Primary Care for Children with Brain Injury

Joshua Alexander, MD, Daniel Moore, MD

Each year in the United States, more than one million children and adolescents sustain brain injuries; 100,000-200,000 of them are hospitalized, and more than 30,000 are permanently disabled by their injuries.1 From the moment of occurrence, traumatic brain injury (TBI) transforms the victims' (and their family's) lives forever, bringing a host of new stressors, challenges and needs. As an integral part of the health care team caring for these children and their families, health care providers need to be familiar with the special needs of these patients. In this article we offer an overview for the office-based primary care provider. It reviews common risk factors, provides guidelines for estimating the extent of injury, lists common secondary conditions, and offers recommendations for the care of children with traumatic brain injury.

Risk Factors and Etiology

Twice as many boys as girls sustain brain injuries,2 and persons of lower socioeconomic status are at increased risk. An unusually high percentage of children who sustain TBI have a prior history of behavioral problems like attention deficit disorder.3

The most common cause of TBI in children varies according to age. Children under five years of age are most often victims of falls; children aged 5-14 are most likely to be brain-injured as passengers in a motor vehicle crash. Motor vehicle crashes are also the leading cause of brain injuries and death in 15- to 20-year-olds, usually with the victims as drivers of the vehicles.4

Estimating the Extent of Injury

The severity of a child’s brain injury may be estimated from the initial score on the Glasgow Coma Scale, the presence (and duration) of post-traumatic amnesia, and the presence (and duration) of coma. First introduced in 1974,5 the Glasgow Coma Scale (GCS) uses eye opening, verbal response, and muscle movements to determine an injured person’s level of consciousness. It has become the standard way of assessing brain injury, and although initially developed for adults, a modified version is used for infants and young children6 (see Table 1). Several terms need definition.

Post-traumatic amnesia (PTA) occurs when a child cannot reliably, consistently, and accurately remember events. Amnesia can be measured in children older than 4 years of age with the Children’s Orientation and Amnesia Test (COAT),7 an age-adjusted test which can be administered in less than five minutes and repeated to monitor changes.

Coma is defined as a state of unconsciousness from which a child cannot be awakened, and during which there are no voluntary activities. Its duration may be defined as the length of time from onset until the child begins to display a meaningful response to external stimuli.

Mild brain injury, often called concussion, occurs when a blow to the head produces any loss of consciousness, loss of memory, change in mental status, or focal neurological deficit. It is associated with a GCS score of 13-15. Post-traumatic amnesia, if present at all, lasts less than 30 minutes.

Moderate brain injury is usually defined by an initial GCS score of 9-12, the presence of post-traumatic amnesia lasting from 30 minutes to 24 hours, or coma lasting less than 6 hours. It can cause serious cognitive and behavioral deficits (Table 2), but there is a good chance for improvement. Recovery may take

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weeks to months (sometimes, years) but children often learn to compensate for any residual deficits.

Severe TBI is characterized by an initial GCS score <9, coma lasting more than 6 hours, or post-traumatic amnesia lasting longer than 24 hours. Severe injuries (typically associated with other physical injuries) generally lead to permanent cognitive and behavioral problems.

**Associated Conditions**

Children and adolescents with TBI have a significant risk of impaired behavioral, cognitive, emotional, and physical functioning that will impede their reintegration into their home and school. We summarize here the secondary conditions commonly associated with pediatric TBI.

**Behavior.** Parents often bring a child who has had a traumatic brain injury to the doctor because of concerns about the child’s behavior. They may not be able to pinpoint the problem, but will describe their concerns by saying, “This is not my child,” or “This is not how my child usually acts.” Any behavioral difficulties that antedate the brain injury are likely to be exacerbated. It may be difficult to determine how TBI contributes to a child’s behavior (which may be due to issues unrelated to the brain injury), but brain injury should always be included in the differential diagnosis. Brain-injured children are at increased risk for psychiatric illness, and should be monitored for this.

**Cognition.** Cognitive impairment can be the longest-lasting sequela of TBI and the condition that most limits the child’s reintegration into the home and classroom. All children with brain injury are at risk for difficulties with attention and concentration, easy distractibility, and impaired short-term memory. In addition they can suffer from deficits in logical thinking and reasoning, and impaired cognitive flexibility. Impaired visual and spatial motor skills, and slowed reaction time, contribute to difficulties in the classroom and on the playground; they also increase the risk of further injury.

**Language.** Injuries to the temporal lobes may produce language problems (aphasia, central auditory processing difficulties, word retrieval difficulties, difficulty writing to dictation, problems organizing thoughts, difficulty understanding multi-step commands, and decreased speed of information processing) that limit the child’s academic and functional skills.

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**Table 1. Coma scales**

<table>
<thead>
<tr>
<th><strong>Glasgow Coma Scale</strong></th>
<th><strong>Children’s Coma Scale</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Eye opening</strong></td>
<td><strong>Eye opening</strong></td>
</tr>
<tr>
<td>4 Spontaneous</td>
<td>4 Spontaneous</td>
</tr>
<tr>
<td>3 Reaction to speech</td>
<td>3 Reaction to speech</td>
</tr>
<tr>
<td>2 Reaction to pain</td>
<td>2 Reaction to pain</td>
</tr>
<tr>
<td>1 No response</td>
<td>1 No response</td>
</tr>
<tr>
<td><strong>Verbal</strong></td>
<td><strong>Verbal</strong></td>
</tr>
<tr>
<td>5 Oriented</td>
<td>5 Smiles, oriented to sound, follows objects, interacts</td>
</tr>
<tr>
<td>4 Confused/disordered</td>
<td>4 Consolable</td>
</tr>
<tr>
<td>3 Inappropriate words</td>
<td>3 Inconsistently consolable</td>
</tr>
<tr>
<td>2 Incomprehensible sounds</td>
<td>2 Inconsolable</td>
</tr>
<tr>
<td>1 No response</td>
<td>1 No response</td>
</tr>
<tr>
<td><strong>Motor</strong></td>
<td><strong>Motor</strong></td>
</tr>
<tr>
<td>6 Spontaneous</td>
<td>6 Spontaneous</td>
</tr>
<tr>
<td>5 Localizes pain</td>
<td>5 Localizes pain</td>
</tr>
<tr>
<td>4 Withdraws in response to pain</td>
<td>4 Withdraws in response to pain</td>
</tr>
<tr>
<td>3 Abnormal flexion to pain</td>
<td>3 Abnormal flexion to pain</td>
</tr>
<tr>
<td>2 Abnormal extension to pain</td>
<td>2 Abnormal extension to pain</td>
</tr>
<tr>
<td>1 No response</td>
<td>1 No response</td>
</tr>
</tbody>
</table>

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**Table 2. Behavior challenges commonly seen after brain injury**

<table>
<thead>
<tr>
<th>Anger</th>
<th>Emotionallability</th>
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<tbody>
<tr>
<td>Apathy</td>
<td>Impaired judgment</td>
</tr>
<tr>
<td>Anxiety</td>
<td>Impulsiveness</td>
</tr>
<tr>
<td>Depression</td>
<td>Irritability</td>
</tr>
<tr>
<td>Disinhibition</td>
<td>Moodswings</td>
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<tr>
<td>Egocentrism</td>
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</tbody>
</table>
Speech. Motor planning problems (oral motor apraxia), dysarthria, spastic dysphonia, and breath control problems all contribute to speech impairment.

Swallowing. Severely injured children may experience swallowing difficulties due to oral motor incoordination, and problems chewing. These impairments may be so severe that they cause dysphagia, aspiration, or poor weight gain.

Cranial Nerve Injuries. Moderate to severe TBI may damage the cranial nerves. There may be anosmia (due to shearing of the olfactory nerves as they travel through the cribiform plate), hearing loss, vertigo or tinnitus (from VIII nerve injury), or facial nerve (VII) palsy. Injury to the optic nerves may lead to scotoma, blindness, or visual field cuts. Extraocular muscle palsies can cause strabismus, diplopia, and difficulty tracking objects. These palsies usually resolve over the year following injury, but must be differentiated from muscle entrapment syndromes seen with orbital fractures (which require immediate surgical intervention). Surgical correction of residual strabismus is usually performed about one year after injury to allow for maximal intrinsic recovery.

Seizures. Seizures following TBI most commonly occur in the first week after injury, but for those with moderate or severe TBI, the risk remains increased up to 2 years after injury. Late-onset epilepsy (more than 1 week after injury) occurs in 8% of severe TBI cases. The following increase the risk of seizure: open skull fractures, an initial GCS <10, cortical contusion, epidural hematoma, wounds with dural penetration, and prolonged PTA or coma. Phenytoin decreases the risk of early but not late post-traumatic seizures in children, and it can impair cognition. There are currently no definitive guidelines regarding the prophylaxis or treatment of post-traumatic seizures. In deciding whether to start or stop anti-epileptic medications in a child with TBI, the primary care provider should consider the child’s seizure risk, current serum blood levels of anticonvulsants, recent EEG findings, detrimental side effects of the medicine, and family’s concerns.

Motor Control Problems. Problems with motor control most commonly occur after severe TBI, but can complicate mild and moderate injury. Weakness, spasticity, dystonia, impaired motor planning (apraxia, dyspraxia), decreased balance (ataxia), and fine motor tremor can all limit the child’s functional independence.

Other Signs. The primary care provider should be aware of the following: hyperphagia following damage to the brain’s satiety center; hypothyroidism, precocious puberty, amenorrhea, or growth failure from injury to the pituitary axis; leg length discrepancy and heterotopic ossification from fractures; and an enlarging skull defect (more common in younger children).

Other Symptoms. Symptoms often seen after all types of head injury include headache, neck or back pain, and sleep disorders. Children with severe injury may also have difficulties with bowel and bladder continence due to altered mental status, diminished control, or alterations in diet and exercise.

Management

Those providing primary care to a child with brain injury should perform a careful initial evaluation, provide appropriate treatment and referrals, assist in coordination of services, monitor the child and family’s condition over time, offer advice on the prevention of future injuries, and advocate for the rights of both their patient and all children with brain injury.

Evaluation. At the first office visit following any brain injury, the provider should review or obtain a complete medical, developmental, and behavioral history, including a focused search for signs and symptoms of brain injury. Children with mild head injury often come to the doctor’s office for initial medical management. If the child is deemed medically stable, the evaluation should include an assessment of the degree of brain injury, using the Colorado Guidelines for the Management of Concussion or the concussion scale developed by Dr. Robert Cantu. The provider should look for other injuries (fractures, abrasions, internal injuries, etc) and manage them appropriately. There should be a systematic search for symptoms commonly observed after mild head injury (headache, nausea with or without vomiting, dizziness, fatigue, irritability, and anxiety). Before discharging the child home, the family should be given an information sheet listing common signs and symptoms to be watched for after brain injury (see Appendix 1). The child and family should be advised about how to reduce the risk of future concussions, and offered the opportunity to come in sooner than their scheduled appointment if any concerns arise. At future visits, the provider should ask whether the child is (still) experiencing symptoms or if new behavior or school problems have arisen.

Children with moderately severe brain injury are usually hospitalized for observation and care. When they come for follow-up, the hospital discharge summary should be reviewed to determine the degree of brain injury and whether there was any associated trauma. The child’s medical, behavioral, and developmental history should be reviewed. There should be a comprehensive physical exam, focusing on cranial nerve testing, and evaluation of the child’s strength, balance, muscle stretch reflexes, and praxis. It should also include screening tests of memory, attention, naming skills, reading, writing, and copying as these skills are necessary for school achievement. If the evaluation demonstrates new impairments in any of these areas, amore complete neuropsychological evaluation should be scheduled to determine the child’s cognitive strengths and weaknesses.
Children with severe brain injury often have had additional trauma or other medical needs. Facial, thoracic, abdominal, and extremity injuries should be evaluated and addressed. A feeding history is needed to rule out dysphagia or aspiration; if a swallowing disorder is suspected, a modified barium swallow radiograph, or functional endoscopic evaluation of swallowing—or both—should be performed. Impairments of self-care and mobility should be identified, and barriers to school reintegration should be anticipated.

Treatment and Referrals

All medical providers should assess their familiarity with the testing and treatment of patients with pediatric TBI to determine their competency in meeting their patients’ needs. Consultation with specialists is warranted when the primary care provider is not comfortable treating the patient alone or when the patient is not responding to treatment. A review of all currently available treatment options is beyond the scope of this article, and readers are encouraged to consult the resources listed in Appendix 2.

Coordination of Services. Primary care providers should ensure that the services provided to each child and family are sufficiently coordinated to reduce fragmentation of care. To improve coordination, a single case coordinator should follow each patient. The authors recommend that this coordinator be hospital-based and begin education and coordination of services in the acute care setting. After discharge, the coordinator can act as a liaison between the hospital, the local primary care provider, the school, and the family. In the absence of such a coordinator, the primary care provider should strive to centralize the child’s care information and link the family to appropriate medical, educational, and support services.

Prevention. Medical providers are responsible for educating patients and families about ways to avoid the occurrence (or reoccurrence) of brain injury. Prevention efforts should be tailored to the age of the child and needs of the family. In younger children, baby walkers should be forbidden and stationary activity centers promoted. There should be stair guards at both the top and bottom of stairs. Window locks should be installed where needed in the home. Suggestions should be provided to decrease family stress and thereby reduce the likelihood of child maltreatment. Parents should be reminded about the necessity of an appropriate car restraint system, and car seats should be checked for proper fit and positioning.

Older children should always wear seat belts in the car, even in cars with air bags. Helmets should always be worn when using a bicycle, scooter, or skateboard. Homes, childcare centers, and schools should be checked regularly to ensure the safety of playground equipment, and athletic programs should teach proper technique to minimize head injury. Adolescent drivers should be counseled to avoid alcohol and other drug use, instructed to monitor their vehicles’ brakes, tires, and restraint systems, and reminded to change driving patterns to accommodate to poor visibility or road conditions. We should adopt a graduated licensure system so that young drivers would gain more driving experience. Medical practitioners should advocate lower speed limits throughout the state to reduce head injury and fatalities from high-speed motor vehicle crashes.

Summary

Children who have sustained a brain injury should receive specialized, coordinated, family-centered care from their primary care providers. By knowing more about the etiology, assessment, associated conditions, and prevention of pediatric TBI, medical providers can better address the multiple needs of the child and family as they cope with new challenges. The management of pediatric brain injury can be complex and time consuming, but we must all be responsive to the needs of these children and their families to ensure their good health, their welfare, and their happiness.

References
9 Cantu RC. Guidelines for return to contact sports after a cerebral concussion. Phys Sportsmed 1986;14:75-83.
Appendix 1. A Pediatric Brain Injury Sign/Symptom Checklist

Please take a few minutes to check off any of the following concerns for yourself and/or your child since the brain injury occurred:

- decrease in smell
- ringing in ears
- sudden changes in emotion
- irritability
- change in personality
- trouble naming things
- problems swallowing
- attention difficulties
- change in appetite
- neck or back pain
- bowel problems
- bladder problems
- nausea or vomiting
- memory problems
- school problems
- anxiety

- change in food tastes
- vision changes
- impulsivity
- depression
- trouble speaking
- problems chewing
- choking on food
- easy distractibility
- headaches
- seizures
- sleep problems
- dizziness
- confusion
- bizarre statements
- tics
- violent behavior

Appendix 2. Resources for Information About Pediatric Brain Injury

<table>
<thead>
<tr>
<th>Organization</th>
<th>Web site</th>
<th>Telephone</th>
</tr>
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<tbody>
<tr>
<td>Brain Injury Association of America</td>
<td><a href="http://www.biausa.org/">http://www.biausa.org/</a></td>
<td>800-444-6443</td>
</tr>
<tr>
<td>Brain Injury Association of North Carolina</td>
<td><a href="http://www.bianc.net/">http://www.bianc.net/</a></td>
<td>919 833-9634</td>
</tr>
<tr>
<td>Exceptional Children’s Assistance Center</td>
<td><a href="http://www.ecac-parentcenter.org">http://www.ecac-parentcenter.org</a></td>
<td>800-962-6817</td>
</tr>
</tbody>
</table>
