Children's Safety Network

Sport-Related Concussions in Children and Adolescents - Fact Sheets

New attention is being paid to the short- and long-term effects of even mild concussions as interest in and knowledge of the dangers of sport-related concussions have increased. In a review of state 2012 MCH Block Grant applications, the Children's Safety Network found that 31 states described their involvement in activities related to the prevention of traumatic brain injuries. These activities include providing education and training, increasing public awareness, partnering and coalition building, collecting data, and disseminating information about new legislation on sport-related concussions.

The Children's Safety Network has produced the following six fact sheets to provide public health professionals with a concise summary of information on a traumatic brain injury that affects many children and teens.

Overview of Sports-Related Concussion

What Are Traumatic Brain Injuries and Concussions?

Traumatic brain injury (TBI) is caused by a blow or jolt to the head that disrupts normal brain function or by a foreign object penetrating the skull. A concussion is defined as “a type of traumatic brain injury (TBI) caused by a bump, blow, or jolt to the head that disrupts the way the cells in the brain normally work.” (Sarmiento, Mitchko, Klein, and Wong 2010) The Consensus Statement on Concussion in Sport from the 4th International Conference on Concussion in Sport held in Zurich in November 2012 finds that while most concussions clear up within seven to 10 days, symptoms can persist for a longer time in chil¬dren and adolescents (McCrory et al 2013). When the symptoms of concussion are protracted and continue for weeks or years, they are called post-concussive syndrome (Ferullo and Green 2010).

The signs and symptoms of concussion may include:

- Headache and feelings of fogginess
- Confusion
- Nausea
- Loss of consciousness or amnesia
- Changes in behavior
- Slowed reaction times
- Disturbances in sleep

(Aloi and Rempe 2008; McCrory et al 2009). The presence of one or more of these signs or symptoms may indicate a concussion.

The Scope of the Problem

The Centers for Disease Control and Prevention (CDC) estimates that each year there are 1.7 million TBIs in the U.S. resulting in 52,000 deaths, 275,000 hospitalizations, and over 1.3 million emergency department visits (Faul, Xu, Wald, and Coronado 2010). Nonfatal sport and recreation-related TBIs to children and youth ages 19 and under accounted for 173,285 visits to emergency departments during 2001-2009 and also resulted in 9,300 to 14,000 hospitalizations each year (Gilchrist, Thomas, Xu, McGuire, and Coronado 2011).

In addition, there are unknown numbers of people who sustain TBIs but do not seek or receive medical treatment for those injuries. Approximately three quarters of the TBIs that occur in the U.S. are classified as mild, and yet research has demonstrated that individuals who sustain repeated mild TBIs over the course of months or years can suffer serious cumulative damage from these injuries (CDC webpage, What Are the Potential Effects of TBI?, Accessed on 3/29/2013).

In particular, young athletes who are allowed to return to play before they have made a full recovery from a concussion are vulnerable to

Second Impact Syndrome (SIS), which is a rare but often fatal rapid increase in intracranial pressure that can result from a second injury to the head before the first injury is completely healed. SIS occurs most often in those under the age of 19 "perhaps because of the sensitivity of their developing brain and perhaps because the seriousness of the first concus¬sion is often overlooked." (Faure 2010). Between 1984 and 1995, there were 17 fatalities attributed to SIS in those under the age of 30 (Duff 2009).

The Personal and Societal Costs of TBI

Death as a consequence of severe TBI has declined substantially in the past two decades from 55% to 20% (Ghajar 2009). However, the treatment and loss of productivity associated with severe TBI impose significant costs on society. These costs include emergency medical services, acute care, work loss costs, and expenses related rehabilitation and follow-up care (Massachusetts Traumatic Brain Injury Task Force 2007). In 2010, the economic costs of TBI in the U.S. were approximately $76.5 billion (CDC webpage, Severe Traumatic Brain Injury, Accessed 3/29/2013).

The personal costs of TBI can be profound with 80,000 to 90,000 individuals each year experiencing a long-term disability as the result of a head injury (Guillamondegui et al 2011). There is an increased incidence of depression among those who have sustained a TBI. Guillamondegui et al report that "symptoms of depression appear common in individuals who have sustained a TBI, with estimates of post-TBI depression ranging from 15 percent to 77 percent in the published literature." Some with TBI are at increased risk for developing brain disorders such as Parkinson's disease or dementia as they grow older.

Severe TBI can cause many kinds of functional problems, including impairment in motor func¬tion, language skills, emotion, memory, attention, hearing, or vision, as well as changes in personality. There is also considerable evidence that adults who have sustained a TBI have more suicide attempts and are more likely to die by suicide than the general population (Wasserman, Shaw, Vu, Ko, Bollegala, and Bhalerao 2008) with the risk being greater for those who experienced a severe TBI than for those who sustained a mild TBI (Simpson and Tate 2007).

Even mild TBI can cause temporary deficits in functioning, which are prolonged for children and adolescents because their brains are still developing. For example, "objective neuropsychological testing of reaction time and cognitive function has shown that, even in athletes with grade one concussions whose symptoms resolve within 15 minutes after injury, deficits may persist until day 6" (Aloi and Rempe 2008; Lovell, Collins, Iverson, Johnston, and Bradley 2004). A study of 393 college and 183 high school football and soccer players found that the high school athletes who sustained concussions took longer to recover than the college athletes (Field, Collins, Lovell, & Maroon 2003). In particular, the high school athletes continued to experience memory problems seven days after their concussions while the memory problems in the college athletes resolved within 24 hours.

Furthermore, mild TBI can interfere with young children's ability to acquire reading skills (Aloi and Rempe 2008). Deficits in communication skills may become apparent in the classroom or in other settings where the child who has sustained a TBI is under pressure to respond to a teacher's questions or to perform on a test (DePompei 2010).

The Risk of TBI and of Repeat TBI

Those most at risk for TBI are infants and young children up to four years of age, adolescents ages 15 to 19, and older adults ages 65 and over (CDC webpage How Many People Have TBI? Accessed on 3/29/2013). Falls are the leading cause of TBI for children ages 0 to 14, accounting for half of the TBIs in this age group. Twenty-five percent of the TBIs among children in this age group occur when they are struck by or against something or someone; just over 15% are the result of unknown/other causes; almost 7% are the result of motor vehicle/traffic crashes; and just under 3% are caused by assault (Faul, Xu, Wald, and Coronado 2010).

Data collected in the Christchurch Health and Development Study in New Zealand, a 25-year longitudinal study of 1,265 children born in 1977, showed that more than 30% of the children had sustained a TBI by the time they were 25 years of age. Boys were much more likely than girls to have a TBI, and adolescents between the ages of 15 and 20 had the highest rates of TBI while children between the ages of 5 and 10 had the lowest (McKinlay, Grace, Horwood, Fergusson, Ridder, and MacFarlane 2008).

Almost 30% of the participants in the Christchurch Health and Development Study experienced more than one TBI (McKinlay, Grace, Horwood, Fergusson, Ridder, and MacFarlane 2008). Other research has found that children who have sustained a TBI have three to six times the risk of sustaining another TBI in the days immediately following the initial TBI (Aloi and Rempe 2008).

In a U.S. study of 2,905 collegiate football players from 1999-2001, Guskiewicz et al found that players with three or more concussions were three times more likely to experience a concussion than those who had no prior concussion. In fact, "[o]f the in-season repeat concussions, 11 (91.7%) of 12 occurred within 10 days of the first injury, and nine (75.0%) of 12 occurred within seven days of the first injury" (Guskiewicz, McCrea, Marshall, Cantu, Randolph, Barr, Onate, and Kelly 2003).

Sport-Related Concussions

Girls now have a higher rate of sport-related concussions than boys (Frommer, Gurka, Cross, Ingersoll, Comstock, and Saliba 2011). Emergency department data reveal that both boys and girls between the ages of 10 and 19 experience TBI most frequently when bicycling. Boys also frequently sustain TBIs during football and girls during basketball or soccer (Gilchrist, Thomas, Xu, McGuire, and Coronado 2011). In a systematic review of literature from 1955 to June 2012, the Guideline Development Subcommittee of the American Academy of Neurology concluded that, "For female athletes, it is highly likely that soccer is the sport with the greatest concussion risk" (Giza, Kutcher, and Ashwal 2013).

There are few studies examining the similarities and differences in sport-related concussions among boys and girls. In a study of 131 high school and collegiate athletes who suffered concussions, 94 of whom were male and 37 of whom were female, Broshek et al found that females were more likely to experience cognitive impairment as a result of concussion (Broshek, Kaushik, Freeman, Erlanger, Webbe, and Barth 2005). A 2005-2006 study using data from the High School Sports-Related Injury Surveillance Study, Reporting Information Online (RIO) on concussions in boys' football, soccer, basketball, wrestling, and baseball and girls' soccer, basketball, volleyball, and softball found that female athletes had a higher rate of concussion than male athletes in soccer and basketball. The researchers cite studies that hypothesize this difference may be due to "smaller head to ball ratios or weaker necks" in girls and to "head and neck acceleration differences between the sexes." (Gessel, Fields, Collins, Dick, and Comstock 2007). They also note that cultural attitudes "may lead coaches, ATs [athletic trainers], and parents to treat head injuries in female athletes more seriously and delay their return to play... [while] encourage[ing] male athletes to play despite injuries or to avoid reporting injuries, particularly in certain sports" (Gessel, Fields, Collins, Dick, and Comstock 2007).

In a 2005-2007 study using RIO, Frommer et al collected and analyzed data on concussions in boys' football, soccer, basketball, wrestling, and baseball and girls' soccer, basketball, volleyball, and softball. The researchers found no gender differences in the frequency with which athletes who sustained concussions experienced loss of consciousness, the number of concussion symptoms reported, the time that it took for concussion symptoms to resolve, or the time it took for the athletes to return to play. They did observe a difference in the types of concussion symptoms that boys and girls experience with boys more often reporting amnesia and confusion/disorientation and girls more often reporting drowsiness and sensitivity to noise (Frommer, Gurka, Cross, Ingersoll, Comstock, and Saliba 2011).

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