Concussion 101: The Current State of Concussion Education Programs

Richard W. Williamson, MD*
Deborah Gerhardstein, MA, RN‡
Javier Cardenas, MD‡§
Daniel B. Michael, MD, PhD‡¶
Nicholas Theodore, MD*‡
Natalie Rosseau‖

*Division of Neurological Surgery and §Division of Child Neurology, Barrow Neurological Institute, St. Joseph's Hospital and Medical Center, Phoenix, Arizona; ‡ThinkFirst National Injury Prevention Foundation, Naperville, Illinois; ¶Oakland University William Beaumont School of Medicine, Royal Oak, Michigan; and ‖Department of History, Cornell University, Ithaca, New York

Correspondence:
Deborah Gerhardstein, MA, RN,
1801 N. Mill Street, Suite F,
Naperville, IL 60563.
E-mail: dbg@thinkfirst.org

Received, August 15, 2013.
Accepted, May 22, 2014.

Concussion is an important cause of morbidity in young student athletes. The prevention, accurate diagnosis, and prompt management of concussions require that players, parents, coaches, and medical personnel are accurately educated on current concussion data and guidelines. All states have laws that mandate concussion education for high school athletes. There is currently no uniform educational program to disseminate information to student athletes regarding concussions. This article highlights a few nationally recognized educational programs that aim to accurately and effectively inform all members of the athletic, academic, and medical communities about the importance and urgency of concussion.

KEY WORDS: Concussion, Education, Head trauma, Traumatic brain injury

Neurosurgery 75:S131–S135, 2014 DOI: 10.1227/NEU.0000000000000482 www.neurosurgery-online.com

More than 1.7 million people suffer a traumatic brain injury (TBI) in the United States each year, resulting in death, hospitalization, or an emergency department visit. TBI is a contributing factor in almost one-third of all injury-related deaths.[1] The Centers for Disease Control and Prevention (CDC) data from 2003 suggest that approximately 75% of all TBIs are considered mild, or concussion, and approximately 20% of all TBI is sports related.[2] Although the CDC estimates that there are just over 170 000 patients under the age of 19 treated for sports- or recreation-related head injuries, this number likely vastly underestimates the rate of concussion.[3] More recent data suggest that there are between 1.6 and 3.8 million sports-related concussions each year in the United States.[4] According to data from the National Collegiate Athletic Association Injury Surveillance System, the rate of concussion among high school and college athletes was found to be between 0.23 and 0.43 concussions per 1000 athlete-exposures, with an athlete-exposure defined as 1 athlete competing in 1 practice or game.[5] Current medical research has found that repetitive mild head trauma can have serious deleterious effects on young athletes. Although there is no consensus in the medical literature, current research has also found an association with repetitive mild head trauma and chronic traumatic encephalopathy, although causality has not been proven.[6] These factors make concussion an important and potentially preventable cause of morbidity in young athletes.

ABBREVIATIONS: CDC, Centers for Disease Control and Prevention; **NFL,** National Football League; **SLI,** Sports Legacy Institute; **TBI,** traumatic brain injury

Our understanding of concussion has evolved, contributing to increased public awareness about the importance of concussion. The popularity of the National Football League (NFL) and its effort to improve concussion management for its athletes have also heightened public awareness. In 2012, the NFL published its first-ever "Health and Safety Report" outlining the policies and programs the league implemented to improve the prevention and management of sports-related concussion in both its own athletes and athletes at the youth, high school, and college levels. The NFL has played a leading role in increasing public awareness of concussion and the importance of continuing concussion education for parents, players, and coaches. Similarly, the National Hockey League adopted a new concussion policy in 2011 in which any player suspected of a head injury is immediately taken to a separate area and evaluated for a concussion. Major League Baseball has also made moves to eliminate home-plate collisions in an effort to reduce the risk of head injury.

Appropriate medical management of concussion requires timely detection and accurate

diagnosis when a patient has suffered a mild TBI. The first part of this equation requires that all of those involved in athletics are adequately educated on the signs, symptoms, screening methods, diagnosis, and appropriate management of concussion. Educating players, parents, coaches, and medical personnel remains a significant challenge to recognizing the importance of timely diagnosis and preventing second-impact syndrome. Although limited by small sample size and surveying method, recent data from high school athletes suggest that $< 50\%$ of "concussion" events were disclosed to trainers or coaches.[7,8] Furthermore, athletes may not necessarily recognize the seriousness of concussion; approximately 56% of surveyed college athletes indicated no knowledge of the possible consequences of mild head injury.[9] The lack of education is not limited to the player; recent evidence has shown that coaches, referees, trainers, and even physicians have incomplete knowledge about the diagnosis and management of concussion.[10-13]

Although the state of concussion education nationwide can be ameliorated, evidence shows that formal educational programs are effective. Players who have received concussion education are twice as likely to report concussion-type symptoms to their coaches compared with student athletes who have not had such training.[14] College athletes who receive concussion education at the beginning of the season demonstrate increased concussion awareness at the end of the season as a result of this training.[15] This article summarizes the current state of concussion education programs across the United States and the world, highlighting some of the major educational programs and the respective strengths of each program. Concussion education should adapt to advances in the medical field; it is essential to validate concussion education programs to evaluate and improve their efficiency.

ROLE OF LEGISLATION

In 2006, Zackery Lystedt, a junior high school football player, suffered multiple concussions in a single game. After hitting his head on the ground in the first half, he struggled to return to the sideline. Fifteen minutes later, another hit in the same game resulted in an intracranial hemorrhage and severe TBI. Zackery's return to the game after his initial mild head injury made him vulnerable to his more severe TBI.

In response to Zackery's case, Washington State passed the Lystedt Law in May 2009. This law has 3 main components:

1. Educate coaches, parents, and athletes: Inform and educate coaches, athletes, and their parents and guardians about concussion through training or a concussion information sheet.
2. Remove the athlete from play: An athlete who is believed to have a concussion is to be removed from play immediately.
3. Obtain permission to return to play: An athlete can return to play or practice only after at least 24 hours and with permission from a healthcare professional.

As of June 18, 2013, 49 states and Washington, DC, have passed similar laws to protect student athletes from suffering an injury similar to Zackery's. Mississippi passed a law similar to the Lystedt law on January 30, 2014. Each state has the jurisdiction to mandate a program for concussion education or to establish a minimum standard for the instructions each school district must provide to its athletes, parents, and school officials.

EXISTING EDUCATION PROGRAMS

Heads Up: Concussion in Youth Sports

The CDC has provided the model for sports-related concussion information and teaching tools. Fact sheets, handouts, and teaching guides are available for coaches, parents, and health educators. The CDC Heads Up program provides kits that offer concussion information for coaches, parents, and athletes involved in school sports. Heads Up includes information on preventing, recognizing, and responding to concussions, as well as action plans for schools, instructor training, posters, and more. Kits are tailored to the specific audience, ie, student athletes, coaches, parents, educators, and medical personnel, and can be ordered online free of charge.

The CDC also offers online concussion training for coaches and healthcare providers, as well as many useful videos and handouts, at www.cdc.gov/concussion. This includes an online educational video series on concussion basics, recognizing concussion, preventing concussion, and responding to concussion appropriately (http://www.cdc.gov/concussion/HeadsUp/Training/index.html). Coaches, parents, and clinicians are encouraged to educate themselves and to use CDC materials to develop a concussion plan, recognize concussions, respond appropriately, and provide information for student athletes.

The CDC Heads Up toolkit has been shown to be effective. After viewing the material, primary care physicians were much less likely to allow student athletes to return to play within 24 hours of a concussion compared with those who did not use the toolkit.[16] In addition, coaches who viewed the materials were satisfied with the content, became more knowledgeable about identifying concussions in student athletes, and were able to respond appropriately to athletes with concussion symptoms.[17-20] The CDC program is not designed for the direct education of student athletes; it relies on the coaches and medical personnel to pass the information on to the players.

ThinkFirst

Although there are many training programs for coaches and athletic trainers and adequate information available for them to post, hand out, or incorporate into their own method of teaching athletes about concussion, there are also programs that are ready-made and available for schools online or through guest presentations. Ideally, combining various program methods and offering a concussion education program in health classes for all students, as opposed to only athletes, will lead to a more educated public and will result in responsible actions being taken when concussion is suspected. The ThinkFirst program aims to help achieve this goal by providing classroom presentations.

Founded by neurosurgeons in 1986 under the aegis of the American Association of Neurological Surgeons and the Congress of Neurological Surgeons, the ThinkFirst National Injury Prevention Foundation provides theory-based programs for teens on the importance of preventing brain and spinal cord injuries (Figure 1).[21] The ThinkFirst Foundation holds monthly online training for injury prevention coordinators interested in operating a ThinkFirst chapter within a hospital or other medical setting for providing ThinkFirst educational programs to schools and other community groups. Each chapter has a chapter director and a sponsoring physician who present programs with Voices for Injury Prevention speakers. Voices for Injury Prevention speakers have experienced a traumatic brain or spinal cord injury themselves and share their personal story with students to help them realize the ramifications of such injuries and the importance of prevention. Student evaluations have shown that students are significantly more influenced to choose safe behaviors when they have heard from someone who has experienced a brain or spinal cord injury, as opposed to hearing the facts on injury or potential for being ticketed through law enforcement.[22] Data demonstrated that the program was efficacious in changing student attitudes about safety and that these attitudes persisted out to 3 months after the presentation.[22] The ThinkFirst Web site (www.thinkfirst.org) has studies on its programs and contact information for the 150 national chapters and 39 international chapters.

ThinkFirst programs are based on the Health Belief Model. The Health Belief Model states that for people to seriously consider changing their behavior, they must be convinced that something serious could indeed happen to them and must recognize that there is something relatively simple that they can do to prevent it. The theory also recommends frequent cues or reminders to maintain awareness of the message.[23]

Using the same principles as the Health Belief Model, ThinkFirst About Concussion combines science with personal testimony to promote safe behaviors. Presentations are given in classrooms or auditoriums to health classes or to athletic groups before a sport season, with the objective that students will be better prepared to prevent, recognize, and respond correctly to concussion. Program presenters, who are trained ThinkFirst health educators based in ThinkFirst chapters at hospitals and medical settings across the country, are usually available free of charge or for a reasonable fee. Presentations are generally 50 minutes long to match the duration of 1 class period. The health educator uses models of the brain and skull with slides and handouts to define concussion and to describe how concussions occur, how they affect the brain, signs and symptoms of concussions, second-impact syndrome, and the various restrictions that could be imposed on an athlete to rest the brain to allow it to heal. The program stresses recognition and management of concussions, including the importance of reporting signs immediately, removing a person with a suspected concussion from play, seeking medical attention, following the prescribed treatment, and not returning to play until cleared by a medical professional skilled in concussion management. The program also covers the need to be monitored while carefully easing back to activities, schoolwork, and sports.

ThinkFirst
National Injury Prevention Foundation

FIGURE 1. *Logo of the ThinkFirst national injury prevention foundation, which provides in-class presentations by trained health educators on how to recognize and prevent concussions. Used with permission from ThinkFirst National Injury Prevention Foundation.*

The informative presentation is followed by personal testimony from a person who shares how a concussion or TBI affected his or her life. Testimony is provided either live or by video, depending on speaker availability. In each case, the personal story describes how the injury occurred, how it affected the individual, its treatment, the level of recovery, and how it might have been prevented. Speakers discuss what was handled correctly or perhaps what they should have done, depending on their situation. The program concludes with the speakers taking questions from the audience.

Pretest and posttest evaluations will evaluate this new program with the intention of publishing results regarding changes in knowledge, attitude, and stated behavior after seeing a presentation.

Sports Legacy Institute Community Educators

The Sports Legacy Institute (SLI) is a Boston-based nonprofit organization founded in 2007 by neurosurgeon Robert Cantu, MD, and Christopher Nowinski, a former Harvard football player and current concussion research advocate. The SLI is dedicated to advancing the study, treatment, and prevention of concussion in young athletes. In 2008, the SLI partnered with Boston University School of Medicine to form the Boston University Center for the Study of Traumatic Encephalopathy. In 2009, 2 Harvard Medical School MD/PhD students helped form the SLI Community Educators (http://www.sportslegacy.org/education/slice/).

Through the SLI Community Educators program, trained students in the health sciences provide age-appropriate educational presentations on concussion to student athletes. The interactive presentations include discussion, videos, audience demonstrations, and case studies from professional, collegiate, and high school athletes. The 1-hour presentation aims to answer 3 main questions for the audience: what is a concussion, why individuals should care about concussions, and what can be done about concussions. The presentations are given to athletes at all levels, including college, high school, junior high, and even elementary-age student athletes. Prospective data indicate that the presentations are effective: Significantly more participants passed a concussion-specific quiz after the presentation compared with before the presentation (34% vs 80%; $P < .001$).[24] Currently, there are 8 SLI Community Educators chapters in the United States.

Brain 101: The Concussion Playbook

The Oregon Center for Applied Science, a health technology and innovation company in Eugene, Oregon, applies behavioral research to mobile self-management interventions to help people manage their health and to change their health-related behaviors. In 2011, the company created Brain 101: The Concussion Playbook, a Web-based comprehensive school-wide concussion management program (http://brain101.orcasinc.com/4000/). With modules for coaches, parents, teachers, and players, its goal is to minimize the risk that concussion poses to young student athletes by educating each group and proposing a unified community response when a young athlete suffers a concussion. The Web-based program provides information on the signs and symptoms of concussion and details how to safely reincorporate brain-injured student athletes back into both athletics and academics. The program is a self-directed Web-based module that provides clear guidelines on how to recognize when a concussion happens, how to respond and treat appropriately, when an athlete can return to play, and how to prevent a concussion. Each module is geared specifically to the role of the vested individual, whether coach, teacher, parent, or athlete. When it was prospectively applied to families with brain-injured athletes, families exposed to the Web-based program had significantly higher rates of concussion knowledge and application of that knowledge.[25]

Barrow Brainbook

Barrow Brainbook, created in collaboration with the Arizona Interscholastic Association, the Arizona Cardinals, and the Arizona State University School of Education, was launched on August 18, 2011, as the most comprehensive educational effort in the state of Arizona (Figure 2). The program consists of 2 phases, the first of which is concussion education. This program is designed to help student athletes understand how to prevent, recognize, and respond to concussions. In 1½ years, >150,000 high school athletes received comprehensive concussion education via an e-learning module developed specifically for the adolescent population. This project is vital to educating youth about maintaining a healthy body and brain and avoiding long-term damage that could disrupt life and learning for athletes who go untreated. This module is based on the content and instructional design approach used by the CDC.

Brainbook is an Internet-based tool that uses a social network interface, videos of professional athletes and doctors, footage of sports concussions, and computer-generated animation to deliver educational content. Content is directed at athletes in all sports, from football and soccer to basketball and wrestling, and to both male and female athletes. Currently, Brainbook is available in English and Spanish. The Barrow Brainbook module can be found at http://www.craniumcommons.com/bb/.

Unpublished data derived from Brainbook have shown a change in attitudes about concussion among Arizona high school athletes, including attitudes about an athlete removing himself or herself from play after sustaining a concussion and refraining from play until all symptoms of a concussion have resolved. Ultimately, the goal of Brainbook is to reduce concussion injury in youth.

The second phase of the Barrow Brainbook project is a registry designed for use by coaches, parents, and teachers, who act as the support system for the student athlete. Athletes or members of their identified support system register in the Barrow Brainbook Concussion Registry when the child has suffered a concussion. Repeat assessments and education regarding concussion is provided, as is a network of support from the Brain Injury Association of Arizona, the Mary Lou Fulton Teachers College at Arizona State University, and the Barrow Neurological Institute. Questions are asked about the timing and mechanism of injury, location and method of assessment and care, and symptom severity and duration. The registry will be populated by the >100,000 athletes in the Arizona Interscholastic Association database. The data derived from it will provide information on epidemiology, regional differences in care, risk factors, and outcomes. A grant from the Charles Maddock Foundation made the development of the registry possible. Student athletes are currently being enrolled in the program.

BARROW BRAINBOOK

FIGURE 2. *Logo of the Barrow Brainbook, a program to educate student athletes about how to prevent, recognize, and respond to concussions. Used with permission from Barrow Neurological Institute.*

CONCLUSION

Concussion is a complex and important issue in today's public healthcare world. It is essential to find an effective way to disseminate knowledge about concussion to the community to aid in preventing concussion and recognizing when concussions occur. The concussion education programs highlighted in this article aim to effectively communicate both the medical facts of concussion and the importance of accurate diagnosis and prompt treatment. All educational programs should be studied and validated to ensure that the information being presented is both accurate and effective. The increased penetration of these types of educational programs into the public sphere will ideally correlate with a decreased rate of sports-related TBI.

Disclosure

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

REFERENCES

1. Faul M, Xu L, Wald MM, Coronado VG. *Traumatic Brain Injury in the United States: Emergency Department Visits, Hospitalizations, and Deaths*. Atlanta, GA: Centers for Disease Control and Prevention, National Center for Injury Prevention and Control; 2010.
2. National Center for Injury Prevention and Control. *Report to Congress on Mild Traumatic Brain Injury in the United States: Steps to Prevent Serious Public Health Problem*. Atlanta, GA: Centers for Disease Control and Prevention (CDC); 2003.
3. Gilchrist J, Thomas KE, Xu L, McGuire LC, Coronado VG; Centers for Disease Control and Prevention. Nonfatal sports and recreation related traumatic brain injuries among children and adolescents treated in emergency departments in the United States, 2001-2009. *MMWR Morb Mortal Wkly Rep.* 2011;60(39):1337-1342.
4. Langlois JA, Rutland-Brown W, Wald MM. The epidemiology and impact of traumatic brain injury: a brief overview. *J Head Trauma Rehabil.* 2006;21(5):375-378.
5. Daneshvar DH, Nowinski CJ, McKee AC, Cantu RC. The epidemiology of sport-related concussion. *Clin Sports Med.* 2011;30(1):1-17.
6. Wetjen NM, Pichelmann MA, Atkinson JL. Second impact syndrome: concussion and second injury brain complications. *J Am Coll Surg.* 2010;211(4):553-557.
7. Register-Mihalik JK, Guskiewicz KM, McLeod TC, Linnan LA, Mueller FO, Marshall SW. Knowledge, attitude, and concussion-reporting behaviors among high school athletes: a preliminary study. *J Athl Train.* 2013;48(5):645-653.
8. McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K. Unreported concussion in high school football players: implications for prevention. *Clin J Sport Med.* 2004;14(1):13-17.
9. Kaut KP, DePompei R, Kerr J, Congeni J. Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. *Clin J Sport Med.* 2003;13(4):213-221.
10. Valovich McLeod TC, Schwartz C, Bay RC. Sport-related concussion misunderstandings among youth coaches. *Clin J Sport Med.* 2007;17(2):140-142.
11. Burke MJ, Chundamala J, Tator CH. Deficiencies in concussion education in Canadian medical schools. *Can J Neurol Sci.* 2012;39(6):763-766.
12. Boggild M, Tator CH. Concussion knowledge among medical students and neurology/neurosurgery residents. *Can J Neurol Sci.* 2012;39(3):361-368.
13. Lebrun CM, Mrazik M, Prasad AS, et al. Sport concussion knowledge base, clinical practises and needs for continuing medical education: a survey of family physicians and cross-border comparison. *Br J Sports Med.* 2013;47(1):54-59.
14. Bramley H, Patrick K, Lehman E, Silvis M. High school soccer players with concussion education are more likely to notify their coach of a suspected concussion. *Clin Pediatr (Phila).* 2012;51(4):332-336.
15. Miyashita TL, Timpson WM, Frye MA, Gloeckner GW. The impact of an educational intervention on college athletes' knowledge of concussions. *Clin J Sport Med.* 2013;23(5):349-353.
16. Chrisman SP, Schiff MA, Rivara FP. Physician concussion knowledge and the effect of mailing the CDC's "Heads Up" toolkit. *Clin Pediatr (Phila).* 2011;50(11):1031-1039.
17. Sarmiento K, Mitchko J, Klein C, Wong S. Evaluation of the Centers for Disease Control and Prevention's concussion initiative for high school coaches: "Heads Up: Concussion in High School Sports." *J Sch Health.* 2010;80(3):112-118.
18. Sawyer RJ, Hamdallah M, White D, Pruzan M, Mitchko J, Huitric M. High school coaches' assessments, intentions to use, and use of a concussion prevention toolkit: Centers for Disease Control and Prevention's heads up: concussion in high school sports. *Health Promot Pract.* 2010;11(1):34-43.
19. Theye F, Mueller KA. "Heads up": concussions in high school sports. *Clin Med Res.* 2004;2(3):165-171.
20. Covassin T, Elbin RJ, Sarmiento K. Educating coaches about concussion in sports: evaluation of the CDC's "Heads Up: Concussion in Youth Sports" initiative. *J Sch Health.* 2012;82(5):233-238.
21. Michael DB, Doherty B, Gerhardstein D, Wade R. The role of the neurosurgeon in the community with a specific eye toward injury prevention and ThinkFirst. *Neurosurgery*. 2013;60(suppl 1):20-23.
22. Gerhardstein DB. ThinkFirst for teens injury prevention program: evidence-based practice: are we making a difference? *SCI Nurs.* 2007;24:13.
23. Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the Health Belief Model. *Health Educ Q.* 1988;15(2):175-183.
24. Bagley AF, Daneshvar DH, Schanker BD, et al. Effectiveness of the SLICE program for youth concussion education. *Clin J Sport Med.* 2012;22(5):385-389.
25. McLaughlin KA, Glang A, Beaver SV, Gau JM, Keen S. Web-based training in family advocacy. *J Head Trauma Rehabil.* 2012;28:341-348.