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Mild Traumatic Brain Injury: Educational Techniques

Katherine R. Racanelli
Illinois Wesleyan University, kracanel@iwu.edu

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A Pilot Study

Katherine Racanelli

Victoria N. Folse, PhD, Faculty Advisor

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Abstract

The awareness of mild traumatic brain injury as a health concern has increased across a multitude of athletic settings due to a plethora of research and clinical findings that indicate the serious threat concussions pose, particularly to young athletes. The need to provide risk reduction and health promotion education to athletes and parents necessitates an innovative approach. This study explores the effectiveness of an educational intervention based on information from the Centers for Disease Control and Prevention to promote awareness regarding the pathophysiology, symptoms, consequences, and prevention of sports-related mild traumatic brain injury. An interactive educational program was administered to student athletes, parents, coaches, and athletic trainers at three public high schools in the Midwest. The sample included 147 athletes and 141 parents. Knowledge of the participants was evaluated with a questionnaire created for this study entitled Protecting Athletes from Injury through Knowledge and Education (PIKE) which was administered prior to and following the intervention to determine changes in comprehension and provide direction to design future programs that promote traumatic brain injury awareness. Results showed an increase in mean scores from pretest to posttest in the athlete and parent samples, indicating the educational intervention was effective at increasing knowledge of mild traumatic brain injury.

Traumatic brain injury (TBI) is a contributing factor to one third of all injury-related deaths in the United States (US) and results in 52,000 deaths, 275,000 hospitalizations and 1.4 million emergency department visits each year (Centers for Disease Control and Prevention [CDC], 2011). Head injuries are a major public health concern due to their high incidence and subsequent morbidity and mortality. Seventy-five percent of TBIs that occur each year are mild traumatic brain injuries, also known as concussions (CDC, 2011). However, the statistics may be deceptive and may not reflect actual incidence and prevalence due to the lack of detection, failure to recognize symptoms, or intentional underreporting of symptoms.

In addition, the Centers for Disease Control and Prevention (CDC) has labeled sports as the second leading cause of brain injury among young adults between ages 15 and 24 years. Sixty-five percent of concussions occur between the ages of 5 and 18 years (CDC, 2011). Young athletes have an increased risk for mild traumatic brain injury due to their underdeveloped brain structures, decreased musculature in the shoulders and necks, and improper techniques in high-risk sports (Daneshvar, Nowinski, McKee, & Cantu, 2011). While 10-15% of high school athletes sustain concussions each year, not nearly enough receive proper medical treatment (Comstock, Nance & Wiebe, 2011). Cognitive function is temporarily diminished after a sports-related concussion and can remain diminished after the resolution of overt symptoms. A prior mild traumatic brain injury puts an individual at an increased risk for obtaining a second injury in the future (CDC, 2011). Moreover, multiple previous concussions are associated with a slow recovery of neurological function. While most athletes who sustain a concussion will recover, many will continue to experience the adverse effects of the injury which will affect the way they think, feel and act (Mitchko, Klein Sarmiento & Wong, 2010).

A concussion is a complex pathophysiological process affecting the brain induced by traumatic biochemical force. It is caused by a bump, blow, or jolt to the head, by deceleration/acceleration injuries, by contact with the ground resulting from a fall or by a hit to another part of the body that transmits an impulsive force to the head (CDC, 2011). Concussions are diagnosed on a functional versus structural level meaning they are diagnosed with regard to the manifestation of symptoms instead of being diagnosed with neuroimaging studies such as computed tomography (CT) and magnetic resonance imagery (MRI) scans. Although conventional neuroimaging is typical in concussive injury, the routine imaging using CT or MRI contributes little to concussion evaluation or management (Halstead & Walter, 2010). Thus, athletes must act as advocates for their own healthcare because reported symptoms are the most important assessment parameter for diagnosis of a concussion.

The symptomatology associated with a concussion is imperative to its diagnosis and treatment. Symptoms of a concussion may last for days, weeks or even longer depending on the severity of the injury, the athlete's age and any history of multiple concussions (CDC, 2011). The most common symptoms of concussions are headache, dizziness, balance problems, fatigue and drowsiness. Loss of consciousness, contrary to the belief of the public, does not always manifest itself in the assessment of a concussion; athletes who sustain a concussion only lose consciousness 8-19% of the time (Bentz & Purzycki, 2008).

According to the CDC, the symptoms of concussion are divided into four categories: somative, cognitive, affective and sleep (2011). The somative symptoms are those that the athlete experiences as a physical ailment. These include nausea, vomiting, fatigue, sensitivity to light or noise, blurred or fuzzy vision, and headache. Cognitive symptoms include difficulty thinking clearly, feeling slowed down, difficulty concentrating, difficulty remembering the past

and difficulty remembering new information. The symptoms placed in the affective and sleep categories are less acknowledged among the public and include difficulty falling asleep, inability to sleep, sleeping more often than usual, irritability or anger, increased emotion, sadness, and mood changes. Dangerous signs and symptoms of concussion that may indicate hemorrhagic processes or an increase in intracranial pressure include a headache that worsens and does not dissipate, weakness, numbness, or decreased coordination, repeated nausea or vomiting, drowsiness and inability to awaken an athlete, unilateral pupil enlargement, seizures, inability to recognize people or places, increased confusion, restlessness, or agitation, unusual behavior, and loss of consciousness. These symptoms necessitate the immediate response of a healthcare provider (CDC, 2011).

Traumatic brain injuries that go unreported may predispose athletes to the development of Secondary Impact Syndrome, which occurs when an athlete returns to a sport before his or her cognitive function has fully returned (Bey & Ostick, 2009). When an athlete experiences a second injury to the head prior to unsuccessful recovery from the previous injury, the brain's ability to balance the amount of blood flow to the brain, known as autoregulation, malfunctions. Increased blood flow to the brain causes blood vessels to rupture, leading to bleeding and swelling of the brain. The pressure to the brain increases rapidly, causing disabilities including paralysis, speech disturbance, and various forms of brain damage (Bey & Ostick, 2009).

Several sports present significant risks for traumatic brain injuries. The sport with the highest risk for concussion in high school males is football, followed by rugby, ice hockey and lacrosse. In female athletics, the rate of concussion is highest in girls' soccer and basketball (Halstead, 2010).

Football

According to the National Center for Catastrophic Sport Injury Research, the annual incidence of football-related concussions in the US is estimated as 30,000 per year (Cantu, 2011). Moreover, young athletes are at an increased risk for injury. Researchers found that high school football tackles are more dangerous than those that occur in college football based on the differences in athletes' heights, weights and techniques. The biophysical rationale for this disparity includes the increased risk that the brain of a high school athlete may not be fully developed, resulting in lower injury threshold, more vulnerable blood vessels, and a thinner, less protective skull. High school football games may lack appropriate medical staff, and poor body control and technique may make younger players more susceptible to brain injury following poorly executed tackles (Daneshvar, Nowinski, McKee, & Cantu, 2011). Moreover, athletes who choose to continue participating in football may enter collegiate play having already suffered multiple concussions or having experienced symptoms of head injury.

Soccer

Recent research has shown that soccer is cited as one of the sports with the highest concussion rates in the US. Soccer, like other high-risk sports, predisposes athletes to a multitude of injuries and 22% of these injuries are due to concussions (Sonntag, 2012). Concussions can be minimized in soccer through the use of protective headgear and strict adherence to the rules of competition. The adherence to rules and regulations has an impact on decreased concussion rates in that it minimizes the impact on less skilled players and controls players who are dangerously aggressive (Sonntag, 2012).

There is a somewhat negative culture surrounding current athletics in that continuing to play through injury is not only condoned but encouraged as a rite of passage and a barometer for the amount of devotion to the sport. Hence, the historical culture of labeling concussions as "getting your bell rung" or referring to them as a "ding" must be challenged. In order to reduce the incidence of concussion in athletics, the culture must appreciate that concussions are *brain injuries* and that all brain injuries can potentially result in life-altering consequences (Adler & Herring, 2011). The promotion of awareness of the severity of concussions is supported through the use of educational materials and legislative changes.

Research has shown that education that lacks the involvement of legislative regulatory bodies is unlikely to reduce the incidence of concussions (Adler & Herring, 2011). Recent legislation has been mandated throughout the state of Illinois. The Concussion Education Legislation signed by Governor Pat Quinn in July 2011 requires student-athletes showing concussion symptoms to get medical approval before resuming play (Haugh, 2011). Illinois is the 28th state to enact a version of the law mandating all school boards adopt a policy on head injuries that fits under Illinois High School Association (IHSA) bylaws. The new measure encourages education as the main source of prevention. Although educational methods have not proven to consistently be effective in altering the behavior regarding medical management of concussions, they remain a valuable component of the effort to change the understanding of this injury (Adler & Herring, 2011). Athletes, coaches and parents are the principle target audience of education components in relation to recent legislation.

The Illinois Elementary School Association (IESA) has provided a Concussion Information Sheet and Sign-Off Form that schools are required to use to notify athletes and their parent/guardian about the dangers of concussion and head injuries (Figure 2). School districts

are required to distribute education materials provided by the IHSA to educate coaches, student-athletes, and parents/guardians of student athletes about the nature and risk of concussion and head injuries, including continuing play after a concussion or head injury (Illinois Elementary School Association [IESA], 2012).

The education sheet is informative regarding symptomatology and action; however, it does not facilitate athletes' and parents' abilities to ask questions or confirm comprehension of information provided. Also, a lack of consistency among the educational methods and how and when materials are distributed may produce knowledge gaps for coaches, athletes, and parents from various teams and schools. Although the facilitation of a uniform standard for awareness and education has emerged through the Concussion Education Legislation with regard to obligation to see a healthcare provider prior to returning to play, consistency among educational interventions are imperative to ensuring approaches are effective (Adler & Herring, 2011).

Education and increased awareness of the signs and symptoms of concussions has proven to result in an increased rate of injury report and therefore a greater opportunity for sufficient recovery (Adler & Herring, 2011). Because of the current information about the negative effect of concussions on youth athletes, there is a vital opportunity for innovative educational interventions to increase the knowledge of concussions and reduce their incidence in youth athletes. This pilot study focused on the development of an educational tool to assess the knowledge of youth athletes and their parents and an educational intervention to increase awareness and familiarity regarding concussion management.

Educational Techniques

The purpose of this study was to measure the awareness of concussions in athletes and parents. Assessment of the differences between pretest and posttest determined the gaps in

knowledge and will facilitate the refinement of future innovative educational approaches. Because the degree of reliability and validity of the educational survey was established, it could serve as a successful adjunct to assessment and evaluation of knowledge related to concussions. The following research questions guided this study:

1. What is the degree of reliability of a 50-item educational survey entitled Protecting Athletes from Injury through Knowledge and Education (PIKE)?
2. How effective is the educational intervention as measured by differences between pre-intervention and post-intervention knowledge?
3. What relationships exist between the variable of sports played and frequency of concussions and willingness to report?

Methods

Subjects

A convenience sample of 147 athletes and 141 parents from three central Illinois high schools was recruited. The sample included high school athletes between the ages of 14 and 18 years participating in spring sports and their parents.

Following Institutional Review Board (IRB) approval, the research team recruited the participants in collaboration with the three public high school athletic directors (ADs). One AD gave the research team direct access to the six spring coaches; of the six coaches the research team were authorized by the AD to contact directly, three agreed, one declined, and two did not respond despite repeated attempts to phone and email. The second AD asked spring coaches to contact the research team if interested in participating; three coaches contacted the research team directly. It is unknown how many coaches were approached by the second AD. At the third school, one coach contacted the research team after the research team was informed by the AD

that this coach would be the sole representative from the school. Again, it is unknown how many coaches besides this one were informed about the opportunity to participate. No athletes or parents were intentionally excluded. Demographic information was collected from all participants.

Measures

Knowledge of concussions was measured through the administration of the Protecting Athletes from Injury through Knowledge and Education (PIKE) tool (See Figure 1). The 50-item tool, which was developed by the research team specifically for this study, took approximately 5 minutes to complete, and was administered prior to and following the educational intervention. Items were derived from CDC- sponsored modules and educational materials and organized with the intention of encompassing an overall evaluation of the knowledge of concussions. The PIKE survey included questions related to definition of concussion, symptoms, signs, emergency indicators, secondary impact syndrome, prevention, and action following a concussion. Participants were further informed that they did not need to answer any questions that caused them discomfort.

Procedure

IRB approval was granted by the researchers' affiliate university. Copies of the complete IRB proposal including the informed consent and assent forms and educational survey were provided to each AD and participating coach. The faculty advisor made arrangements for the student researcher and faculty advisor to attend seven separate spring parent meetings during March 2012. Study participants signed the informed consent or assent form (See Figure 3) prior to the completion of the PIKE survey. No incentives for participation were offered and participants were notified that there were no consequences for not participating in the study.

Contact information of the student researcher and faculty advisor was disseminated to all participants at the end of the presentation for questions or concerns throughout the duration of the study.

Data were collected at seven separate spring parent meetings. After receiving verbal information about the study, the athletes and parents were administered an informed consent or assent form, a pre-survey, and a post-survey. The pre-survey and post-survey were differentiated by colors; white indicated pre and green indicated post. Materials were distributed separately during the first two spring parent meetings; materials were distributed in packet form for the final five sessions and included a blank white paper labeled "STOP, The Post-Survey is not to be completed until after the presentation". Following the completion of the pre-survey, a 10-15 minute educational intervention (See Figure 4) focused on the signs, symptoms, prevention, consequences, and pathophysiology of concussions was implemented. The post-survey was completed at the end of the presentation and collected by the research team.

A written evaluation of knowledge in the form of the PIKE questionnaire was administered before and immediately after exposure to the educational intervention. Data included demographics, sport-involvement, reasons not to report a concussion, incident of concussion in the past, and knowledge of the following: symptoms/signs, cause, complications, response, recovery, prevention, and secondary impact syndrome. Each item of the PIKE survey was worth one point except for true-false questions, which were worth two points; a total of 56 points was possible on both the pre-survey and post-survey.

Statistical Analysis

SPSS 19.0 was utilized for statistical analysis. Reliability of the PIKE was measured by calculating coefficient alpha (Cronbach's alpha). Reliability is the consistency with which the

instrument's items measure the same trait or attribute. Internal consistency reliability is the most widely used approach among researchers and remains the best approach for assessing the sampling of items (Polit & Beck, 2010). Item total correlations were not calculated because the survey was not designed to evaluate individual responses to questions. Paired *t*-tests, also known as dependent groups *t*-tests, were used to examine the statistical significance of the difference between the means of pretest and posttest results of parents and athletes. Pearson's *r, or* Pearson's correlation coefficient, was utilized to calculate and analyze correlations between participants' involvement in specific sports and the history of concussions and decision to report concussions.

Cronbach's alpha ensures that the items in the scale are measuring the same attributes; in this case, the consistent evaluation of the attribute of knowledge regarding sports-related concussion was evaluated (Polit & Beck, 2010). A higher reliability coefficient indicates more accurate (internally consistent) measures or scales. Moreover, reliability coefficients higher than 0.70 are considered acceptable, but coefficients greater than 0.80 are superlative (Polit & Beck, 2010).

Paired *t*-tests are used to test the difference between the means of a paired group; it is illustrated in this study as the difference between the pretest and posttest scores for the same people. The *t*-test values are considered significant if the corresponding p value is less than .05, confirming that results were not related to chance (Polit & Beck, 2010). Pearson's *r* acts as a descriptive statistic because it summarizes the magnitude and direction of a relationship between two variables; it also stands as an inferential statistic in its ability to test hypotheses about population correlations. Moreover, Pearson's *r*, or Pearson's correlation coefficient, is used to test the existence of a relationship between two variables (Polit & Beck, 2010).

Results

The athlete sample (See Table 1) was comprised of 27 males (18.2%) and 121 females (81.8%). The ethnic breakdown of the student sample was as follows: 123 Caucasians (83.1%), 1 African American (.7%), 15 Hispanics (10.1%), 2 Asian Pacific Islanders (1.4%), 5 individuals of two or more racial or ethnic backgrounds (3.4%) and 2 individuals of other racial or ethnic backgrounds (1.4%). The parent sample (See Table 1.2) was comprised of 58 males (38.9%) and 82 females (55%). The ethnic breakdown was as follows: 132 Caucasian (88.6%), 6 Hispanics (4%), 1 African American (.7%), and 1 individual of other racial background (.7%). Forty-nine surveys were excluded from analysis because of the inability to match pre and post test results with certainty or because either the pretest or posttest was missing.

At the time of enrollment, student athletes were participating in the spring sports of soccer, softball, baseball, or tennis. The survey instructed athletes to indicate every sport they played in high school. Based on the results from the sample of athletes, 2 (1.4%) individuals participated in football, 18 (12.2%) in basketball, 15 (10.1%) in baseball, 54 (36.5%) in softball, 13 (8.8%) in tennis, 18 (12.2%) in volleyball, 9 (6.1%) in cross country, 2 (1.4%) in track, 72 (48.6%) in soccer, 1 (.7%) in golf, 8 (5.4%) in cheerleading, 8 (5.4%) in other sports. A total of 57 (38.5%) marked they participated in two or more sports.

Reliability

Internal consistency. The degree of reliability of PIKE was established and measured through internal consistency. Internal consistency was determined and reported through the use of Cronbach's alpha. For parent responses (n=141), adequate reliability was established (α=.88). For athlete responses (n=147), adequate reliability was also established (α=.87). A comparison

of the degree of reliability supported in the 50-item PIKE for athletes and parents is highlighted in Table 3**.**

Criterion Related Validity

Paired sample *t*-tests. A paired sample *t*-test was utilized to determine statistically significant differences between pretest and posttest knowledge for the athlete and parent sample. A paired sample *t*-test confirmed a statistically significant difference between pre and posttest in both the athlete and parent samples. The difference between pretest and posttest means for the sample of athletes was statistically significant (t (147) = -6.539 p= .000). The mean results of pre and post PIKE were as follows: pre-score 41.80/56.00 and post-score 45.63/56.00. The difference between pretest and posttest means for the sample of parents was also statistically significant (t (140) = -8.999 p= .000). The mean results of pre and post PIKE were as follows: pre-score 46.07/56.00 and post-score 50.28/56.00. In addition to the total score differences, responses to PIKE questions in the athlete sample yielded statistically significant differences between pretest and posttest on numerous individual items (See Tables 4.1-4.5).

All five items related to the definition of a concussion yielded statistically significant differences between pretest and posttest results: it is a minor brain injury that usually does not interfere with normal functioning (t (147) = 2.453, p= .015), it can be prevented by wearing protective gear (t (147) = -2.964, p= .004), it is only possible when the individual is knocked unconscious (t (147) = 2.648, p= .004), it is a traumatic brain injury that interferes with normal functioning (t (147) = 3.454, p= .001), it is serious and life threatening to play or practice with a concussion (t (147) =2.578, p= .011) (See Table 4.1). Multiple items related to signs and symptoms also yielded statistically significant differences between pretest and posttest results (See Table 4.2-4.3). The following items regarding signs and symptoms of concussion yielded

statistically significant differences: nausea or vomiting (t (147) = 4.776, p= .000), balance problems or dizziness (t (147) = -2.211, p= .029), mood changes t (147) = 7.961, p= .000), inability to fall asleep at night t (147) = 5.14, p=.000), fatigue or low energy t (147) = 2.00, p = .047), irritability t (147) = 5.228, p= .000), more emotional than usual t (147) = 7.657, p= .000), forgets plays (t (147) = 2.164, p= .032), shows behavior or personality changes (t (147) = 3.272, p = .001).

The following emergency signs and symptoms indicated statistically significant differences: any change in typical behavior or personality (t (147) = 6.166, p= .000), one pupil is larger than the other (t (147) = 6.284, p = .000), and exhibiting unusual behavior (t (147) = 3.154, p= .002).

Similar findings were determined in the parent sample pretest and posttest results. The PIKE results showed statistically significant differences between pre and posttest responses with regard to the following definitions of a concussion (See Table 5.1): it can be prevented by wearing protective gear (t (140) = -2.521, p= .013) and it is a traumatic brain injury that interferes with normal functioning (t (140) = 2.302, p= .023). Individual items pertaining to signs and symptoms also yielded a statistically significant difference between pretest and posttest. The following items showed statistical significant differences: sensitivity to light or noise (t (140) = 3.739, p= .000), feeling sluggish or slowed down (t (140) = 3.538, p= .001), mood changes (t (140) = 6.683, p= .000), inability to fall asleep at night (t (140) = 8.110, p= .000), "don't feel right" (t (140) = 3.549, p= .001), fatigue or low energy (t (140) = 3.003, p= .003), irritability (t (140) = 6.080, p= .000), more emotional than usual (t (140) = 7.980, p= .000), forgets plays (t (140) = 2.745, p = .007), answers questions slowly (t (140)= 2.221, p= .028), arm pain (t (140) =-2.934, p =.004) and shows behavior or personality changes (t (140) = 5.135, p=

.000). The following items related to emergency signs and symptoms of concussion yielded statistically significant differences: Any change in typical behavior or personality (t (140) = 4.101, p= .000), one pupil is larger than the other (t (140) = 4.753, p= .000) and exhibiting unusual behavior (t (140)= 3.159, p=.002).

Pearson's product-moment correlation (Pearson's *r*). Pearson's product-moment correlation (Pearson's *r*) demonstrated a moderate correlation (See Table 6) between the student athlete's history of concussion and his or her likelihood of reporting the concussion to a coach or athletic trainer (r = -.672, p= .000) as well as the likelihood of reporting the concussion to a healthcare provider (r = -.672, p= .000). The low number of high school athlete participants (n =20) who endorsed a history of concussion and the limited sample sizes of individual sports did not allow analysis of correlations between the variable of sports played and frequency of concussions and willingness to report. Because soccer is a high-risk sport for youth athletes and the sample was comprised of 72 soccer players, Pearson's *r* was utilized to evaluate the correlation between participation in soccer and likelihood of reporting concussion signs and symptoms. This yielded a moderate correlation (See Table 7) between the history of concussion in soccer players and willingness to report to coach or athletic trainer (r= -.622, p= .000) and willingness to report to a healthcare provider (r= -.634, p= .000).

The results indicated that out of the 147 athletes, 20 (13.5%) reported a positive history of a concussion (See Table 8). Although the majority of these athletes (10.8%) reported concussions to their healthcare providers, 3% of athletes did not report their concussion signs and symptoms.

Discussion

Reliability was established in the PIKE scale at a level of .87 for the athlete sample and .88 for the parent sample indicating consistency among items. The establishment of an adequate degree of reliability is important because it signifies that the scale is consistent in measuring the same attributes consistently and accurately. In this case, the knowledge related to concussion was accurately measured through the use of the PIKE scale.

Although the 3% of unreported concussions appear quite small in this sample, the recruitment of a greater number of athletes may yield a higher percentage of unreported concussions. This perspective is supported by the rationale many athletes have indicated for failing to report a concussion (See Table 9). The majority of athletes indicated that they would not report a concussion because they do not know it has occurred. In this sample, 18.2% of athletes did not think a concussion was serious enough to report and 13.5% did not want to sit out of the game. This information presents an opportunity for educational intervention in increasing the awareness of the significant impact concussion has on youth athletes.

Validity results confirmed differences between pretest and posttest knowledge; the mean score of posttest knowledge was significantly increased in comparison to pretest for both athlete and parent samples. Paired *t*-tests yielded statistically significant findings. The results indicate that there are significant differences between pretest and posttest responses in the athlete and parent samples. This indicates that the educational intervention was successful in improving awareness and knowledge related to concussions. Potential implications for these data include the expansion of educational approaches in youth athletics to include interactive presentations and more consistent innovative approaches, beyond the distribution of a two-sided handout at the beginning of the academic year. The ultimate outcome of these innovative approaches will be to

establish a well-informed population of student athletes, parents, coaches and athletic trainers who understand the health ramifications of their activities on an immediate and prolonged basis.

Along with the obligation to involve a healthcare provider with concussed athletes, the recent legislation mandates the utilization of CDC derived educational material related to traumatic brain injury in all schools. It is noteworthy that although the research team brought multiple copies of power-point handouts to administer to parents and athletes following the presentation, less than 10 handouts were actually requested by the audience. This suggests handouts and obligatory educational sessions have the potential to be disregarded and are not the most effective means of education. The athlete and parent samples both scored lower on their pretest than posttest, indicating that the IHSA endorsed handout received at the start of the academic year was not sufficient to educate about concussion signs and symptoms. Moreover, the government handout did not include or categorize the many signs and symptoms that are often unrecognized.

The verbal and written responses from the athlete and parents provided rich data. When the audience was asked about signs and symptoms of concussion during the presentation, there were overt commonalities between all three high schools. Neither the athletes nor the parents in any of the high schools verbalized concussion symptoms that fell into the affective or sleep category (e.g., mood changes, sleeping more or less than usual, inability to fall asleep, depression). Although these symptoms are not the cornerstones of concussions, they are relevant in assessment and diagnosis and therefore vital to the recognition of a traumatic brain injury. Furthermore, these observations suggest that the current knowledge that is common to the public is insufficient.

One written pre-test comment was particularly alarming as a female athlete wrote, “I don’t know if I have ever had a concussion.” It is unknown how long this participant has been involved in sports or if she has ever sustained a concussion. Moreover, the results regarding the rationale for not reporting concussion signs and symptoms (See Table 9) indicated that 58 (39.2%) athletes would not report a concussion because they are unaware that they have been injured. The query suggests the inadequacy of the educational handout mandated by the government and disseminated by the schools and reinforces the need for an interactive educational program.

Limitations

The most significant limitation in this study was the limited access to research participants. Due to the limited number of participants and access to only spring sport athletes, a follow-up study to assure generalizability of results is warranted. Inability to compare knowledge of concussion relative to the specific sports played restricted analysis. A more substantial sample size with a wider variety of athletes in the future will be necessary to replicate results. Also, although the coaches and athletic trainers observed the presentation, they did not complete pretests and posttests. This was a limitation in that the research team was unable to assess the knowledge of this important target population.

The timing of the study only allowed access to spring season athletes, which was an obstacle based on the fact that many high-risk sports, specifically football, take place in the fall. It was also implausible to analyze data between sports because of the inequalities in number of participants. Other limitations included a lack of a controlled environment, inconsistent availability of equipment, and limited time. Because the presentation was administered at each spring parent meeting, a multitude of additional tasks were being completed at the same time as

the pretest and posttest and may have impacted responses. The limited availability of equipment was not conducive to showing video clips. It would be interesting to study the differences between pretest and posttest responses after showing videos to determine the additional benefits of innovative educational approaches. The limited time to complete each pretest and posttest was also a substantial limitation. As guests, the research team attempted to facilitate the tasks of the annual parent meeting while still administering education, pretests, and posttests; the inconsistency of the testing environment may have also impacted results.

Conclusion

The focus on protective gear, rule changes, identification of at-risk athletes and continuous education for everyone involved in youth athletics becomes imperative to protecting the health of youth athletes (Halstead & Warner, 2010). Increasing awareness through education remains one of the most important components of improving the care of athletes with concussions. Previous studies have demonstrated a poor knowledge base of recognition and management of concussion (Halstead & Warner, 2010). Moreover, future studies should focus on developing and evaluating innovative educational interventions that effectively raise awareness and knowledge of concussions.

The results from this study indicated that the PIKE survey was psychometrically sound in its ability to evaluate knowledge related to concussions. Results manifested an increase in the mean from pretest to posttest, indicating success in the educational intervention. Education should target all the key individuals involved, including athletes, parents, coaches, school administrators, athletic directors, teachers, and athletic trainers, physicians and other healthcare providers (Halstead & Warner, 2010). The involvement of healthcare professionals in assessment methods on the field or in the hospital setting will facilitate a rapid assessment and diagnosis and

therefore reduce the resultant complications. Continuous education about concussions directed toward parents and athletes at physical exams and disseminated throughout the school year will be advantageous in the development of a solid knowledge base.

Future research studies should address alternate educational interventions to effectively enhance the knowledge and awareness of concussion in youth athletes. Also, controlling the environment that the research team utilizes for each presentation will be advantageous to the methodology of future studies. The utilization of an electronically based pretest in the form of a module may assist in ensuring the environment is more controlled in that participants will be placed in specific locations of adequate proximity from one another, reducing the chance that participants will share answers. Because of the potential for participants to return to the pretest following the intervention and change their answers, a separation of the pretest and posttest for each participant will decrease the chance of unreliable results. Moreover, administering a second posttest may determine if the intervention was truly successful at maintaining knowledge levels. Augmentation of recruitment methods to involve an increased number of athletic teams will be beneficial in future research involving correlations between history of concussion, knowledge of concussion, and specific involvement in sports. The increased number of participants will enable the research team to determine correlations between number of sports, frequency of concussions and willingness to report. Also, it would be beneficial to include qualitative comments at the end of each test to determine what the participants feel is relevant to include in educational practices.

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Table 1

Demographic Data of Athletes (n=147)

Gender	Male	18.2%	Female	81.8%
Ethnic/Racial Background	Caucasian	83.1%	African American	0.7%
	Hispanic	10.1%	Other	1.4%
	Asian-Pacific Islander	1.4%	Multi-racial	3.4%

Table 1.2

Demographic Data of Parents (n=141)

Gender	Male	3.9 %	Female	55%
Ethnic/Racial Background	Caucasian	88.6 %	African American	0.7%
	Hispanic	4.0%	Other	0.7%
	Asian-Pacific Islander	0	Multi-racial	3.4%

Table 2

Frequency of Athlete Participation in Sports

Sport	Percentage of Athlete Participation
Football	1.4%
Basketball	12.2%
Baseball	10.1%
Softball	36.5%
Tennis	8.8%
Volleyball	12.2%
Cross Country	6.1%
Track	1.4%
Soccer	48.6%
Golf	.7%
Cheerleading	5.4%
Other	5.4%
Two or more	38.5%

Table 3

Reliability

	Cronbach's Alpha Athlete (n=147)	Cronbach's Alpha Parent (n=141)
PIKE	.87	.88

Table 4

Mean Scores of Athletes

	N	Mean	Std Dev.	Std Error Mean
Pre-score out of 56.00	148	41.80	7.40	.61
Post-score out of 56.00	148	45.63	7.41	.61

Table 4.1

Paired t-Test Athletes-Definition

Differences between pre and post responses

	t	df	Sig. (2-tailed)
It is a minor brain injury that usually does not interfere with normal functioning.	2.453	147	.015
It can be prevented by wearing protective gear.	-2.964	147	.004
It is only possible when the individual is knocked unconscious.	2.648	147	.009
It is a traumatic brain injury that interferes with normal functioning.	3.454	147	.001
It is serious and life threatening to play or practice with a concussion.	2.578	147	.011

Table 4.2

Paired t-Test Athletes-Symptoms

Differences between pre and post responses

	t	df	Sig. (2-tailed)
Nausea or vomiting	4.776	147	.000
Balance problems or dizziness	-2.211	147	.029
Mood changes	7.961	147	.000
Inability to fall asleep at night	5.14	147	.000
Fatigue or low energy	2.00	147	.047
Irritability	5.228	147	.000
More emotional than usual	7.657	147	.000

Table 4.3

Paired t-Test Athletes-Signs

Differences between pre and post responses

	t	df	Sig. (2-tailed)
Forgets plays	2.164	147	.032
Shows behavior or personality changes	3.272	147	.001

Table 4.4

Paired t-Test Athletes-Emergency Signs/Symptoms

Differences between pre and post responses

	t	df	Sig. (2-tailed)
Any change in typical behavior or personality	6.166	147	.000
One pupil is larger than the other	6.284	147	.000
Exhibiting unusual behavior	3.154	147	.002

Table 5

Mean Scores of Parents

	N	Mean	Std Dev.	Std Error Mean
Pre-score out of 56.00	141	46.07	6.48	.55
Post-score out of 56.00	141	50.28	5.34	.45

Table 5.1

Paired t-Test Parents-Definition

Differences between pre and post responses

	t	df	Sig. (2-tailed)
It can be prevented by wearing protective gear.	-2.521	140	.013
It is a traumatic brain injury that interferes with normal functioning.	2.302	140	.023

Table 5.2

Paired t-Test Parents- Symptoms

Differences between pre and post responses

	t	df	Sig. (2-tailed)
Sensitivity to light or noise	3.739	140	.000
Feeling sluggish or slowed down	3.538	140	.001
Mood changes	6.683	140	.000
Inability to fall asleep at night	8.110	140	.000
“Don’t feel right”	3.549	140	.001
Fatigue or low energy	3.003	140	.003
Irritability	6.080	140	.000
More emotional than usual	7.980	140	.000

Table 5.3

Paired t-Test Parents-Signs

Differences between pre and post responses

	t	df	Sig. (2-tailed)
Forgets plays	2.745	140	.007
Answers questions slowly	2.221	140	.028
Arm pain (distractor)	-2.934	140	.004
Shows behavior or personality changes	5.135	140	.000

Table 5.4

Paired t-Test Parents- Emergency Signs and Symptoms

Differences between pre and post responses

	t	df	Sig. (2-tailed)
Any change in typical behavior or personality	4.101	140	.000
One pupil is larger than the other	4.753	140	.000
Exhibiting unusual behavior	3.159	140	.002

Table 6

Correlation- History of Concussion and Willingness to Report

	1	2	3
History of a concussion			
Was concussion reported to coach or trainer?	-.506** (148) .000		
Was concussion reported to healthcare provider?	-.506** (148) .000	.960** .000 148	

** Correlation is significant at the 0.01 level (2 tailed).

Table 7

History of Concussion in Soccer Players and Willingness to Report

	1	2	3
History of a concussion			
Was concussion reported to coach or trainer?	-.622** (72) .000		
Was concussion reported to healthcare provider?	-.634** (72) .000	.966** (72) .000	

** Correlation is significant at the 0.01 level (2 tailed).

Table 8

Frequency of History of Concussions and Willingness to Report

	Frequency	Percent
Positive history of concussion	20	13.5%
Concussion reported to coach or trainer	16	10.8%
Concussion reported to healthcare provider	16	10.8%

Table 9

Frequency of Rationale for not reporting Concussions

	Frequency	Percent
No response	4	2.7%
Don't think it is serious	27	18.2%
Don't realize it has occurred	58	39.2%
Don't want to let down teammates	13	8.8%
Don't want to look weak	11	7.4%
Don't want to sit out	20	13.5%
Multiple choices	15	10.1%

Figure 1.

PIKE

Identify your status as a participant (check all that apply):

- ☐ Student Athlete
- ☐ Parent
- ☐ Coach
- ☐ Athletic Trainer

Identify the sport(s) that you are involved with at your high school (check all that apply):

- ☐ Football
- ☐ Basketball
- ☐ Baseball
- ☐ Softball
- ☐ Tennis
- ☐ Lacrosse
- ☐ Volleyball
- ☐ Cross Country
- ☐ Track
- ☐ Soccer
- ☐ Golf
- ☐ Wrestling
- ☐ Hockey
- ☐ Cheerleading
- ☐ Other

Are you male or female?

- ☐ Male
- ☐ Female

What is your race?

- ☐ Caucasian
- ☐ African American
- ☐ Hispanic
- ☐ Asian-Pacific Islander
- ☐ Native American
- ☐ Other

Which of the following regarding a concussion is true? Check all that apply.

- ☐ It is a minor brain injury that usually does not interfere with normal functioning
- ☐ It can be prevented by wearing protective gear
- ☐ It is only possible when the individual is knocked unconscious
- ☐ It is a traumatic brain injury that interferes with normal functioning
- ☐ It is serious and life threatening to play or practice with a concussion

What symptoms may indicate a concussion? Check all that apply.

- ☐ Headache
- ☐ Missed menstrual period
- ☐ Nausea or vomiting
- ☐ Balance problems or dizziness
- ☐ Blurred, double or fuzzy vision
- ☐ Sensitivity to light or noise
- ☐ Feeling sluggish or slowed down
- ☐ Mood changes
- ☐ Increased musical ability
- ☐ Leg pain
- ☐ Inability to fall asleep at night
- ☐ "Don't feel right"
- ☐ Fatigue or low energy
- ☐ Irritability
- ☐ More emotional than usual
- ☐ Concentration or memory problems
- ☐ Repeating the same question/comment

What observed signs may alert you to suspect a concussion in a teammate, child or athlete? Check all that apply.

- ☐ Appears dazed
- ☐ Vacant facial expression
- ☐ Forgets plays
- ☐ Is unsure of game, score or opponent
- ☐ Moves clumsily or displays incoordination
- ☐ Misses menstrual period
- ☐ Answers questions slowly
- ☐ Slurred speech
- ☐ Arm pain
- ☐ Shows behavior or personality changes
- ☐ Can't recall events prior to injury
- ☐ Can't recall events after injury
- ☐ Seizures or convulsions
- ☐ Diarrhea

- ☐ Any change in typical behavior or personality

Which of the following symptoms of concussion indicate an emergency? Check all that apply.

- ☐ Appears very drowsy or can't be awakened
- ☐ One pupil is larger than the other or oval shaped (pupil is the black part of the eye)
- ☐ Convulsions or seizures
- ☐ Missed menstrual period
- ☐ Inability to recognize people or places
- ☐ Increased confusion, restlessness, or agitation
- ☐ Exhibiting unusual behavior
- ☐ Diarrhea
- ☐ Loss of consciousness (even brief)

Returning to sports too soon puts an athlete at higher risk for a second concussion and may cause complications and death.

- ☐ True
- ☐ False

What should an athlete do if he or she thinks he or she has sustained a concussion in the middle of a game?

- ☐ Tell the athletic trainer or coach immediately.
- ☐ Continue to play, tell the athletic trainer or coach after the game is complete.
- ☐ Drink some water and continue to play.
- ☐ Don't do anything.

After a collision, a player is removed from play by the coach and athletic trainer because of a possible concussion. The next day, the player is not experiencing any of the signs and symptoms experienced the previous day, therefore they may return to play without seeing an appropriate health care professional.

- ☐ True
- ☐ False

Protective equipment protects from **all** types of brain injury.

- ☐ True
- ☐ False

The following questions are only for high school athletes:

What is the number **one** reason that would stop you from reporting a concussion to your coach or trainer?

- ☐ Don't think it is serious enough.
- ☐ Don't realize a concussion has occurred.
- ☐ Don't want to let down teammates.
- ☐ Don't want to look weak.
- ☐ Don't want to sit out.

Have you suffered a concussion in the past?

- ☐ Yes
- ☐ No

If yes, did you report your concussion to a coach or trainer?

- ☐ Yes
- ☐ No

If yes, did you report your concussion to a healthcare provider?

- ☐ Yes
- ☐ No

Comments

Figure 2.

Concussion Information Sheet

A concussion is a brain injury and all brain injuries are serious. They are caused by a bump, blow, or jolt to the head, or by a blow to another part of the body with the force transmitted to the head. They can range from mild to severe and can disrupt the way the brain normally works. Even though most concussions are mild, **all concussions are potentially serious and may result in complications including prolonged brain damage and death if not recognized and managed properly.** In other words, even a "ding" or a bump on the head can be serious. You can't see a concussion and most sports concussions occur without loss of consciousness. Signs and symptoms of concussion may show up right after the injury or can take hours or days to fully appear. If your child reports any symptoms of concussion, or if you notice the symptoms or signs of concussion yourself, seek medical attention right away.

Symptoms may include one or more of the following:	
• Headaches • "Pressure in head" • Nausea or vomiting • Neck pain • Balance problems or dizziness • Blurred, double, or fuzzy vision • Sensitivity to light or noise • Feeling sluggish or slowed down • Feeling foggy or groggy • Drowsiness • Change in sleep patterns	• Amnesia • "Don't feel right" • Fatigue or low energy • Sadness • Nervousness or anxiety • Irritability • More emotional • Confusion • Concentration or memory problems (forgetting game plays) • Repeating the same question/comment

Signs observed by teammates, parents and coaches include:	
• Appears dazed • Vacant facial expression • Confused about assignment • Forgets plays • Is unsure of game, score, or opponent • Moves clumsily or displays incoordination • Answers questions slowly • Slurred speech • Shows behavior or personality changes • Can't recall events prior to hit • Can't recall events after hit • Seizures or convulsions • Any change in typical behavior or personality • Loses consciousness	

Adapted from the CDC and the 3rd International Conference on Concussion in Sport
Document created 7/1/2011

Concussion Information Sheet

What can happen if my child keeps on playing with a concussion or returns too soon?

Athletes with the signs and symptoms of concussion should be removed from play immediately. Continuing to play with the signs and symptoms of a concussion leaves the young athlete especially vulnerable to greater injury. There is an increased risk of significant damage from a concussion for a period of time after that concussion occurs, particularly if the athlete suffers another concussion before completely recovering from the first one. This can lead to prolonged recovery, or even to severe brain swelling (second impact syndrome) with devastating and even fatal consequences. It is well known that adolescent or teenage athletes will often fail to report symptoms of injuries. Concussions are no different. As a result, education of administrators, coaches, parents and students is the key to student-athlete's safety.

If you think your child has suffered a concussion

Any athlete even suspected of suffering a concussion should be removed from the game or practice immediately. No athlete may return to activity after an apparent head injury or concussion, regardless of how mild it seems or how quickly symptoms clear, without medical clearance. Close observation of the athlete should continue for several hours. The Return-to- Play Policy of the IESA and IHSA requires athletes to provide their school with written clearance from either a physician licensed to practice medicine in all its branches or a certified athletic trainer working in conjunction with a physician licensed to practice medicine in all its branches prior to returning to play or practice following a concussion or after being removed from an interscholastic contest due to a possible head injury or concussion and not cleared to return to that same contest. In accordance with state law, all schools are required to follow this policy.

You should also inform your child's coach if you think that your child may have a concussion. Remember it's better to miss one game than miss the whole season. And when in doubt, the athlete sits out.

For current and up-to-date information on concussions you can go to:
http://www.cdc.gov/ConcussionInYouthSports/

_____	_____	_____
Student-athlete Name Printed	Student-athlete Signature	Date
_____	_____	_____
Parent or Legal Guardian Printed	Parent or Legal Guardian Signature	Date

Adapted from the CDC and the 3rd International Conference on Concussion in Sport
Document created 7/1/2011

Figure 3.

Informed Consent

I understand that I am being asked to participate in a research study through Illinois Wesleyan University. This research study will evaluate: the current knowledge and awareness of concussion in athletes, trainers, parents and coaches. If I agree to participate in this study, I will attend one educational lecture and complete a pre and post survey. The evaluation will be anonymous; identifying information will be limited to the participant's status as a coach, parent, athlete or trainer. Theses statuses will be linked to codes and the codes delineating the statuses will be placed in a locked file cabinet in Stevenson Hall on Illinois Wesleyan University campus. All evaluations will be placed in a separate locked file cabinet in Stevenson Hall.
The risks in this study are minimal. Major risks I may encounter include fatigue or boredom, loss of time, and psychological or emotional distress resulting from lecture information.
I realize that the knowledge gained from this study may help either me or future athletes comprehend the implications of concussion in athletics.
I realize that my participation in this study is entirely voluntary. I may withdraw from the study at any time I wish. If I decide to discontinue my participation in this study, I will continue to be treated in the usual fashion.
I understand that all study data and identifying information will be kept confidential. However, this information will be used in nursing publications or presentations.
I understand that if I sustain injuries from my participation in this research project, I will not be automatically compensated by Illinois Wesleyan University.
If I need to, I can contact Katherine Racanelli or Dr. Victoria Folse, School of Nursing, Illinois Wesleyan University any time during the study.

The study has been explained to me. I have read and understand this consent form, all of my questions have been answered, and I agree to participate. I understand that a copy of this informed consent and the survey are available upon request.

_____ _____

Signature of Participant Date

*Parental signature indicates consent to participate granted for minor

Figure 3.1.

Assent

I understand that I am being asked to participate in a research study through Illinois Wesleyan University. This research study will evaluate: the current knowledge and awareness of concussion in athletes, trainers, parents and coaches. If I agree to participate in this study, I will be an educational lecture and complete a pre and post survey. The evaluation will be anonymous; identifying information will be limited to the participant's status as a coach, parent, athlete or trainer. Theses statuses will be linked to codes and the codes delineating the statuses will be placed in a locked file cabinet in Stevenson Hall on Illinois Wesleyan University campus. All evaluations will be placed in a separate locked file cabinet in Stevenson Hall.

I realize that because I am under eighteen years, legally and ethically, I am not able to give consent. However, if I sign this document, I will have affirmed my agreement to participate in this research study.

The risks in this study are minimal. Major risks I may encounter include fatigue or boredom, loss of time, and psychological or emotional distress resulting from lecture information.

I realize that the knowledge gained from this study may help either me or future athletes comprehend the implications of concussion in athletics.

I realize that my participation in this study is entirely voluntary. I may withdraw from the study at any time I wish. If I decide to discontinue my participation in this study, I will continue to be treated in the usual fashion.

I understand that all study data and identifying information will be kept confidential. However, this information will be used in nursing publications or presentations.

I understand that if I sustain injuries from my participation in this research project, I will not be automatically compensated by Illinois Wesleyan University.

If I need to, I can contact Katherine Racanelli or Dr. Victoria Folse, School of Nursing, Illinois Wesleyan University any time during the study.

The study has been explained to me. I have read and understand this form, all of my questions have been answered, and I agree to participate. I understand that a copy of this assent form and the survey are available upon request.

_____ _____

Signature of Participant Date

_____ _____

Signature of Parent or Guardian (if under 18 years of age) Date

*Parental signature indicates consent to participate granted for minor

Figure 4

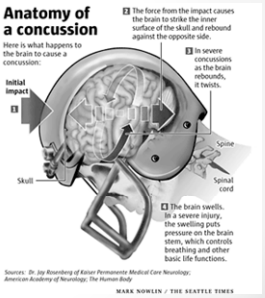
Sports-Related Concussions

It's better to miss one game than to miss them all.

http://www.youtube.com/watch?v=WmhQ65y5cRI&feature=relmfu

Concussion

- Complex pathophysiological process affecting the brain induced by traumatic biochemical force.
- Cause:
  - Bump, Blow or Jolt to the head, face or neck
  - Deceleration/Acceleration
  - Fall
  - Hit to another part of the body, with an impulsive force transmitted to the head
- Diagnosis:
  - Functional versus Structural
  - Symptoms
  - Neuroimaging Studies

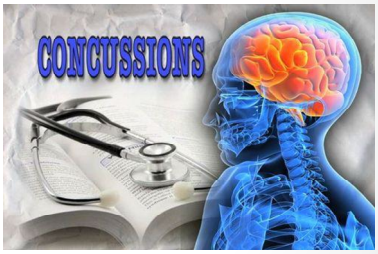


Sports Related Concussion

- The number of athletes entering hospitals with concussions is up 60% in the last decade.
- Estimates of concussion rates likely are low.
  - Failure to report.
  - Failure to recognize.
- **It does not show strength or courage to play injured.**

Youth At Risk

- 65% of concussions occur between the ages of 5 and 18.
- Why are youth at high risk?
  - Underdeveloped brain
  - Decreased musculature
  - Improper technique



Symptoms

- Symptoms may last for days, weeks, or even longer.
- Symptoms may not occur right away.
- "While the brain is restoring itself, people suffer from a long list of side effects, which are intended to keep them from thinking too hard. Bright lights are painful; memory is fragile and full of holes; focus is impossible."
- **What are the symptoms?**

Signs and Symptoms

Cognitive

- Difficulty thinking clearly
- Feeling slowed down
- Difficulty concentrating
- Difficulty remembering past events or new information

When in doubt...all out !!

Affective

- Irritability or anger
- Increased emotion
- Sadness

Somative

- Headache
- Fatigue
- Nausea/Vomiting
- Blurred/Fuzzy Vision
- Sensitivity to light

Sleep

- Sleeping more or less than usual
- Inability to sleep

Dangerous Signs

- Headache that worsens and does not go away.
- Weakness, numbness or decreased coordination.
- Repeated nausea or vomiting.
- Slurred speech.
- Appears drowsy or can't be awakened.
- One pupil is larger than the other.

- Convulsions (seizures).
- Inability to recognize people or places.
- Increased confusion, restlessness or agitation.
- Unusual behavior.
- Loss of consciousness must be taken very seriously.
- **If you or an athlete experience any of these signs or symptoms, contact your healthcare provider immediately!!!**

If you think you have a concussion…

- Tell your coach or athletic trainer immediately if you think you or a teammate has suffered a concussion.
- Remove yourself from play.
- **See a healthcare professional-do not try to judge the severity of the injury on your own.**
- Coaches and trainers, do your best to record:
  - Cause of injury
  - Any loss of consciousness
  - Memory loss
  - Seizures
  - Number of previous concussions

Tips to Recovery

- It usually takes about 2 weeks to regain normal function, but it may take even longer.
- Stop activities that cause symptoms to return or worsen symptoms.
  - Physical demanding activities
  - Activities that require a lot of concentration
  - Sustained computer and video game usage
  - Texting
  - Reading
- Collaborate with your healthcare provider.
  - Do not take drugs your healthcare provider does not approve
  - Avoid alcohol
  - Gradually return to activities as your healthcare provider advises
- Do not "tough it out" it only slows the recovery.

Prevention

- Follow the rules and practice good sportsmanship
- Wear Protective Equipment
  - Make sure all protective equipment (helmets, padding, shin guards, and eye/mouth guards) fit correctly and are worn consistently.

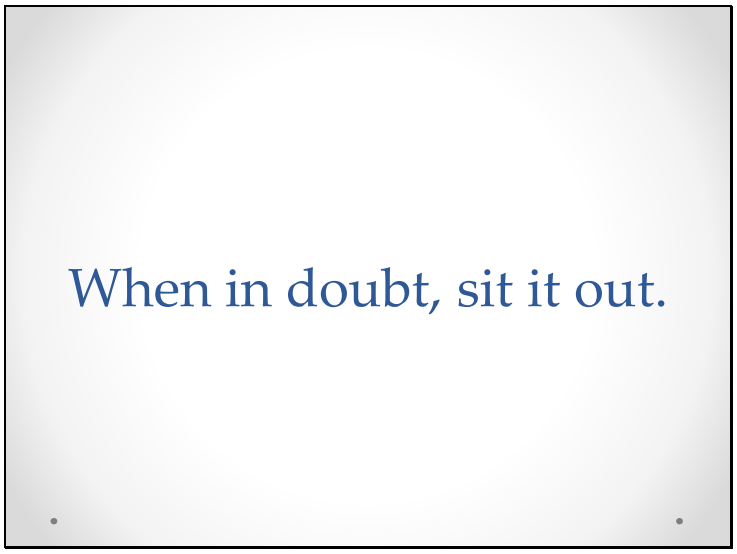
Secondary Impact Syndrome

http://youtu.be/pu6pNTHmVCg

Secondary Impact Syndrome

- DEFINITION: An athlete takes second blow before recovering from the first, causing the nerves that monitor blood flow to the brain to malfunction.
  - HOW: brain swells initially but ability to compensate maintains the balance
    - After a second impact, the brain loses its ability to maintain the balance
    - Intracranial and cerebral perfusion pressures INCREASE
    - Death can occur within 2-5 minutes even before transferring a patient to the emergency room

A repeat concussion that occurs before the brain recovers from the previous concussion can **slow recovery** and increase the potential for problems such as **brain swelling**, **permanent brain damage**, and **death**.


When in doubt, sit it out.


Illinois Wesleyan
UNIVERSITY
Contact Information
Katherine Racanelli
kracanel@iwu.edu
309-556-3051
Dr. Victoria Folse
vfolse@iwu.edu
309-556-3051