Concussion Education Training and Healthcare Provider Knowledge

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Abstract: As of this year, all but two U.S. States have passed laws requiring management protocols for concussion in student-athletes. These laws feature provisions that institute mandatory clinical examination and clearance by a medical professional for return-to-play after sport-related head injuries. However, a large majority of medical providers are not equipped to meet this increasing demand for concussion knowledge, creating a clinical “practice-gap” in concussion care. To help address this increased need for concussion education in the medical community, the current study administered an online concussion training program in the context of the Health IMPACTS for Florida Network. This network of health care providers was created in order to conduct community-based research including a concussion study on the youth population across the state of Florida. Participating health care professionals completed a pre-test, training modules based on current concussion consensus knowledge, and a post-test primarily delivered through a virtual format on the study website portal. Results showed a significant effect of training from pre- to post-test analysis in that providers improved an average of 23% on the measure of concussion knowledge after viewing the training modules. These findings support the utility of virtual concussion training for health care providers as a feasible means of reducing the “practice-gap” between legislative mandate and provider knowledge.

Keywords: Concussion, Health Care Providers, Training, Sport-Related Injury, Youth Sports

The Clinical “Practice Gap” in Clinical Concussion Care for Youths

Sport-related concussions have become a major public health issue, bolstered in mainstream conversation by recent media attention on research findings that demonstrate an association between multiple concussions and negative, long-term health outcomes such as chronic traumatic encephalopathy (CTE) (Schatz and Moser 2011; Schatz et al. 2011; McKee et al. 2009). Anywhere from 1.6-3.8 million mild traumatic brain injuries (mTBI) occur annually based on emergency department estimates, along with an 800,000 additional outpatient visits (Mannix et al. 2013). Unrecognized or unreported concussion incidence probably doubles those rates (Llewellyn 2014). As a result, the Centers for Disease Control and Prevention (CDC) have stated that concussions are at an “epidemic level” within the United States (Langlois et al. 2006). The reported number of concussions likely underestimates the true incidence for several reasons, including, but not limited to, failure of athletes to report concussions, social and cultural pressure within sports to “stay in the game,” and lack of knowledge on the part of physicians and other health care providers regarding proper concussion diagnostics (Moser et al. 2005).

Youth athlete populations tend to be at higher risk for suffering a concussion than their adult counterparts, due in large part to greater participation in organized athletics (Gilchrist et al. 2011). Approximately 65% of all nonfatal TBIs occur in children ages 5 – 18, and United States emergency departments have seen the number of concussion visits triple in the 15-19 year old age group from 1997 – 2007 (Gilchrist et al. 2011; Lebrun et al. 2013). Other studies have shown longitudinal increases in the incidence of concussions among female and male high school athletes specifically (Lincoln et al. 2011; Guerriero et al. 2012). The rising trend of concussion in youth athletes is especially problematic because the developing brain is more vulnerable to...
neuropathology following injury that can interfere with sensitive neurological formative processes (Kirkwood et al. 2006; McCrory et al. 2013; Prins et al. 2013).

As of 2013, 48 out of 50 states have adopted some form of youth concussion legislation that specifically addresses concussion policies in youth sports and prescribes return-to-play procedures after head injury (Schatz and Moser 2011; Law Atlas). The majority of these regulations were modeled after the state of Washington’s Zackery Lystedt Law passed in 2009 (Washington State, 2009), which requires the development of guidelines of the risks, dangers, and nature of sports-related head injuries for athletes, coaches, and parents. These regulations also require informed consent from parents and youth athletes acknowledging said risks. In addition to the educational guidelines, players suspected of head injury must be removed from play and may not return until evaluated and medically cleared by a licensed health care provider. These regulations give healthcare providers a central role in concussion injury identification and management. However, existing legislation does not necessarily set forth requirements for specific training or prerequisite background knowledge for those health care providers tasked with managing concussions.

Family and pediatric physicians are uniquely situated to understand a given athlete’s individual needs and developmental history, which are critical to exercising proper clinical judgment in the event of a suspected brain injury. As post-concussion clinical management is directed by an athlete’s health care provider, they must also provide appropriate referrals to specialists such as neurologists and neuropsychologists who may aid in the athlete’s concussion management and recovery (Lebrun et al. 2013; Master and Grady 2012).

Proper concussion diagnosis is complicated and requires multimodal assessment of domains typically affected by injury, such as cognition, balance, and symptom report. This approach provides a comprehensive picture of post-injury change as possible given that conclusive neuroimaging findings are absent after a concussion by definition (Lebrun et al. 2013; Lincoln et al. 2011; Kay et al. 1993). These domains often overlap with other medical and/or mental health conditions, requiring medical professionals who diagnose concussions to utilize well-tuned clinical judgment based on up-to-date knowledge of proper concussion diagnostics and treatment (Kirkwood et al. 2006). Unfortunately, many physicians do not possess the requisite knowledge to meet the needs of the legislative mandates for concussion care, nor is training appropriately incorporated into existing medical education curricula, thereby creating a “practice gap.” A 2011 study of primary care physicians found that only 30-50% were knowledgeable about the standard return to play (RTP) guidelines at the time (Chrisman et al. 2011). Though sports medicine physicians might be expected to be better educated on the matter, a survey of the American Society for Sports Medicine found only 30% of sports medicine doctors were familiar with the current established guidelines (Chrisman et al. 2011). Additional studies have found that many physicians provide improper return to play directions to patients (Master and Grady 2012, Master et al. 2012). In Burke et al.’s 2012 survey of Canadian medical schools, only 23.5% provided concussion-specific education. Boggild and Tator’s 2012 study found similar concussion knowledge deficiencies in medical students and residents, indicating that the “practice gap” is not isolated to later medical cohorts, but rather endemic in medical training models. The goal of the current study is to explore the effect of a training program intervention on concussion knowledge among health care providers in a physician-based research network. Training that results in improved baseline knowledge in providers could essentially be part of the solution to the “practice gap” discussed above and lead to better clinical management of concussion in youths.
Methods

Participants

Participants in this study were health care providers who took part in the Health IMPACTS (Integrating Medical Practice and Community-based Translational Science) for Florida Network, a research collaborative between the University of Florida and Florida State University. This practice-based research network consisted of University-affiliated health care providers who administered the Sport Concussion Assessment Tool-Second Edition (SCAT2), an open-source, multi-component assessment approach for concussion, during routine, qualifying office visits for youth athletes in their community. Providers in this network included medical doctors, registered nurse practitioners (ARNP), physician assistants and medical assistants located in Orlando, Tallahassee, and Jacksonville, as well as surrounding rural communities including Jackson and Gadsden counties. This study was approved by institutional review boards from the University of Florida, Florida State University, Tallahassee Memorial Hospital, Arnold Palmer Medical Center, and Florida Hospital-Orlando. A total of 37 providers participated including 24 males and 13 females. The majority of participants were medical doctors (30) with pediatricians (53.7%) and family medicine (39.3%) being the two most common specialties among this group. The remaining providers included nurses (3), medical students (2), a physician assistant (1), and a medical assistant (1).

Research Design

As part of the study protocol, student-athlete participants who attended these medical practices for qualifying physical examinations agreed to return to the examining physician if and when the participant sustained or was suspecting of having had a concussion during season play for follow-up SCAT2 testing to assist in concussion diagnosis and management. Network health care providers were trained through an online portal provided by the Health IMPACTS for Florida website (www.healthimpactsflorida.org) accessible through project-administered passwords. The training program data were collected and managed using REDCap, (Research Electronic Data Capture) a secure, web-based application designed to support data capture for research studies (Harris et al. 2009). In order to assess the effectiveness of the training program, a pre- and post-test were included in the training workflow.

Measures

Concussion knowledge was measured before and after training by a 20-item, multiple-choice pre-test and a 20-item multiple-choice post-test (using different questions) that were based on content from the 2008 Consensus Statement on Concussion in Sport (McCrory et al. 2008) and the National Collegiate Athletic Association (NCAA) Concussion Guidelines (Lincoln et al. 2011). Questions tested provider awareness of topics related to concussion clinical diagnosis, assessment, return to play management, sports regulations, and general knowledge.

Procedure

Providers were administered a pre-test, underwent training, and completed a post-test through an online portal at their own convenience on personal or office computers. Providers were first administered an untimed 20-item pre-test via REDCap. Following the completion of all items, their scores and the opportunity to review missed questions was provided. Health care providers were then automatically navigated to the training modules consisting of: 1) National Collegiate Athletic Association Webinar on Concussion Management as of July 16th, 2010, which provided basic education on the nature and impact of concussion and outlined basic procedures for
evaluation and management of concussion events, 2) Consensus Statement on Concussion in Sport from the 3rd International Conference on Concussion in Sport, held in Zurich, November 2008, 3) video demonstration of the SCAT2 produced by the University of North Carolina at Chapel Hill Matthew A. Gfeller Sport-Related Traumatic Brain Injury Research Center as of October 12, 2012, and 4) video demonstration of the modified Balance Error Scoring System (BESS) produced by the University of North Carolina at Chapel Hill Matthew A. Gfeller Sport-Related Traumatic Brain Injury Research Center as of October 12, 2012. A twenty-item untimed multiple-choice post-test followed the training modules. Providers were required to score 80% or higher on the post-test in order to participate in the baseline concussion testing network and receive Continuing Medical Education (CME) credits. Providers were given the opportunity to re-take the final post-test, though they were not permitted to view the correct answers. Licensed physicians were eligible to receive 2.5 CME credits for successful training completion. Of the 37 Health IMPACTS network providers who passed the post-test, 30 were eligible for and earned CME credits.

Results
A total of 37 network health care providers participated in concussion training with 36 completing the pre-test and 34 completing the post-test. One of the 34 providers who completed the post-test did not complete a matched pre-test. Due to virtual portal functionality difficulties, some of the providers did not complete the full training workflow but viewed the training modules online and answered pencil and paper versions of the pre- and post-tests that were administered by research coordinators and later entered into the portal. In order to assess the effect of concussion education training on concussion knowledge, a repeated samples t-test was conducted on the 33 providers who finished both 20-item pre- and post-tests. Only the initial post-test score was used in the following analysis since providers were allowed to retake the post-test as many times as necessary to obtain a passing score of 80%. Results from a paired-samples t-test indicated that after completing the requisite training modules, providers significantly improved their concussion knowledge (post-test score, \( M = 86.41, SD = 8.54 \)) by an average of 23% over their pre-test score (\( M = 70.31, SD = 11.35 \)), \( t(32) = -5.64, p < .001 \). This finding represents a small effect size, \( r = 0.26 \).

Most providers achieved a passing score of 80% on the post-test with their first attempt (84.8%), and the average number of attempts to pass the post-test was 1.3. On the pre-test, 5 questions were identified on which providers answered correctly less than 50% of the time. On the post-test, most items were answered correctly with a high percentage of accuracy (79% and above), but 2 of the 20 items were answered correctly with less than 50% accuracy, scoring notably lower with 44% and 38% accuracy for each. (See Figure 1)
A sizable proportion of providers (58.3%) were unable to identify that complex behavioral and emotional symptoms are the typical signals of a concussion, incorrectly answering that abnormalities on neurological examination (36%), loss of consciousness for greater than three minutes (11.1%), or blunt contact with an object (11.1%) are the most common concussion presentations. Over half the physicians in this sample also incorrectly answered questions relating to basic concussion pathophysiology. However, after the training protocol, the health care providers’ accuracy as a whole improved to 80% or higher on almost all questions, including those concerning pathophysiology and treatment.

Discussion

Our study contributes to the rising concern over the ability of health care providers to meet the legislative mandates for proper concussion diagnosis and management in youth sports. The presented findings provide evidence of the clinical “practice gap” between health care providers’ baseline clinical concussion knowledge and current, adequate understanding needed to address complicated concussion diagnostic and return to play issues in medical practice. Results on the pre-test evidenced several conceptual misunderstandings in physicians’ formulation of concussion. The present study found that an online training program for which providers obtained continuing education credits effectively improved concussion knowledge, presumably enhancing their clinical abilities to manage concussions in their respective practices.
The provision of education and psychological treatment after a brain injury is known to reduce the negative effects associated with mild head injury (Mittenberg et al. 2001). Health care providers are in a unique position to provide guidance on the expectations and attributions of post-concussion symptoms which can ameliorate their severity over time (Mittenberg et al. 1992, Daneshvar et al. 2011). Therefore, proper knowledge for physicians is crucial to reducing the negative impacts of concussion. Other efforts have been made to address the “practice gap” but have been less successful. After mailing the CDC concussion-specific “Heads Up” toolkit to 183 physicians, Chrisman, Schiff, and Rivara (2011) found that no significant improvement in concussion knowledge between control and treatment groups was detected. Therefore, the use of incentives such as CMEs in our study may have improved physician attention to education materials, but this is an assumption only, and physician motivation and engagement variables should be further investigated in future research to maximize intervention effectiveness. Future directions for this study should include refinement of the questions on the pre- and post-test, as well as longitudinal follow-up assessments to determine both retention and application of knowledge. Replication in a larger sample size is also critical to extrapolating findings from this analysis to any kind of systematic educational program for health care providers.

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Appendix

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Pre-Test

1) Recent estimates suggest that there are _____ concussions each year in NCAA collegiate athletics.
   a. 5,000
   b. 40,000
   c. 10,000
2) Thirty-seven percent of sports concussions in the NCAA occur in football. The sport with the second highest number of concussions is:
   a. Men's hockey  
   b. Women's soccer  
   c. Men's baseball  
   d. Women's volleyball  
   e. Wrestling

3) A concussion is not a brain injury, and athletes and their families should be counseled about the distinction.
   a. True  
   b. False

4) Within the brain, a concussion results in
   a. Decreased energy demand  
   b. Increased cerebral blood flow  
   c. Increased intracranial pressure  
   d. Increased energy demand  
   e. Hyper-efficiency in cellular metabolism

5) A concussion is typically signaled by
   a. Complex behavioral and emotional symptoms  
   b. Abnormalities in structural neuroimaging  
   c. A loss of consciousness for >3 minutes  
   d. Abnormalities on neurological examination  
   e. Blunt contact with an object

6) Current NCAA guidelines allow the concussed athlete to return to play the same day if they are asymptomatic for more than 30 minutes.
   a. True  
   b. False

7) One particularly significant short-term risk of mismanaging concussions is
   a. Development of dementia  
   b. Development of post-traumatic Parkinsonism  
   c. Second Impact Syndrome  
   d. Delayed Neurological Deterioration Syndrome  
   e. Development of psychiatric symptoms

8) Preseason baseline testing is
   a. Relatively uncommon in organized US nonprofessional sports  
   b. Becoming the standard of care in organized sports at all levels  
   c. Becoming the standard of care, but only in NCAA Division 1  
   d. Required only in football at the present time  
   e. Costly and difficult to implement

9) A concussed athlete had symptoms but now tests normally on quantitative measures. If s/he remains asymptomatic for 1 additional day, s/he may
a. Stop the testing protocol
b. Return to play
c. Begin a graduated exertional return to play
d. Begin sports-specific practice (return to practice with the team)
e. Begin full conditioning drills

10) Which of the following is cause for concern in an athlete sustaining a concussion?
   a. Extensive amnesia for the event
   b. Deterioration over time instead of resolution
   c. Symptoms lasting more than a week
   d. Personality changes
   e. All of the above

11) After initial monitoring, there is no need to wake up the concussed athlete every hour as was once thought.
    a. True
    b. False

12) Typically, symptoms of concussion
    a. Improve with/after exertion
    b. Are unrelated to exertion
    c. Are worse later in the day due to fatigue
    d. Worsen with exertion
    e. All resolve or worsen together

13) According to current standards, on-site (sideline) evaluation of concussion
    a. Can be performed by health care providers or trainers experienced in concussion assessment and management
    b. Cannot be performed by coaches, who have a vested interest
    c. Must be performed by a physician
    d. Is not mandatory except if the athlete has loss of consciousness >1 minute
    e. Typically involves the administration of brief paper-and-pencil tests

14) The presence of other health problems in the athlete usually does not affect how the concussed athletes symptoms are expressed.
    a. True
    b. False

15) Which of the following is not a primary symptom of postconcussion syndrome?
    a. Sensitivity to light and noise
    b. Loss of verbal ability
    c. Headache
    d. Impaired concentration
    e. Depression and/or irritability

16) One problem with neuropsychological testing as an indicator of cognitive symptoms is:
    a. It is not objective
    b. There are no norms for how the "typical" athlete performs
    c. They are too difficult for the typical athlete to complete
    d. They measure abilities that are not affected by concussions
    e. The athlete can affect baseline scores by exerting poor effort
17) After acute evaluation and stabilization over the first few hours, the concussed athlete's status should be monitored ________ until they are regarded as ready to return to play
   a. Weekly  
   b. Daily  
   c. 6 hours  
   d. Twice a day  
   e. Every other day

18) At a minimum, baseline and incident concussion testing should evaluate symptoms, cognitive function, and balance.
   a. True  
   b. False

19) The majority of states in the United States have laws that govern how children and minors with concussions should be treated and managed.
   a. True  
   b. False

20) Chronic traumatic encephalopathy refers to
   a. A condition in which there is a buildup of the tau protein in the brain  
   b. Neural degeneration after repeated concussion  
   c. The disorder that was originally referred to as "dementia pugilistica"  
   d. A condition that can even affect young athletes who have been repeatedly concussed  
   e. All of the above

KEY
1) C  
2) B  
3) B  
4) D  
5) A  
6) B  
7) C  
8) B  
9) C  
10) E  
11) A  
12) D  
13) A  
14) B  
15) B  
16) E  
17) B  
18) A  
19) B  
20) E

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Post-Test

1) The Zurich (2008) Consensus Statement on Concussion in Sport defines concussion as:
   a. The same entity as mild traumatic brain injury (mTBI)  
   b. A natural occurrence to be expected from sports participation  
   c. A complex pathophysiological process affecting the brain, induced by biomechanical forces  
   d. A condition that warrants hospitalization regardless of severity  
   e. A demonstrable alteration of mental status that last longer than 30 minutes

2) Current thinking on concussion
   a. Recognizes the distinction between “simple” and “complex” concussions  
   b. Suggests that the majority of patients continue to exhibit symptoms beyond 1 month after injury  
   c. Suggests that the majority of patients are ready to play the day after injury
d. Suggests that the majority of concussions resolve within a 7-10 day period

e. Suggests that athletes should be removed from play only after sustaining their second concussion

3) Structural neuroimaging
a. Is typically normal in uncomplicated concussion, particularly in the immediate post-injury period
b. Is typically abnormal in uncomplicated concussion, particularly in the immediate post-injury period
c. Is not useful in the diagnosis of concussion
d. Is primarily focused on imaging grey matter disturbances after concussion
e. Has no proven efficacy in the neurologic examination of the concussed athlete

4) Deficits in postural stability
a. Persist for at least a month after uncomplicated concussion
b. Persist for approximately 72 hours (on average) after uncomplicated concussion
c. Are nonspecific to head injury and should not be used as evidence of a concussion
d. Are not typically assessed in office practice because their assessment requires complex technology
e. Is not considered a reliable method for evaluating post-concussive deficits in neurologic function

5) Systematic, office based assessment of concussion in youth sports participants
a. Is considered the standard of care according to the American Academy of Pediatrics
b. Is considered impractical in most primary care or pediatric practices
c. Is practiced by the vast majority of medical professionals today
d. Is not currently possible because of the lack of available tools
e. Can be accomplished with a basic mental status examination

6) The Zurich statement suggests
a. That concussed athletes can return to play the next day if their reflexes are normal
b. A graduated return to play protocol that allows the concussed student athlete to return to play within 48 hours.
c. A graduated return to play protocol with a duration determined by the student-athlete’s individual progress through increasingly demanding activities
d. That the athlete’s neuropsychological performance at rest is the best determiner of readiness to play
e. That a concussed athlete can return to play in the next scheduled athletic contest if s/he is asymptomatic for 24 hours

7) Which of the following factors have not been shown to affect/modify recovery from concussion?

a. Number of concussion symptoms
b. Multiple injuries spaced close in time
c. Injury severity
d. Motivation to return to play
e. Age at first injury (pediatric vs. adult onset)
8) The Maddocks scale
   a. Is an assessment of balance disturbances after concussion
   b. Is designed as a quick sideline measure of mental status
   c. Requires special equipment to administer
   d. Is only useful if the athlete has lost consciousness
   e. Is a sideline assessment of reflexes and visual acuity

9) Most NCAA athletic departments
   a. Have articulated sports concussion management protocols
   b. Have not developed a systematic approach to sports concussion
   c. Utilize athletic trainers as the sole professional managers of sports related concussion
   d. Fail to recognize sports concussion as a significant problem
   e. Return concussed athletes to play according to a set, nonindividualized schedule

10) The role of neuropsychologists in sports concussion
    a. Is overvalued due to the fact that the symptoms that are most predictive of recovery are simple reflexes
    b. Is not important since the majority of valid assessments are unrelated to cognition
    c. Is important as a source of critical information about specific functions typically impaired in concussion
    d. Is primarily restricted to the evaluation of concussion impact in the first 24 hours after injury
    e. Is minimal with respect to the design and interpretation of standardized, computer-based tests of cognitive function, such as ImPACT

11) One problem with accurately assessing the incidence of sports related concussion is that
    a. There is poor understanding of the signs and symptoms of concussion
    b. Concussion is such a rare event there is little chance of studying it
    c. There is a tendency to overdiagnose concussion, confusing it with other medical problems
    d. The tendency for some athletes to “tough it out” and fail to report their injury
    e. The definition of concussion requires a loss of consciousness, which doesn’t always happen

12) The current standard of care in concussion management
    a. Requires at least a coach’s release to allow the student athlete to return to play
    b. Requires a medical professional evaluation and clearance prior to return to play
    c. Allows the student-athlete to return to play the same day if no loss of consciousness occurred
    d. Requires all student athletes to miss at least one game while they recover from a concussion
    e. Allows child and adolescent athletes to proceed through the graduated return to play protocol faster than adults

13) Athletes can return to play
    a. When they are symptom-free both at rest and with exertion
    b. When balance and cognitive function have returned to baseline
    c. After the athlete has received education about risks for repeated concussion
d. After cleared by a medical professional

e. All of the above must occur before return to play

14) Second impact syndrome refers to

a. The phenomenon that a second concussion can occur with less mechanical force

b. Catastrophic injury that can occur if the brain is concussed a second time before it has the chance to fully recover from a previous concussion

c. The appearance of plaques and tangles in the brain as a result of concussion

d. The effects of movement of the brain inside the skull with an impact to the head

e. Dementia pugilistica

15) Which of the following is a “red flag” for a potentially serious injury that bears special attention by the medical professional?

a. Brief loss of consciousness

b. Disorientation in time

c. Failure of the sideline Maddocks scale immediately after the injury

d. Deterioration, rather than resolution, over time

e. Headache

16) The proper evaluation and management of mild sports-related concussion

a. Typically requires a multidisciplinary team of physicians, neuropsychologists, athletic trainers, etc.

b. Is best done by computerized testing

c. Does not require an evaluation of balance or coordination

d. Requires structural neuroimaging scans such as CT

e. Requires at least 4-5 hours of neuropsychological testing

17) One drawback of computerized tests of cognitive function is that

a. They are weak in measuring reaction time

b. They are sometimes inaccurate because of lack of computer expertise

c. They are less effective in evaluating memory function than are traditional paper and pencil tests administered by a professional neuropsychologist

d. No norms exist for these computerized tests

e. They are very difficult to implement in an office environment

18) According to the NCAA, Women’s Ice Hockey is #3 in the rate of concussion in competition, even though checking is not allowed. One reason for this might be:

a. Less effective protective equipment in women’s sports

b. Women are more likely to report concussions than are men

c. The female brain is more susceptible to concussion

d. The frequent starts and stops required of the hockey player

e. Women ice hockey players are not required to wear helmets by the NCAA

19) The metabolic cascade after mild traumatic brain injury/concussion involves

a. Decreased energy demand and increased cerebral blood flow

b. Hyperefficiency of cellular metabolism

c. Hypерexcitability of cerebral neurons

d. Increased energy demand coupled with reduced cerebral blood flow

e. Increased cerebral blood flow only
20) The baseline (pre-participation) evaluation of concussion-related symptoms (SCAT2) is important because
   a. It is the best method for quantitatively establishing the individual’s “normal” function, which serves as a benchmark against which to evaluate recovery
   b. It determines whether the student-athlete is at risk for concussion
   c. It provides a quick and effective method of evaluating the athlete’s IQ
   d. It discloses whether the athlete has had any previous concussions or not
   e. It contains a balance and coordination assessment that helps the student athlete learn what is the best position to play on the team.

KEY

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