirds (64%) of children under one year of age that are physically abused sustain brain injuries (Billmire & Myers, 1985). An outcome study of children younger than six years found that cognitive and motor abilities were more damaged in children who had been abused versus children who had sustained accidental brain injuries (Kriel et al., 1989).

***Shaken Baby Syndrome***—is a disturbing and serious cause of brain injury caused by a vigorous shaking of an infant or child by the arms, chest or shoulders. This forceful shaking can result in brain injury leading to cognitive, physical and behavioral impairments and even death.



Head trauma is the most frequent cause of permanent damage or death among abused infants and children, and shaking accounts for a significant amount of these cases (Showers, 1999).

The potential outcome of shaken baby syndrome is generally severe brain injury or even death. Approximately 75-90% of these cases exhibit retinal hemorrhages, a symptom almost never seen with accidental brain injuries (The National Conference on Shaken Baby Syndrome, 1996). Males are the predominant perpetrators, involved in between 65-90% of the cases, followed by female babysitters or childcare providers. The number one cause of Shaken Baby Syndrome and other forms of child abuse is inconsolable crying.

### ***Preventing Abuse***

Any parent or caregiver who fears they may injure a child should follow three simple steps:

- **Stop:** Put the child in a safe place and leave the room for a few minutes
- **Calm Down:** Call a friend or neighbor. Take 10 deep breaths. Change the activity. Sit down, close your eyes and think of a pleasant memory
- **Try Again:** Go back to your child and try again to deal with the problems at hand

***Firearms***—Every two hours in the United States someone's child is killed with a loaded gun (American Academy of Pediatrics, 1994). It is estimated that half of all American households have firearms. In 1992, firearms surpassed motor vehicles as the number one cause of brain injury fatalities in the United States (Sosin et al., 1995).

Firearm violence is a uniquely American problem, with a rate approximately 90 times greater than any other similar country (Martin, 1998). In 1992, handguns were used to murder 13 people in Australia, 33 in Great Britain, 36 in Sweden, 60 in Japan, 97 in Switzerland, 128 in Canada and 13,495 in the United States (Think First Foundation, 1999).

Exposure to guns and access to a loaded firearm increase the risk of unintentional brain injury and death in a child. The unintentional death rate among children 14 years of age and younger is nine times higher than in 25 other industrialized countries combined (National Safe Kids Campaign, 1999c). Nearly all unintentional shootings occur in or around the home. Most unintentional shooting deaths involve guns that have been kept loaded and accessible to children and occur when children play with loaded guns (National Safe Kids Campaign, 1999c).



## ***Preventing Firearm Injuries***

An estimated 30% of all unintentional shootings could be prevented by the presence of safety features such as trigger locks and loading indicators, but American-made guns are not subject to federal safety standards like other consumer products. To help protect a child from sustaining a brain injury from firearms, follow these simple steps:

- Always keep guns unloaded and locked up. Lock and store bullets in a separate location and make sure children do not have access to the keys
- Explain to children that guns are dangerous and that they never should touch guns or remain in a home where a gun is accessible
- Tell children that gun violence in the media is not real — in real life children are hurt and killed with guns
- Talk with children about ways to solve arguments and fights without guns or violence
- The best way to reduce gun risks is to remove the gun from your home

## **Consequences**

Impairments from brain injury can be divided into three major categories: physical, cognitive and behavioral.

### **Physical Impairments**

- Speech, vision, hearing and other sensory impairments
- Headaches
- Lack of coordination
- Muscle spasticity (A condition that causes stiff, tight muscles, especially in the arms and legs, making movements stiff, jerky or uncontrollable)
- Paralysis
- Seizure disorders
- Problems with sleep
- Dysphagia (a disorder of swallowing)
- Dysarthria (a disorder of articulation and the muscular/motor control of speech)

### **Cognitive Impairments**

- Short- and long-term memory deficits
- Slowness of thinking
- Problems with reading and writing skills
- Difficulty maintaining attention and concentration



- Impairments of perception, communication, reasoning, problem solving, planning, sequencing and judgment
- Lack of motivation or inability to initiate activities

## Behavioral Impairments

- Mood swings
  - Denial
  - Depression and/or anxiety
  - Lowered self esteem
  - Sexual dysfunction
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- Restlessness and/or impatience
  - Inability to self-monitor, inappropriate social responses
  - Difficulty with emotional control and anger management
  - Inability to cope
  - Excessive laughing or crying
  - Difficulty relating to others
  - Irritability and/or anger
  - Agitation
  - Abrupt and unexpected acts of violence
  - Delusions, paranoia, mania

## Outcome After Pediatric Brain Injury

When dealing with pediatric brain injury, it is important to recognize that children are not simply smaller versions of adults. When infants and toddlers sustain traumatic brain injuries, many people cite the adage that the younger the child, the better they will do. The assumption is made that because the very young child has yet to use many parts of his/her brain, there is ample room for a good outcome (Wedel-Sellers & Hill-Vegter, 1997).

Further studies seem to cast doubt on this theory when the causes of injury and the outcome of the young child are examined (Wedel-Sellers & Hill-Vegter, 1997). In any case, the child's cognitive, personality and psychosocial development need to be considered in the assessment and treatment of a brain injury. Unlike adults, the effects of brain injury on brain function interact with the maturation or development of the child. Skills that are emerging or developing may be affected differently by brain injury than skills that are already established.





The child with a brain injury is unique not only in comparison with peers of the same age, but also to other children with brain injuries. Each child's recovery process, outcome and family are different and unique. Although this is true for any man, woman or child who sustains a brain injury, nowhere is it more different than in the very young child (Wedel-Sellars & Hill-Vegter, 1997).

## **Return To School After A Brain Injury**

The education of a student with brain injury becomes more complex over time, as schoolwork gradually becomes more difficult with each grade level entered. Outcomes from pediatric brain injury are rarely predictable and neither is the student's progress in school.

The pattern of quicker physical recovery among children and the emergence of cognitive and behavioral impairments over time make accurate assessments much more complicated. As the child's brain is still maturing, the full impact of a brain injury may not become evident for many months or even years. This time delay makes it even more difficult for parents, educators and clinicians to establish the relationship between an earlier injury and altered abilities to learn and function in the classroom and school environment.

Before the child returns to school, it is necessary for the student, parents, rehabilitation and educational professionals to sit down and complete an Individualized Educational Plan (IEP). An IEP is an educational plan designed by the public school system outlining the special learning needs of a child, including:

- The amount of special education or resources which needs to be provided
- The educational and learning goals
- The frequency of the interventions within the school (usually revised yearly)

Although it can be extremely challenging for parents and educators to work together to develop and continue supporting an IEP for a student with such unique and complex needs, it is essential to the successful return to school of a child with a brain injury.



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For more information about any topic covered in this educational pamphlet, contact the Brain Injury Association's (BIA's) Family Helpline at (800) 444-6443, visit its web site at <http://www.biausa.org> or write to BIA, Information and Resources Department, 105 North Alfred Street, Alexandria, VA 22314.

## Additional Resources

American Academy of Pediatrics  
141 Northwest Point Blvd.  
Elk Grove Village, IL 60007-1098  
Phone: (847) 228-5005  
Fax: (847) 228-5097  
Web site: <http://www.aap.org>

National Safe Kids Campaign  
1301 Pennsylvania Ave., NW  
Suite 1000  
Washington, DC 20004-1707  
Phone: (202) 662-0600  
Website: <http://www.safekids.org>

American Academy of Neurology  
1080 Montreal Avenue  
St. Paul, MN 55116  
Phone: (800) 879-1960  
Fax: (612) 695-2791  
Web site: <http://www.aan.com>

National Highway Traffic Safety Administration (NHTSA)  
National Organizations for Youth Safety  
400 7th Street  
Washington, DC 20590  
Phone: (800) 424-9393  
Web site: <http://www.nhtsa.dot.gov>

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