

Understanding Traumatic Brain Injuries

The recent tragic death of Natasha Richardson has raised a lot of questions about how traumatic brain injury occurs—around the country and even here at Children’s. We heard feedback that many people on our staff, clinical and non-clinical, wanted a better understanding of how it happens and what the warning signs are.

We asked Andrew Reisner, M.D., pediatric neurosurgeon and Medical Director of the Children’s Neuro Trauma program, to answer some questions about traumatic brain injury (TBI).

What is traumatic brain injury?

Traumatic brain injury (TBI) occurs when a force is applied to the brain, resulting in impairment of function. TBI is classified by severity, and this in turn is based on the degree of unconsciousness sustained at the time of injury. This degree of unconsciousness is scored by medical personnel according to the internationally recognized Glasgow coma score (GCS) system (range = 3-15). Severe head injuries are those patients that have a GCS of less than 8, and mild head injuries are 13 or greater, with moderate injuries in the intermediate category.

Trauma may injure the brain by two main mechanisms; *diffuse widespread injury and/or a focal blood clot* (hematoma). Diffuse injury to the brain causes brain swelling which may elevate the intracranial pressure (ICP). Focal bleeding may occur intra-cranially and results in focal deficits to that area, as well as elevation of ICP. The brain is a unique organ in a number of respects, including the fact that it is housed in the skull, a rigid, fixed cavity. Therefore, any pathologic increase in mass, such as brain swelling due to edema or an expanding blood hematoma may increase the ICP to a point that blood flow to the brain is compromised.

Bleeding that occurs outside the brain is known as an *extra-axial hematoma* and includes epidural, and subdural hematoma. Epidural hematomas involve bleeding between the skull and the dura mater and in subdural hematomas the bleeding occurs between the dura and the brain. Blood clots can occur within the brain itself, and are known as *intra-axial hematomas*.

How common is it?

TBI is a health problem of epidemic proportions. The most recent statistics from the CDC revealed that in 2003, there were approximately 1.5 million TBIs in the United States (Rutland-Brown, November-December 2006, *Journal of Head Trauma and Rehabilitation*), resulting in 1.2 million emergency room visits, 290,000 hospitalizations, and 51,000 deaths. TBIs not only affect the patient but also carry social, emotional, and financial ramifications for the family and society at large.

TBI is common in all ages. TBI is the most common cause of death and acquired disability among children from ages 1-18. The causes of TBI vary among ages and

countries, but overall, motor vehicle accidents, military conflicts and sporting injuries are the leading causes.

If someone has injured his or her head, what are the warning signs that something might be wrong and medical attention is required?

The clinical manifestations of head injury depend on the severity.

Mild TBI (symptoms may vary in length of time):

- Patients may be dazed or lose consciousness for a few seconds and then recover
- Persistent headache
- Nausea and/or vomiting
- Sleep and appetite disturbance
- Personality changes
- Lethargy

These symptoms may also be found in those that are recovering from moderate or severe head injuries.

More severe TBI symptoms:

- The cardinal sign that pressure in the brain is increasing is decreasing level of consciousness
- A change in the size of the pupils (anisocoria)
- Cushing's triad (low, slow heart rate, high blood pressure, and respiratory depression)
- As ICP increases, there may be abnormal posturing or position of the limbs

On occasion, patients will sustain a head injury and be dazed or disoriented for a brief period of time. They may make an apparent recovery, known as a lucid interval. This is then followed by a deeper level of consciousness. This occurs when the diffuse swelling of the brain, and/or the hematoma expands in size and increases the ICP. In situations of the latter, often the best treatment is to remove the blood clot as soon as possible. This can be a life-saving measure.

How is TBI diagnosed and treated?

Most patients with a head injury will undergo urgent head CT scan evaluations, which are excellent in confirming or excluding the presence of intracranial hematomas. Other imaging studies that may be needed include x-rays, particularly of the cervical spine and MRI evaluation.

The treatment of head injuries is aimed at stabilizing the patient and preventing further (secondary) injury to the brain. In cases of severe head injury, the treatment options include surgical evacuation of a hematoma as well as catheters to drain cerebrospinal fluid (CSF). Medical treatments include the use of sedatives, paralytic agents, hypertonic

saline, and mannitol. Often the patient is unable to breathe on their own and require mechanical ventilation.

After the acute management in the ICU, survivors are ideally transferred to a rehabilitation center where aggressive physiotherapy is initiated to regain as much of the pre-injury function as possible.

At Children's we have developed and implemented an evidence-based clinical pathway for the treatment of pediatric TBI. This allows for more consistent care, better outcomes and improved cooperation between departments for those children who have sustained a TBI. The pathway has recently reached several new milestones, including the completion of Epic orders for both Children's at Egleston and Children's at Scottish Rite campuses; finalizing guidelines for preadmission management; and increasing the age limit for acceptance to 18 years of age. The neurosurgery team also is providing ongoing training to trauma nurse specialists, who are a tremendous resource in treating patients with severe TBI.

Visit the Brain Injury Association of American [Web site](#) for more information related to TBI.

If someone is diagnosed early enough, do they return to normal or are there long-term effects from the injury?

The prognosis of TBI depends primarily on the severity of the injury. Most mild TBI do not cause significant permanent or long-term disability. However, almost all with severe TBI have the potential to cause significant lifelong complications. Permanent disabilities are thought to occur in 10% of mild injuries, 60% of moderate injuries, and 100% of severe injuries.

A tremendous amount of research has been directed towards the treatment of traumatic brain injuries. Neural protection refers to methods to halt the secondary injuries that occur following a TBI. A number of agents have been tried, but to date none have proved to be universally successful. These treatments include hypothermia, and drugs such as NMDA receptor antagonists.

How can TBI be prevented?

Because the treatment of head injury is not yet ideal, major emphasis is placed on prevention. A number of public health measures have been introduced that have had a significant effect. These include the widespread use of seat belts, child safety seats, motorcycle helmets, the presence of roll bars and air bags. In addition, increasing awareness of the deleterious effects of multiple head injuries are now recognized by most amateur and professional sporting organizations. Simple measures can also be instituted in playgrounds, such as shock absorbing surfaces, as well as in the homes of elderly, such as the installation of grab bars in the bathroom and hand rails on the stairways. Other preventative measures include child abuse prevention, as well as gun safety.

