Published in final edited form as:
J Sch Nurs. 2016 April ; 32(2): 132–137. doi:10.1177/1059840515579084.

Head Injuries in School-Age Children Who Play Golf

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Abstract

Traumatic brain injury (TBI) is the leading cause of death and disability in children. We conducted a prospective study, which examined injury characteristics and outcomes of school-age children of 5.0–15.0 years (N = 10) who were admitted to hospital for a TBI. This study evaluated the role of age, gender, the Glasgow Coma Scale, mechanisms and severity of injury, and functional outcomes. Seventy percent of the children sustained a TBI from a fall. We also found that playing golf was associated with 40% of the TBIs, with three (30%) children being unrestrained passengers in a moving golf cart and another one (10%) was struck by a golf club. Injury awareness could have benefited or prevented most injuries, and school nurses are in the best position to provide preventative practice education. In golf-centric communities, prevention of golf-related injuries should include education within the schools.

Keywords

golf; Glasgow Outcome Scale–Extended Pediatric; head injury; pediatric; traumatic brain injury

Introduction

Traumatic brain injuries (TBIs) are the leading cause of death and disability in children (Bazarian, Blyth, Mookerjee, He, & McDermott, 2010; Beers et al., 2012). Studies have reported that children who suffer head trauma show high degrees of functional disability upon discharge from the hospital and up to 12 months after the initial injury (Beers et al., 2012; Cassidy, Potoka, Adelson, & Ford, 2013). Medical advancements have enabled reduction in death rates of pediatric TBIs, however, this leaves many children having to live with the effects of their sustained injuries (Anderson, Godfrey, Rosenfeld, & Catroppa, 2012). The childhood and adolescent years are crucial for proper development of skills and

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Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

basic functions. When a child sustains a brain injury, there is a concern that the child will lose learned cognitive and motor function, lose the ability to develop future functions properly, or fall behind when compared to other children of similar age (Beers et al., 2012).

Over the last decade, emergency department visits for sports- and recreation-related TBIs, which include concussions, by children and young adults have increased by 60% (Gilchrist, Thomas, Xu, McGuire, & Coronado, 2011). According to Gilchrist, Thomas, Xu, McGuire, and Coronado (2011), activities that resulted in most children receiving a TBI were bicycling, football, playground activities, basketball, and soccer. Their team found that males between the age of 10 and 19 years were the most at risk group to go to the emergency department with a sportsor recreation-related TBI (Gilchrist et al., 2011). Gilchrist et al. (2011) also concluded that males aged 10–19 years sustained the most sports- and recreation-related TBIs when playing football or bicycling and females, aged 10–19 years, sustained the most sports- and recreation-related TBIs when playing soccer or basketball or when bicycling.

When conducting a study to assess the functional outcomes in pediatric TBIs, a common thread emerged among the school-age children, defined as aged 5–15 years, in this study. Children suffered their injuries while not wearing helmets or while being involved in golf-related activities. Previous data on this patient population do not recognize golf as a potentially dangerous recreational activity. Thus, it is the role of a school nurse to educate students, parents, and communities on the importance of helmet use and the unrecognized dangers associated with golfing and golf carts.

Purpose

In this prospective study, we examined the correlation between various factors, including demographics, mechanism/severity of injury, and brain injury location. We also examined the length of hospital stay and functional outcomes upon discharge and upon first follow-up visit to determine which patients were most at risk of sustaining worse functional outcomes following a TBI. The information allows for a better understanding about head injuries in school-age children, thereby providing schools and families the opportunity to take preventative measures.

Design and Method

Design

This study was conducted in a large urban Level-1 trauma tertiary care children’s hospital. After Institutional Review Board approval, we conducted a prospective study examining the characteristics and physiologic mechanisms of children admitted to hospital for a TBI. The data for this article are from an ongoing larger study that examine a time period from March through November 2013. Inclusion criteria for this analysis included children aged 5–15 years, who were previously healthy, who were admitted to hospital for a TBI, and in whom we could assess a functional outcome score at discharge and at first post-discharge follow-up visit (usually around 30 days). No children who had a developmental delay or who were admitted for an acquired brain injury, such as meningitis, were enrolled. All children had

parental consent to participate and those who were older than 12 years of age and were cognitively intact were assented for participation. All de-identified data were recorded using RedCap database. Extracted data included demographics (age, gender), Glasgow Coma Scale (GCS) upon admission, mechanism of injury, location and type of head injury (fracture and hematoma) determined by diagnostic imaging, length of hospital stay, and Glasgow Outcome Scale–Extended Pediatrics (GOS-E Peds) at discharge and first follow-up visit with the neurosurgeon.

Measures

The GCS is a measure used to assess neurologic status. In patients with TBI, by examining the patients' eye, verbal, and motor responses following the injury, the GCS can quantify the severity of a brain injury by assessing the depth and duration of impaired consciousness (Teasdale & Jennett, 1974). The GCS score is a sum of the individual scores from the eye, verbal, and motor responses, ranging from 3 to 15, with 3 being the most severe injury and 15 being the mildest injury (Teasdale & Jennett, 1974). In general, a severe injury is a score of 8 or less, a moderate injury is a score of 9–12, and a mild injury is a score of 13–15 (Teasdale & Jennett, 1974). The main purpose of the GCS in a child with a TBI is to provide health care providers a quick and easy way to communicate the severity of a patient's head injury. The scale may also indicate improvement or worsening of a patient's neurologic status, thereby keeping the health care provider informed of the child's ongoing recovery.

The GOS-E Peds categorizes TBIs based on the quality of an injured child's outcome using an 8-point numerical scale (Beers et al., 2012). The scale ranges from 1 to 8 (upper good recovery to death). The outcome score is determined using an interview questionnaire that accounts for the child's independence inside and outside the home, ability to function in a school environment, participation in leisure and social activities, and maintenance of healthy friendships and relationships (Beers et al., 2012). This scale was adapted to modify the GOS-E, the adult version that does not account for the differences in developmental activities specific to children under the age of 17 years. The GOS-E Peds and GOS-E are mostly used in research to quantify a patient's recovery and not specifically in the clinical management of a patient.

Procedures

Every patient was assessed for age, gender, mechanism of injury, type of brain injury including skull fractures and hematomas determined by diagnostic imaging, GCS upon admission to the study, and GCS/GOS-E Peds upon discharge from the hospital. The GOS-E Peds follow-up score was assessed at approximately 1 month post-injury at the patients' follow-up visit with the neurosurgeon. Injury mechanisms were recorded as motor vehicle accident as a passenger, motor vehicle accident as a pedestrian who was struck, as a fall, or as golf-related injuries. Golf-related injuries included falls from golf carts and traumas sustained from improper use of golfing equipment.

Results

Descriptive analysis included several approaches. We described the participants' demographic information, including gender, age, and race/ethnicity. In addition, description of injury characteristics was analyzed using frequencies and measures of central tendencies such as the means were applied. Statistical analyses were performed using SAS 9.0 (SAS Institute, Cary, NC).

The main study population included a sample of children aged 2 months–15 years ($N = 25$). Only 10 children met the inclusion criteria of being 5–15 years of age. Of those 70% ($n = 7$) were male, and 90% ($n = 9$) suffered a mild TBI as measured by a GCS score of 13 or greater. The remaining 10% ($n = 1$) suffered a severe TBI indicated by a GCS score of 8. All the patients sustained accidental trauma versus non-accidental trauma incurred by abuse. The GOS-E Peds score was measured upon discharge from hospital and during hospital follow-up. The remaining demographic characteristics are presented in Table 1.

Because there were no patients who were sustained to have a moderate injury (GCS between 9 and 12), we describe only the mild and severe injury classifications. One patient with an initial GCS of 8 was included in the severe injury group and the other nine patients with a GCS of greater than 13 were included in the mild injury group. A good outcome was classified by a GOS-E Peds score of 1, which indicates no disability or impact to daily life. The poor outcome included a GOS-E Peds score of 2 or greater, which involves *lower good recovery* (no disability but some impact to daily life such as headaches, sensitivity to light, memory failures, or other problems) and *death* (score of 8). For determining good versus poor outcome, we used the GOS-E Peds score at discharge because 30% of our population failed to report back for a follow-up GOS-E Peds evaluation after discharge. Descriptions of the results based on injury characteristic are shown in Table 2.

Our data could not conclusively show that age was associated with severity of injury or outcome because this analysis included only one school-age child who met the severe TBI classification. Of those admitted for a TBI, majority were males, and females comprised 33.3% of the mild injury group. The study demonstrated that 70% of the population suffered injury from a fall and all falls resulted in an impact with a solid (concrete) surface. All fall injuries were of mild severity, with the exception of one who was diagnosed as having a severe brain injury. Overall 70% of the population suffered injuries from wheeled toys/vehicles (i.e., skateboard, golf cart, motor vehicle, moped), wherein none of the patients were wearing helmets. Of the fall population, 42.9% ($n = 3$) suffered falls from a moving golf cart while unrestrained, whereas one child's head injury resulted from being struck with a golf club. Interestingly, previous data showed that males were more at risk for sustaining sports- or recreational-related TBIs, yet our data showed that females were just as likely as males to sustain a TBI from a golf-related injury.

A majority of patients stayed for an average of 2.9 (± 1.3) days. Eighty percent of the population suffered a skull fracture. The length of hospital stay for a patient with severe TBI was 9 days, which was triple the length of stay compared to other patients. All patients ($N = 10$) suffered some type of hematoma. There appeared to be no association of injury severity

or outcome with the type of hematoma. We noted that in our population, all patients with an associated frontal bone skull fractures had worse outcomes. Patients with a good outcome had an initial GCS score within the normal range of 15, indicating no neurologic impairment. There was no apparent association of injury severity with GOS-E Peds scores at discharge or follow-up.

Discussion

Based upon the results of this study, there is a need for, especially in golf-centric communities, parent education on the risks associated with golf-related activities. It is imperative that parents are educated on the risks of golfing because it pertains equally to both girls and boys. The age of children who sustained golf-related injuries ranged from 5 to 13 years.

The results of this study indicate that age was not associated with injury severity or outcome. A study conducted by Hukkelhoven et al. (2003) found that increasing age shows an association with poorer outcomes. More specifically, they found that the odds of having a poor outcome increase by roughly 40–50% for every 10 years increase in age. However, this study did not specifically assess for any thresholds on age, meaning that there could be a point where age increases but the odds of having a poor outcome decreases. This threshold was addressed in a study conducted by Crowe, Catroppa, Babl, Rosenfeld, and Anderson (2012). They found that the probability of having a poor outcome increased with age, showing a peak at age 7–9. Those aged greater than 10 had the lowest probability of having a poor outcome compared to all of younger age. Crowe et al. (2012) attribute this pattern to the fact that children of age 7–9 are developing “down-the-line” skills such as time management, task planning, reasoning, and impulsivity, which are more dynamic and specialized. An injury during this age range will inhibit learning processes and specialized skill acquisition. The small sample size in our study could have prevented a possible association between age and injury severity or outcome. In future studies, a larger sample size would be recommended.

Our study showed that TBIs were more common in males than in females, with males making up 70% of our injured population. In this analysis, no females suffered severe injuries, however one female did experience a poor outcome. We considered this female as an outlier in our data. While she was admitted to and discharged from the hospital with a mild head injury (GCS 13 followed by 15), her GOS-E Peds outcome score at discharge was poor (GOS-E Peds = 6). Her length of hospital stay was also within the range of those patients who had good outcomes and mild injury. According to the literature, females seem to suffer worse outcomes than males suffer (Bazarian et al., 2010; Farace & Alves, 2000). Possible reasons include the fact that females tend to be more likely than males to report symptoms following their injury, and they are more likely to follow safety regulations, meaning that a more significant injury is needed to severely injure a female patient to the point that she receives a poor outcome (Bazarian et al., 2010). Gender is a variable that is difficult to address separately due to the confounding factors. Males are known to engage in higher risk activities that lead to more severe injuries and also make up the great majority of total brain injuries each year (Farace & Alves, 2000). The lack of more defined differences

between genders in TBI suggests the need for more studies to better determine gender as a factor that causes a significant difference in outcomes.

Of all injury mechanisms, 70% of our population suffered brain injuries from a fall. There appeared to be no association of falls with a certain age range in our population. Such a high incidence of falls in our population was not surprising. The Centers for Disease Control and Prevention recorded that falls are the leading cause of TBIs, accounting for 41% of all injuries (Centers for Disease Control and Prevention, 2014; Ibrahim, Wood, Margulies, & Christian, 2011). Approximately 55% of TBIs in children under 14 years of age are caused by falls (Ibrahim et al., 2011). Ibrahim and colleagues (2011) reported that although falls were responsible for the majority of TBIs in younger children, the etiology of the fall may influence the severity of the injury. In our study, the most common type of fall was a fall from a moving golf cart, accounting for 43% of the fall population. This high proportion of golf cart–related injuries became less surprising as we looked at golf cart's structure and safety regulations. Golf carts are traditionally used for transportation on golf courses, however, they have more recently been used for recreational and alternative transportation purposes in neighborhood and beach communities. There are approximately 13,000 annual golf cart–related emergency room visits each year, and 40% of these involved children under the age of 16 (Seluga & Long, 2009). Also, around 50% of the golf cart–related injuries in children are from falls from a moving golf cart. Seluga and Long (2009) attribute this high incidence rate to the fact that golf carts are largely unregulated. Unlike all-terrain vehicles or other form of personal transport vehicles, there are no laws regarding seat belts, minimum age requirements, or other safety measures in golf carts. Most golf carts do not have seat belts, and the only physical safety measure is a hip bar on the outside of the seats, which is meant to prevent occupants from sliding out of the cart on a turn. However, for small children whose feet are unable to touch the ground for additional support, this hip bar acts as a tripping mechanism around sharp turns. A child's center of gravity is higher than the hip restraint, so if the golf cart takes a sharp turn at close to 20 miles/hr, the child will flip over the hip restraint, head first onto the ground at a high-speed impact. Seluga and Long (2009) found that with just the addition of a seat belt, 80% of golf cart ejections could be prevented.

In our analysis, 90% of our patient population sustained a mild TBI. It is very important that school nurses, as well as parents, are aware of the signs and symptoms of mild TBIs because, in order to reduce worse outcomes, a child who sustains a mild TBI needs to seek medical attention. It may be hard to diagnose a mild TBI because there may be lack of physical evidence of trauma to the skull. Table 3 highlights the signs and symptoms of mild TBIs.

Implications for Practice

It is important for school nurses to know the signs and symptoms of a mild TBI, because the student, parent, and school should be aware of the potential struggles a child may face when returning to school. Based upon the recommendations of the Brain Injury Association of America (2014), a child's posttraumatic return to school needs to be handled with care because the child may require special accommodations. The school nurse can be very

helpful in planning for a child's return to school by working with the child's medical team and putting into action the recommendations of the child's health care provider. The school nurse can work to ensure the child returns to school with the ability to follow discharge instructions by his or her health care provider. Also, the school nurse may be the liaison between the expectations in the classroom and return-to-school instructions.

The impact of TBIs extends to those who suffer brain injuries and also to their friends, family, and community. When a child suffers a TBI, there is a possibility that the child's normal functions will be impaired. Not only can the school nurse help facilitate a child's new posttraumatic needs, he or she can also be crucial in providing potential need for emotional health support for the parents. School nurses can also provide the parents with information useful in caring for themselves by being aware of the resources in the community available to parents of children who have suffered TBIs. The actual impairments a child faces after an injury might not be apparent until the child gets older and is expected to function with more complex cognitive and social behaviors. There is no cure to completely reverse the effects of a brain injury. However, with rehabilitation and therapy, children have an opportunity to regain functions or find modified ways to function normally. More emphasis needs to be given in the prevention of TBIs, including wearing helmet when riding a skateboard or bike, enforcing the use of seat belt in motor vehicles and golf carts, or providing safe playground environments. A child should never suffer the rest of his or her life from the debilitating effects of a preventable brain injury.

Limitations/Future Studies

The small population size could have prevented us from seeing trends in the data. The limited number of participants in our study limits the generalizability to the larger population. However, the geographic nature of our study supports the role of including golf as an injury mechanism and also emphasizes the need to analyze the risk for injury critically and without bias to one particular activity. The difficulty in defining poor outcome because of the number of "lost to follow- up" prevented us from seeing the change in their outcome at discharge to their outcome 1 month later. In future studies, we would like to include a larger study population. Also, we would assess the patients at longer follow-up intervals (3 months, 6 months, and 1 year post-injury) to get a better sense of the severity of the patient's injury and how the patient progresses or worsens.

Conclusion

The majority of TBIs suffered by school-age children occur due to falls from wheeled vehicles. School nurses and families need to be aware of the TBIs related to being an unrestrained passenger in a golf cart or golf equipment. Therefore, in golf-centric communities, it behooves the school and community to be proactive and monitor for TBIs when children engage in the sport. Injury prevention should be a part of all school curriculums. The role of the school nurse is essential in translating best prevention practices as well as ensuring that all return-to-school instructions are followed should a TBI occur. Injuries sustained by wheeled toys/vehicles in school-age children can best be avoided with

the use of properly fitted helmets, adult supervision, and safe environments for children to learn and play.

Acknowledgments

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Karin Reuter-Rice, PhD, NP, FCCM, FAAN has center project support by NIH-NINR 1P30 NR014139-01 Adaptive Leadership for Cognitive Affective Symptom Science ADAPT), Institute of Nursing Research Center of Excellence (2012–2015) in addition to funding by the Robert Wood Johnson Foundation as a Nurse Faculty scholar project 71244 (2013–2016). Madelyn Krebs has no funding Julia Eads has no funding.

References

Anderson V, Godfrey C, Rosenfeld J, Catroppa C. 10 years outcome from childhood traumatic brain injury. International Journal of Developmental Neuroscience. 2012; 30:217–224. [PubMed: 22100364]

Bazarian J, Blyth B, Mookerjee S, He H, McDermott M. Sex differences in outcome after mild traumatic brain injury. Journal of Neurotrauma. 2010; 27:527–539. [PubMed: 19938945]

Beers S, Wisniewski S, Garcia-Filion P, Tian Y, Hahner T, Berger R, Adelson D. Validity of a pediatric version of the Glasgow Outcome Scale–Extended. Journal of Neurotrauma. 2012; 29:1126–1139. [PubMed: 22220819]

Brain Injury Association of America. 2014 Retrieved from http://www.biausa.org.

Cassidy L, Potoka D, Adelson P, Ford H. Development of a novel method to predict disability after head trauma in children. Journal of Pediatric Surgery. 2013; 38:482–485. [PubMed: 12632372]

Centers for Disease Control and Prevention. 2014. Retrieved from http://www.cdc.gov/traumaticbraininjury

Crowe L, Catroppa C, Babl F, Rosenfeld J, Anderson V. Timing of traumatic brain injury in childhood and intellectual outcome. Journal of Pediatric Psychology. 2012; 37:745–754. [PubMed: 22669504]

Farace E, Alves W. Do women fare worse? A meta-analysis of gender difference in outcome after traumatic brain injury. Neurosurgical Focus. 2000; 8:1–8.

Gilchrist J, Thomas KE, Xu L, McGuire LC, Coronado VG. Nonfatal sports and recreation related traumatic brain injuries among children and adolescents treated in emergency departments in the United States, 2001–2009. Morbidity and Mortality Weekly Report. 2011; 60:1337–1342. [PubMed: 21976115]

Hukkelhoven C, Steyerberg E, Rampen A, Farace E, Habbema J, Marshall L, Maas A. Patient age and outcome following severe traumatic brain injury: An analysis of 5600 patients. Journal of Neurosurgery. 2003; 99:666–673. [PubMed: 14567601]

Ibrahim N, Wood J, Margulies S, Christian C. Influence of age and fall type on head injuries in infants and toddlers. International Journal of Developmental Neuroscience. 2011; 30:201–206. [PubMed: 22079853]

Seluga, K.; Long, T. Analysis and prevention of child ejections from golf cars and personal transport vehicles. 21st International Technical Conference on the Enhanced Safety of Vehicles (ESV), Paper #09-0186. 2009. Retrieved from http://www-nrd.nhtsa.dot.gov/pdf/esv/esv21/Track%2029%20Written.pdf

Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet. 1974; 2:81–84. [PubMed: 4136544]

Traumatic Brain Injury. 2014 Retrieved from http://www.traumaticbraininjury.com.

Washington State Traumatic Brain Injury Council. 2014 Retrieved from http://www.tbiwashington.org.

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Table 1

Patient Demographics.

Gender	Age (years)	Race
Male	13	Caucasian
Male	5	Hispanic
Male	10	Caucasian
Male	6	African American
Female	9	Caucasian
Female	11	Caucasian
Male	15	Caucasian
Male	15	Caucasian
Male	9	Caucasian
Female	12	Caucasian

Note. $N = 10$.

Table 2

Injury Characteristics for the Sample Population.

	Mild Injury (*n* = 9)	Severe Injury (*n* = 1)
Average hospital stay length (days)[a]	4.3 ± 4.5	9 ± 0
Neurologic and functional measures[a]		
GCS upon admission	14.8 ± 0.4	8 ± 0
GCS discharge	15 ± 0	14.5 ± 0.5
GOS-E Peds discharge	7.75 ± 0.7	6 ± 1
GOS-E Peds follow-up (if applicable)	7.71 ± 0.7	—
Mechanism of injury[b]		
Motor vehicle (passenger)	1 (11)	0 (0)
Motor vehicle (pedestrian)	0 (0)	1 (100)
Fall	4 (44.4)	0 (0)
Golf related	4 (44.4)	0 (0)
Injury finding diagnostic imaging[b]		
Skull fracture location		
Temporal	2 (22.2)	0 (0)
Parietal	2 (22.2)	0 (0)
Occipital	1 (11.1)	0 (0)
Frontal	4 (44.4)	1 (100)
Hemorrhage location		
Epidural hematoma	6 (66.7)	0 (0)
Subdural hematoma	2 (22.2)	0 (0)
Other hematoma	1 (11.1)	1 (100)
Epidural hematoma	6 (66.7)	0 (0)

Note. *N* = 10. GCS = Glasgow Coma Scale; GOS-E Peds = Glasgow Outcome Scale–Extended Pediatrics.

[a] *M* ± *SD*.

[b] *n* (% Frequency).

Table 3

Common Signs and Symptoms in Children With Mild Traumatic Brain Injury.

Physical	Cognitive	Emotional, Social, or Behavioral
Fatigue	Memory loss	Mood changes
Headaches	Poor attention/concentration	Depression
Nausea and vomiting	Loss of consciousness	Irritability
Dizziness/loss of balance	Delayed mental acuity	Lack of interest in toys, friends, school, etc.
Change in eating or sleeping habits		Augmented way they play
Hearing, vision, or speech dysfunction		

Note. Adapted from The Brain Injury Association of America (2014), http://www.biausa.org; Traumatic Brain Injury (2014), www.Traumaticbraininjury.com; and Washington State Traumatic Brain Injury Council (2014), http://www.tbiwashington.org.