

**(Peer Reviewed Article)****Safety Concerns in Football: A Systemic Review on the Protocol of Return to Play after Concussion**

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**Abstract**

The purpose of this article was two-fold: (1) to address and highlight the standards of concussion management protocol provided by the NATA, CDC and major sports governing bodies, and (2) to examine how concussion protocols of different levels of athletic programs and organizations adhere to the proposed guidelines and standards. According to the literature, an ideal concussion management plan must cover elements such as: concussion education, responsibility and information about student athletes' self-reporting signs and symptoms, policy and rules on restricting activities of athletes who are diagnosed with a concussion, requirements and procedures for diagnosis of a concussion and clearance before returning to play (RTP), baseline testing for athletes, return to learn guidelines, and a stepwise RTP progression. The results of our analysis revealed that most of the programs had complied with the NATA concussion treatment protocol and standards, particularly on the element of the stepwise progression RTP protocol. Implications and practical suggestions are discussed to help improve existing protocols to better serve injured athletes and protect all athletes from further exposure to sport related concussions (SRC).

**Introduction**

American football is one of the most popular and prominent sports in the United States (Sage, Eitzen, & Beal, 2019). Boys begin playing football at a young age and many aspire to play at the collegiate and professional levels. Football leagues for kids around the country remain popular with variations such as flag football, youth football, interscholastic football, and/or pop warner leagues (Kahler, 2016). Despite being the most popular high school sport in the country, the number of kids participating in football at the community and youth level has seen a gradual decrease in recent years (Sage et al., 2019). The discovery of chronic traumatic encephalopathy (CTE), a progressive degenerative disease caused by suffering repeated concussions and traumatic brain injuries, has resulted in serious concern about players' safety in the sport of football (Reiter, 2015; Sage et al, 2019). Due to the high speed actions, size of the players, and full-contact nature of the sport, football carries a substantial risk of injury. Undoubtedly, head injuries, specifically concussions, have been a growing concern surrounding the game of football and have become an important discussion in the sports world (Kluger, 2011, Gregory, 2014). The autopsy findings of Dr. Bennet Omalu on deceased professional football players, had generated public attention about the impact of concussions associated with playing football (Gregory, 2020; Reiter, 2015). Head injuries can have long-lasting impacts on athletes for years down the road, ultimately affecting quality of life. Concussion have been linked to early onset dementia, chronic traumatic encephalopathy (CTE), personality changes, mood swings, and even suicides (Mayo Clinic, 2019; Taylor, 2015).

## **Head Injuries in Football**

It is estimated that 1.6 to 3.8 million concussions occur in sports and recreational activities annually (Daneshvar, Nowinski, McKee, & Cantu, 2011). Between 2001 and 2009, emergency room visits for brain injuries increased up to 62% (Daneshvar et al., 2011; Datalys Center, 2009; Kerr, Simon, Grooms, Roos, Cohen, & Dompier, 2007). Among females ages 10-19, the most common causes for concussion-related head injuries were soccer, basketball and bicycling (Daneshvar et al., 2011). Football was the most common cause of concussions for all male athletes for all ages (Gessel, Fields, Collins, Dick, & Comstock, 2007; Datalys Center 2009). More than a half million concussions in the U.S. were sustained by children who played tackle football (Datalys Center, 2009). It was estimated that concussions accounted for nearly 15% of sports related injuries in high school athletics. Since 1997, at least 50 high school or younger football players in more than 20 states have died due to poor concussion management after experiencing serious head injuries on the field (Kerr et al, 2007).

At the collegiate level, the rate of football-related head injuries might seem less severe; nevertheless, the risk is still high and alarming (Inside Higher Ed, 2012). The overall injury rate in the National Collegiate Athletic Association (NCAA) football was 8.1 injuries per 1,000 athlete exposures, and concussions alone accounted for 7.4% of all injuries (NCAA, 2009). Players are seven times more likely to get hurt during a game than in practice (NCAA, 2009). From 2004-2009, there were no fatalities from direct catastrophic injuries; however, 11 deaths were caused by the complication of sustaining repeated head trauma (Datalys Center, 2009).

Many sports carry the risk of concussions and other head injuries. However, football is potentially the most dangerous sport when it comes to concussions, due to its highest rates of concussions and brain injuries among collegiate sports (Datalys Center, 2009; Kerr et al, 2007). For these reasons, the goals of this review are to: (1) discuss and highlight the standards of concussion management protocol provided by the NATA, CDC and major sports governing bodies, and (2) examine how concussion protocols for different levels of athletic programs and organizations (n = 10) adhere to the proposed guidelines and standards.

### **The NATA Management of Sport Concussion Position Statement**

To understand how to manage concussions, one must know the definition of concussions, pathology of their occurrence, and procedures for treating the concussions (AANS, n.d.; Baugh, Kroshus, Stamm, Daneshvar, Pepin, & Meehan, 2016; McCrory et al, 2012). Concussion, or mild traumatic brain injury, is described as a traumatic brain injury (TBI) that is induced by a force that's transmitted to the head from a direct or an indirect impact, resulting in rapid acceleration and then deceleration of the brain (Broglia et al, 2014; CDC, 2019). The sudden change in cerebral velocity elicits neuronal shearing, which causes changes in ionic balance and metabolism (Broglia et al., 2014). Signs of a concussion may include memory problems, confusion, dizziness, headache, double vision, nausea or vomiting, sensitivity to light or noise and many other issues (AANS, n.d.; Asken, Snyder, Clugston, Gaynor, Sullan, & Bauer, 2017; Ontario Neurotrauma Foundation, 2018).

Athletic Trainers (ATs) are licensed medical professionals who receive both clinical and comprehensive educational instruction in concussion management. ATs are usually the frontline personnel who respond to identify and evaluate injured athletes (Broglio et al., 2014; Notebaert & Guskiewicz, 2005). Therefore, ATs play a huge role in concussion management and the return to play (RTP) process. It is recommended that ATs should be present at all levels of play and work closely alongside a physician to develop and implement a concussion management protocol (Broglio et al 2014; McCrory et al, 2012).

Most ATs rely on clinical examination or symptom checklists to evaluate athletes with concussion, and decide whether to return an athlete to play (Notebaert & Guskiewicz, 2005). Additional methods for making a return-to-play decision also include the use of the return-to-play guidelines. The National Athletic Trainer's Association's (NATA's) Management of Sport Concussion position statement, which advocated using symptom and procedure checklists to determine student-athletes' condition for return to play, was perceived as the best practice guidelines for managing sports related concussions (Alla, Sullivan, McCrory, & Hale, 2011; Broglio et al., 2014; McCrory et al, 2012; Notebaert & Guskiewicz, 2005). During the early introductory stage of the Concussion position statement, only 3% of certified athletic trainers surveyed used a multifaceted objective assessment battery (Notebaert & Guskiewicz, 2005). A more recent study indicated that over 60% of ATs working in small or mid-size athletic programs at the NCAA Division II and III level, adopted multifaceted objective tests to track concussion symptoms at different stages (Buckley & Kelly, 2015). In addition, over 80% of schools reported using a graded exercise protocol before return to play (Buckley & Kelly, 2015).

In addition to standard guidelines for testing and monitoring student-athletes' baseline and recovery, this statement also provided athletic trainers, healthcare professionals, and administrators information, such as concussion education, basic strategies for injuries prevention, and proper documentation for legal concerns (Alla et al., 2011). Following is a brief introduction and description of each of the major components covered in the NATA's concussion management statement.

### **Concussion Education**

Prior to each football season, the sports medicine staff, coaches, and the administrators should review the current institutional concussion protocol and policies/procedures established under the guidelines of NATA. In general, the protocol should cover injury definition, signs and symptoms, and concussion management procedures (Broglio et al., 2014). Data has shown that athletes have limited knowledge in regard to concussion symptoms and non-reporting of concussion symptom rates were astonishingly high (Broglio et al 2014; Wallace, Covassin, Nogle, Gould, & Kovan, 2017).

Athletes who are not aware of the signs and symptoms of a concussion would likely continue to play and aggravate brain injuries. As part of an effective education program, the concussion protocol as well as prevention, recognition and referral, returning to play, physical and cognitive restrictions, and consequences of improper concussion management, should be communicated and made readily available to coaches, athletes, parents, administrators, and other appropriate healthcare



professionals. When properly implemented, these educational programs have shown to be effective (Alla et al., 2011; Broglio et al, 2014).

### **Baseline Testing, Evaluation, and Diagnosis**

The NATA strongly recommends choosing a concussion-assessment model covering objective baseline and post-injury testing (Broglio et al., 2014). When selecting a concussion management protocol and evaluation, all members of the sports medicine team should be involved and obtain approval from the athletic administrators (Broglio et al 2014). Most appropriate concussion protocols and assessment tools should be easily utilized in both the clinical setting and on the field. Once the testing protocol has been chosen, each athlete will be examined in an appropriate environment that is designed to amplify test performance. Tests should be able to be easily reproduced in the post-injury setting (Broglio et al., 2014; Ontario Neurotrauma Foundation, 2018).

Ideally, all athletes, especially adolescents whose brains are still developing, should go through an annual pre-season baseline testing procedure. The purpose of baseline testing is to obtain a representation of the athlete's brain function at an uninjured state, with the intention of assisting the clinician if a TBI is incurred. Baseline testing covers clinical history, medication, physical and neurologic evaluations, measures of motor control, neurocognitive function, and pre-injured self-reported symptoms (Erdal, 2012; Randolph, 2011). At minimum, athletes who are at a high risk of concussion based on their sport, should be screened. Since baseline data from group testing has not been available and well-identified, individual baseline testing becomes more critical and necessary. If an athlete has a past concussion history or has a condition(s) such as attention-deficit hyperactivity disorder (ADHD), the individual would be more susceptible to aggravate the concussive impact (Broglio et al., 2014). To ensure baseline data is accurately obtained, athletes should not undergo any baseline testing, if they are injured, ill, or physically and/or mentally fatigued (Erdal, 2012).

Players suspected to have sustained a concussion during competition or practice, or are exhibiting any concussion-like symptoms, should be removed from activity immediately. Once removed from the activity, their mental status should be regularly monitored and checked (Broglio et al., 2014; Ontario Neurotrauma Foundation, 2018). Most of the time, patients are sent home with post-injury instructions, but if there is a significant decline in mental status, this could reflect severe trauma and warrant transport to a medical facility. Diagnosis of a concussion would then be made through a clinical evaluation by a trained medical professional. Additional assessments with several useful tools are often used to assist the clinicians for monitoring the recovery progress. If a concussion diagnosis is made, the participant should not be allowed to return to physical activity until they are cleared by a physician (Broglio et al., 2014; Wallace et al., 2017).

Objective baseline and post-injury information collected during different stages are important because they increase the sensitivity and utility of various tests (Broglio et al 2014; Randolph, 2011). Once a concussion diagnosis has been made, the patient should undergo daily check-ins to monitor the course of recovery. The emphasis of post-injury management covers the cessation of symptoms, restoration of motor control, and return of neurocognitive function to the pre-injury levels (Broglio et al., 2014). It is essential to instruct the athletes and coaches about post-injury

recovery protocol. During the acute phases of recovery, the athlete should avoid all physical activity and limit cognitive activity, so that concussion symptoms are not worsened. However, evidence has shown that support for active recovery is growing and deserves consideration (Leddy, Wilber, & Willer, 2018).). Table 1 lists many assessment tools and their function for monitoring athletes' recovery in post-injury management. These tools are used in a recovery protocol as well as the pretesting and baseline testing. However, none of them can be used alone as a solo diagnostic tool or a standard tool for determining the athletes' concussion. Some of these tools are often used for post-injury testing to collect meaningful data for comparisons. When the patient reports zero symptoms, then their objective assessments should be repeated and compared with their baseline testing results (Asken et al., 2017; Broglio et al., 2014).

*Table 1. Key elements of various diagnostic tests (Baugh et al., 2015; Broglio et al, 2014; Erdal, 2012; Mack et al., 2019; Randolph, 2011)*

Test	Function
Self-Report Symptom Assessment	A test with great sensitivity that uses symptom checklists or scales to assess symptom duration or severity.
Measurement of motor control	Documenting changes in gait, postural control, and hand movement.
ImPACT	A neuropsychological testing used for baseline testing.
Balance Error Scoring System (BESS)	A sensitive and economical evaluation on overall postural control (balance). The test is highly portable and can be administered with minimum training.
Standardized Assessment of Concussion (SAC)	A five-minute screening test on mental status used at the sideline. It assesses orientation, immediate memory, concentration, and delayed recall. The test's sensitivity declines after twenty-four hours. It should be used in combination with a motor-control evaluation and symptom assessment.
Ocular test (Vestibular ocular motion screening, VOMS)	The VOMS is a screening tool developed to detect signs and symptoms of a concussion. It examines the systems responsible for integrating balance, vision, and movement.

Self-reporting of symptoms is a highly recommended procedure of concussion management, because the collected data at the baseline and post injuries stage are the primary measures used to proceed to the next stage of the recovery (Broglio et al., 2014). The decision-making process for return to play should not start until the patient no longer reports concussion-related symptoms, has a normal clinical examination, and achieves at or above pre-injury levels on neurocognitive function and motor control (Asken et al., 2017; Broglio et al 2014). During the entire recovery process, the ATs should closely communicate with the physician and ensure the athletes' recovery is progressing normally (Broglio et al., 2014).

### **Return To Play (RTP) and Other Considerations**

Because everyone reacts to a concussion differently, there is no definite time that guarantees a full recovery. Athletes should not progress to the RTP stage until they are symptom free and able to perform at or above their pre-injury levels of functioning on all objective concussion assessments

(Broglia et al., 2014). There should be a minimum of 24 hours between each of the seven progression steps of the RTP protocol (see Table 2) (Broglia et al., 2014). At any stage of the RTP protocol, if the participant complains of symptoms or shows a decline in their testing/assessment performance, the participant should stop their tasks and activities immediately. Subsequent attempts should be given at a minimum of twenty-four hours later (Asken et al., 2017; Broglia et al., 2014).

*Table 2. Seven steps of the RTP protocol*

Step 1	No activity
Step 2	Light exercise. No greater than 70% age predicted max heart rate
Step 3	Sport specific activities w/ no contact
Step 4	Non-contact training involving others and resistance training
Step 5	Unrestricted training
Step 6	Return to play

Cognitive rest is just as important as physical rest. Cognitive rest refers to limiting academic and cognitive stressors (i.e., reading, writing, mathematics, and computer analytic work) in daily activities (Broglia et al 2014). The goal of cognitive rest is to keep the brain from engaging in stressful mental tasks that may aggravate concussive symptoms. Cognitive dysfunctions such as slow processing speed and reaction time were documented on a number of concussed individuals (Williamson, Norte, Broshek, Hart, & Resch, 2018). These dysfunctions hindered student-athletes' performance in school and prolonged the recovery process (Williamson et al., 2018). Students recovered from the concussion have reported difficulty with learning and dealing with anxiety in school. Therefore, in addition to focus on RTP, research also continues to explore on the return to learn (RTL) practices as well. The existing RTL protocol addresses academic accommodations such as a temporary adjustment to an individual's learning environment and education plans (Williamson et al., 2018). In collegiate athletics, the ATs also monitor the RTL protocol of the patients. The stepwise progression includes: (1) remain at home or in a residence hall, if the student-athlete can't tolerate light cognitive activity, (2) allow student-athletes to return to the classroom once they are able to tolerate cognitive activity without exhibiting concussion symptoms, and (3) allow a gradual increment of cognitive and learning activities as student-athletes return to the baseline level of their cognitive function (NCAA Sports Science Institute, 2017).

### **General Contents of Studied Concussion Management Protocols**

As the governing body of all high school state athletic federations, the National Federation of State High School Federation (2015) had created an updated clear concussion management standards and guidelines for member schools to utilize. These guidelines were set forth to be administered and implemented by the member schools. Its stepwise RTP protocol specifically followed the "Consensus Statement on Concussion in Sport" given by the Center for Disease Control and Prevention (CDC, 2015).

In 2010 the NCAA put forth the "Inter-association Consensus: Diagnosis and Management of Sport-Related Concussion Guidelines" to all affiliated institutions, and requested that each submitted its concussion safety protocol to the committee by May 1 of each year (Baugh et al 2016). The protocol should include: (a) policies and procedures that meet the requirements of the constitution,



(b) procedures for pre-participation baseline testing of each student athlete, (c) procedure for reducing exposure to head injuries, (d) procedures for education about concussion including a policy that addresses RTL, and (e) procedures that ensure proper and appropriate concussion management. The guidelines were made available to all student-athletes who have suffered a concussion. Each school's athletic director was required to sign the certificate of compliance and ensured to implement best treatment for any injured athletes. A five-step (stepwise progression) RTP protocol was adopted. The injured student-athlete should only be progressed to this protocol when he/she returned to baseline levels of symptoms, cognitive function, and balance. At any step of RTP, if the student-athlete for whatever reason becomes symptomatic or experiences a decline in clinical/cognitive measures, the team physician should be notified and request the student-athlete to return to the previous step (level) of activity.

A general outline of the NCAA's RTP protocol was highlighted in Table 3. The NCAA is not the only organization that has crafted the protocol for returning to play. The National Football League (NFL) and numerous high school athletic associations also have similar guidelines for their athletes to follow.

*Table 3. NCAA's five-step RTP protocol*

Step 1	Light aerobic exercise: Activities can include walking, swimming, or riding a stationary bike. No resistance training and if asymptomatic with this, then can continue with the next step.
Step 2	Sport specific activity without head impact: Patients can continue onto next step, if remains asymptomatic.
Step 3	Non-contact sport drills and resumption of progressive resistance training: If patients are asymptomatic after finishing Step 3, they can continue onto next step.
Step 4	Unrestricted training: If patients are asymptomatic after finishing Step 4, then they can continue onto the last step.
Step 5	Return to competition/play. Medical clearance will be determined by the team physician/physician designee, or ATs (in consultation with the team physician).

### **Analyses of the Concussion & RTP Protocol of Selected Athletic Programs/Organizations**

Second-impact syndrome, a second blow to the head of a concussed player exhibiting symptoms, is the primary concern of returning that player back to play too quickly (Broglia et al., 2014; Sport Concussion Center, n.d.). Media has raised the concerns of concussed players who returned to play too soon and resulted more severe brain trauma or even deaths (Taylor, 2015; Wertheim, 2014). The authors conducted a systematic review by examining the concussion management and return to play (RTP) protocol of 10 athletic programs and organizations. The goals of this analysis were to examine: (1) how these teams' and organizations' concussion management protocol adhere to the guidelines recommend by the NATA (or CDC), and (2) what practices were implemented by these teams and organizations to minimize the impact of concussion.

### **The Observed Sample and Examined Procedures**

Ten organizations whose concussion management protocols under this systematic review included four high school state federations, five NCAA affiliated members (three Division-I, one Division-II and one Division-III institutions), and one professional league (NFL). These organizations were chosen in a convenience fashion and were selected based on following: (1) their locations were geographically close to the research team's affiliated institution, (2) the authors had a unique tie or relationship with the selected organization (i.e., having a fellow athletic trainers working there or has worked with the organization before), (3) these organizations represented each level of play (including high schools, major collegiate and small collegiate programs, and professional organizations).

Each member of the research team was assigned to summarize the concussion management protocol of selected organizations. All used Google.com with the following key words to locate the protocol documents: (1) name of the organization, (2) athletics, (3) concussion management protocol, and (4) return to play. When the summaries were completed, all authors would individually go over all ten protocols and review each other's summaries for accuracy based on the protocols posted online. It was noted that each online protocol contained the most updated current information provided by the institutions or organizations during the period of analysis. Each of the observed collegiate institutions and high schools affiliated with the observed state federations had at least one athletic trainer confirm the program's maximum effort in concussion management protocol compliance.

A summary table covering the available contents in six specific areas of management protocol were created based on a consensus agreement among all members of the research team (please refer to Table 4). The detailed descriptions of all ten protocols were shown in Appendix A. Four high school organizations in this study sample had adopted CDC's recommendations as primary guidelines. The following summary table (Table 4) displayed how each organization's protocol complied with the six content-areas of the gold standard set by the NATA.

*Table 4. Illustration of various organizations' compliance to the NATA position statement*

Organization	Concussion Education	Responsibility to Report Signs/Symptoms	Physician Clearance	Baseline Testing	RTL Considerations	Adoption of a Stepwise RTP Protocol
HS1	✓	✓	✓		✓	✓
HS2	✓	✓	✓			✓
HS3	✓	✓	✓		✓	✓
HS4	✓	✓	✓	✓	✓	✓
U1	✓	✓	✓	✓	✓	✓
U2			✓	✓		✓
U3	✓	✓	✓	✓	✓	✓
U4	✓	✓	✓	✓	✓	✓



U5	✓	✓	✓	✓	✓	✓
NFL	✓	✓	✓	✓	N/A	✓

**HS= High School; U = College/University; NFL = National Football League**

*\*Note: All organizations have a stepwise progressive protocol for RTP; however, the strenuous level and depth of the stepwise program may vary.*

### Discussion and Conclusions

There were both similarities and differences in all the concussion protocols among ten observed organizations. All of them generally followed the guidelines set by the NATA, CDC, and their primary governing bodies closely; however, some of the protocols were simpler and vaguer than the others in certain sections. Differences in the RTP protocols were found with duration ranging from four, five, or seven days long. Ideally, it was recommended all concussion protocols should include all six listed elements: (1) concussion education, (2) responsibility for the diagnosed student athletes to report their concussion signs and symptoms, (3) requirements for receiving clearance from a physician before returning to play, (4) baseline testing for athletes in high risk sports, (5) return to learn (RTL) guidelines, and (6) a stepwise RTP protocol (Baugh et al., 2016). In general, most of the entities had adhered to the NATA concussion treatment protocol and standards. *Baseline Testing* and *Considerations for Return to Learn* were two criteria requiring better conformity. As for the Return to Play protocol, all organizations have their own stepwise progressive measures; however, the strenuous level and depth of the program may vary. Eight of the ten RTP protocols followed a five-step progression. University 1's progression had an additional step between light aerobic exercise and sport-specific activity to ensure that the recovered athlete was truly ready to move on to more rigorous activity. In University 2's four-step progression protocol, after the non-contact practice phase, it allowed the player to engage in full contact activity with no restrictions. However, it was hard to know if the individual was to return for competitions. Research suggested it was safer for the player to engage in a full-contact practice or simulation before they were released to full activity and competition (Broglio et al., 2014). In addition, University 2 might need to expand the contents of concussion management protocol by inserting more guidelines on RTL. Typically, three of the four high school protocols had relatively less information addressing the specificities of baseline testing. Only High School Federation 4, showed more contents in baseline testing in its protocol. The authors wondered if budget limitations precluded most of the high schools from conducting thorough in-house baseline testing. The NFHS may need to create amendments to address this topic in its existing 2017 guidelines for management of concussion sports.

All reviewed collegiate concussion protocols met the recommendations in all six criteria from the NATA and NCAA, except University 2. University 2's online protocol was not very clear and had no mention of doing any concussion education for all athletes and related personnel. It did not address the responsibility of athletes to report any signs or symptoms. Nor did it discuss any RTL criteria or considerations.

Studies has shown the difficulties in identifying how various athletic programs and organizations adhere to the NATA standards and guidelines for managing concussions (Notebaret & Guskiewicz,

2005; Buckley & Kelly, 2015). Due to the small size of the review sample and limited surveyed information from the ATs, this review cannot be seen as a study of various organizations' compliance level. Nevertheless, when institutions are willing to post and update their concussion management protocol online and make the information available, this practice begins to show the good faith and the transparency in dealing with the concussion issue and serving the student-athletes with the best medical care.

Even with little research investigating in RTL progression, the NCAA deemed this topic as a necessary component in a concussion management protocol for athletes recovering from a head injury. The NCAA recommended a stepwise progression for RTL, as for RTP as well. The student's cognitive recovery and integration back into learning should be as important as (if not more important than) safe integration into their sport participation

Youth sports and high school programs typically don't have the resources for sophisticated baseline testing and sideline support of medical personnel. However, it was encouraging to witness the observed HS state federations all implemented a concussion management protocol following the guidelines provided by the NATA and CDC. The individual schools also need to deal with exceptional challenges in implementing these policies. Across the board, high school players are not as strong and athletic as college players. Many young athletes are still developing physical and mentally in their high school careers, so traumatic head injuries could be even more damaging. Medical professionals, whether it is an athletic trainer or doctor, may not be easily available for practices and competitions as in the collegiate and professional setting. In the authors' opinions, the rules and guidelines recommended by the NFHS and the state athletic associations should be as stringent as those of colleges and universities, if not more so. They should be clear and concise enough to be understood and followed by non-medical professionals, such as parents, coaches, and administrators. However, additional consideration should be given to which aspects of concussion management can be handled by the non-medical professionals. The practice is highly important since there is a risk and liability issue when involving the non-medical professionals managing the RTP protocols and baseline testing. The education program for understanding various aspects of concussion must be effectively delivered to students and parents. It would be wise to look into some economic baseline testing options (i.e., SCAT 5, which can be done by pen and paper) to ensure safety of the athletes.

## **Conclusions**

This systemic-review was an evaluation of a small size of sample's (n = 10) concussion protocols at four levels of competition (high school, small colleges, Division-I institutions, and the NFL). Although the sample might not be the true representation of concussion protocols of all programs, it was promising that schools and organizations had adopted the recommended guidelines and standards set by the NATA, CDC, and their primary governing body. It was also apparent that some protocols were updated annually. All institutions should ensure the concussion management protocol is updated to provide the best medical care to their athletes. Every school and organization should implement the standards and best practices set by the NATA and CDC. All concussion management protocols should cover the six examined elements in the study as well. Failure to carry out the standards or protocol procedures could result in a detrimental sport related concussion.

## References

- AANS (n.d.). *Concussion*. <https://www.aans.org/en/Patients/Neurosurgical-Conditions-and-Treatments/Concussion>
- Alla, S., Sullivan, S. J., McCrory, P., & Hale, L. (2011). Spreading the word on sports concussion: Citation analysis of summary and agreement, position and consensus statements on sports concussion. *British Journal of Sports Medicine*, *45*(2):132-135. doi: 10.1136/bjism.2010.074088.
- Asken, B. M., Snyder, A. R., Clugston, J. R., Gaynor, L. S., Sullan, M. J., & Bauer, R. M. (2017). Concussion-like symptom reporting in non-concussed collegiate athletes. *Archives of Clinical Neuropsychology*, *32*(8), 963–971. <https://doi.org/10.1093/arclin/acx018>
- Baugh, C. M., Kroshus, E., Stamm, J. M., Daneshvar, D. H., Pepin, M. J., & Meehan, W. P. (2016). Clinical practices in collegiate concussion management. *The American Journal of Sports Medicine*, *44*(6), 1391–1399. <https://doi.org/10.1177/0363546516635639>
- Broglio, S. P., Cantu, R. C., Gioia, G. A., Guskiewicz, K. M., Kutcher, J., Palm, M., & McLeod, T. C. V. (2014). National Athletic Trainers Association position statement: Management of sport concussion. *Journal of Athletic Training*, *49*(2), 245–265. doi: 10.4085/1062-6050-49.1.07
- Buckley, T. A., Burdette, G., & Kelly, K. (2015). Concussion-management practice patterns of National Collegiate Athletic Association Division II and III athletic trainers: How the other half lives. *Journal of Athletic Training*, *50*(8), 879–888. doi: 10.4085/1062-6050-50.7.04
- Center for Disease Control and Prevention. (2015). *Managing Return to Activities: Information for Healthcare Professionals*. [http://www.cdc.gov/headsup/providers/return\\_to\\_activities.html](http://www.cdc.gov/headsup/providers/return_to_activities.html)
- Center for Disease Control and Prevention. (2019). *Concussion information sheet*. [http://www.cdc.gov/headsup/pdfs/youthsports/parent\\_athlete\\_info\\_sheet-a.pdf](http://www.cdc.gov/headsup/pdfs/youthsports/parent_athlete_info_sheet-a.pdf)
- Daneshvar, D. H., Nowinski, C. J., McKee, A. C., & Cantu, R. C. (2011, January). The epidemiology of sport-related concussion. *Clinical Sports Medicine*, *30*(1), 1–17. doi: 10.1016/j.csm.2010.08.006. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2987636/>
- Datalys Center for Sports Injury and Prevention (2009). *Football injuries: Data from 2004/05 to 2008/09 seasons*. [www.datalyscenter.org](http://www.datalyscenter.org)
- Erdal, K. (2012). Neuropsychological testing for sports-related concussion: How athletes can sandbag their baseline testing without detection. *Clinical Neuropsychology*, *27*(5), 473–479. DOI: <https://doi.org/10.1093/arclin/acs050>
- Gessel, L. M., Fields, S. K., Collins, C. L., Dick, R. W., & Comstock, D. (2007). Concussions among United States high school and collegiate athletes. *Journal of Athletic Training*, *42*(4): 495–503.
- Gregory, S. (2020, February 3). Is it unethical to watch football with my son? *Time*, *195*(3), 26-27.
- Guskiewicz, K. M., Bruce, S. L., Cantu, R. C., Ferrara, M. S., Kelly, J. P., McCrea, M., Putukian, M., & Valovich McLeod, T. C. (2004). National Athletic Trainers' Association position statement: Management of sport-related concussion. *Journal of Athletic Training*, *39*(3), 280–297.
- Inside Higher Ed (2012). *Despite NCAA efforts, concussion rates hold steady*. <http://www.insidehighered.com/quicktakes/2012/09/24/despite-ncaa-efforts-concussion-rates-hold-steady>



- Jim (2017, June 20). *NFL head, neck and spine committee's concussion diagnosis and management protocol*. <https://www.playsmartplaysafe.com/focus-on-safety/protecting-players/nfl-head-neck-spine-committees-protocols-regarding-diagnosis-management-concussion/>
- Kahler, K. (2016, September 19). The town that doesn't tackle. *Sports Illustrated*, 125(9), 7-8.
- Kerr, Z. Y., Simon, J. E., Grooms, D. R., Roos, K. G., Cohen, R. P., & Dompier, T. P. (2009). *Epidemiology of football injuries in the National Collegiate Athletic Association, 2004-2005 to 2008-2009*. <https://journals.sagepub.com/doi/pdf/10.1177/2325967116664500>
- Kluger, J. (2011). Headbanger nation. Concussions are clobbering U.S. kids. Here's why. *Time*, 177(4), 42-51.
- Leddy, J. J., Wilber, C. G., & Willer, B. S. (2018). Active recovery from concussion. *Current Opinion in Neurology*, 31(6):681-686. doi: 10.1097/WCO.0000000000000611.
- Mayo Clinic (2019, March 16). *Concussion*. <https://www.mayoclinic.org/diseases-conditions/concussion/symptoms-causes/syc-20355594>
- Mack, C., Myers, E., Barnes, R., Solomon, G., & Sills, A. (2019) Engaging athletic trainers in concussion detection: Overview of the National Football League ATC spotter program, 2011–2017. *Journal of Athletic Training*, 54(8), 852-857.
- McCrory et al. (2012). Consensus statement on concussion in sport: the 4<sup>th</sup> International Conference on concussion in sport. *British Journal of Sports Medicine*, 47(5), 250-258. doi:10.1136/bjsports-2013-092313
- Murphy, A. (2016, August 31). *Football's Endgame: What would happen if America's pastime just ... died?* <https://www.si.com/nfl/2016/08/31/future-of-football-nfl-safety-concussions>
- National Federation of State High School Federation (NFHS) (2017). *Suggested guidelines for management of concussion sports*. [https://www.nfhs.org/media/1018446/suggested\\_guidelines\\_management\\_concussion\\_april\\_2017.pdf](https://www.nfhs.org/media/1018446/suggested_guidelines_management_concussion_april_2017.pdf)
- NCAA Sports Science Institute. (2017, September 21). *Concussion diagnosis and management best practices*. <http://www.ncaa.org/sport-science-institute/concussion-diagnosis-and-management-best-practices>
- Notebaert, A. J., & Guskiewicz, K. M. (2005). Current trends in athletic training practice for concussion assessment and management. *Journal of Athletic Training*, 40(4), 320-325.
- Ohio High School Athletic Association. (2014). *Implementation of NFHS playing rules changes related to concussion and concussed athletes and return to play protocol*. <https://concussion.jmc.kent.edu/docs/gahanna.pdf>
- Ontario Neurotrauma Foundation. (2018). *Guideline for concussion/mild traumatic brain injury and persistent symptoms*. (3rd ed.). [https://braininjuryguidelines.org/concussion/fileadmin/user\\_upload/Concussion\\_guideline\\_3rd\\_edition\\_final2019.pdf](https://braininjuryguidelines.org/concussion/fileadmin/user_upload/Concussion_guideline_3rd_edition_final2019.pdf)
- Optim Sports Medicine (2017). *Athletic trainer (AT) concussion management protocol*. Retrieved from [http://www.gobaronso.com/d/2017-18/Optim\\_Concussion\\_Protocol.pdf](http://www.gobaronso.com/d/2017-18/Optim_Concussion_Protocol.pdf)
- Randolph, C. (2011). Baseline neuropsychological testing in managing sport-related concussion: Does it modify risk? *Current Sports Medicine Reports*, 10(1), 21-26. doi: 10.1249/JSR.0b013e318207831d
- Reiter, B. (2015, December 28). Brain trust. *Sports Illustrated*, 123(25), 29-34.
- Sage, G., Eitzen, D. S., & Beal, B. (2019). *Sociology of North American Sport* (11th ed.). Oxford University Press.

- Sports Concussion Center (n.d.). *What is a sport concussion?* [www.sportsonconcussioncenterky.com](http://www.sportsonconcussioncenterky.com)
- Taylor, T. (2015, December 14). Brain and brawn. *Sports Illustrated*, 123(23), 74-79.
- Tennessee Secondary School Athletic Association. (2019) *Tennessee Secondary School Athletic Association concussion policy*. <https://cms-files.tssaa.org/documents/tssaa/Concussion-Policy-updated-12.2019.pdf>
- Wallace, J., Covassin, T., Nogle, S., Gould, D., & Kovan, J. (2017). Knowledge of concussion and reporting behaviors in high school athletes with or without access to an athletic trainer. *Journal of Athletic Training*, 52(3): 228–235. doi: 10.4085/1062-6050-52.1.07
- Wertheim, L. J. (2014, December 8). Bully market. Despite its concussion controversy and rash of off-field ills, the NFL casts a shadow that other leagues seem afraid to step out of. *Sports Illustrated*. <https://vault.si.com/vault/2014/12/08/bully-market>
- Williamson, C. L., Norte, G. E., Broshek, D. K., Hart, J. M., & Resch, J. E. (2018). Return to learn after sport-related concussion: A survey of secondary school and collegiate athletic trainers. *Journal of Athletic Training*, 53(10), 990–1003. doi: 10.4085/1062-6050-234-17

*Appendix A. Major contents of concussion management protocol of various levels*

Organization	Contents
(HS1)	Educational rulebook updated in April of 2012 was intended to distribute all to athletes, parents, or coaches. The information mimicked the concussion statements provided by the NFHS. No student should return to play on the same day a concussion occurs and after medical clearance by a professional. The concussed student-athlete should follow a step-by-step protocol for delayed reentry in his or her sport to make sure symptoms do not reoccur. This state protocol covers logistics of handling a suspected concussion and diagnosis of a concussion. The protocol also discusses the role of coaches and officials. The final section of the protocol revolves around the six-step RTP protocol.
(HS2)	This five-page Concussion Policy was consistent with guidelines of the NFHS as well. It made clear that the education for all individuals involved in athletics in Tennessee was a clear priority. All coaches needed to complete online trainings before the start of their season. The protocol gave 10 responsibilities for officials and five for coaches to look for concussion symptoms and remove any athlete exhibiting those symptoms. A lot of details covered additional duties of obtaining clearance from a medical official, filing appropriate paperwork, and informing the proper authorities. Neither the coach nor the official has any role at all in diagnosing a concussion. The state Concussion Return to Play form must be filled out by a medical professional in order for a student athlete to be cleared to return to athletic activity. The RTP protocol followed a six-step (6-day) stepwise progression. The medical personnel would give one of the five recommendations on RTP.
(HS3)	This 4-page concussion document did not read as much like a rule book. It was presented as information to be understood by athletes, parents, and others associated with sporting activities (with a signature requirement). Much of the information was provided in a Q&A format. The list of rules was similar to those of NFHS. It required written authorization by medical professionals to clear athletes to play. Concussion management contents covered symptoms, the roles and responsibilities, medical official's responsibility for the diagnosis and granting the RTP decision. Surprisingly, the gradual RTP protocols were not displayed specifically in details and information was just merely suggestions. The final part of the protocol was to be signed by the athletes and their parents related to liability concerns about the severity and risks of concussions. This protocol was easier to navigate than the HS1 protocol. The Q&A format is informative and extremely presentable. The question and answer portion of the document gives answers that are not found in the HS1. The last page asks for signatures from parents and student athletes. It also provided links to the CDC and NFHS sites.
(HS4)	The organization partnered with Optim Sports Medicine to develop the concussion protocol. The diagnoses were made by clinicians who received CDC's Heads Up Training. ATs contracted at each school are responsible for dispersing and collecting all concussion paperwork and awareness forms for all athletes and their parent/guardians. The neuropsychological testing, ImPACT, was used for baseline testing. Sports Concussion Assessment Tool (SCAT 5) was used for supplemental testing. Baseline testing is repeated every two years at a minimum. Concussion evaluations are completed by an Optim athletic trainer or other qualified healthcare professional (MD or PA). A general concussion handout was given to the parent or guardian as well as the concussion evaluation and RTP form. ATs would communicate with the school staff in regards to academic modifications for injured students. An athlete can only be cleared to begin the RTP progression while taking medication if cleared by a physician. The RTP protocol follows five-steps procedures.
(U1)	Education was given to all student-athletes and coaches on concussions in their pre-participation medical package and video sessions annually. All student-athletes required to sign a statement of accepting the responsibility of reporting their injuries, illnesses, and any signs or symptoms of a concussion. Initial baseline ImPACT testing and baseline symptom assessment were given. Athletes that show any signs, symptoms, or behavior of a concussion were removed from activity immediately. The initial concussion evaluation included a symptom assessment, a physical and neurological exam, cognitive assessment, balance exam, and a



	<p>clinical assessment for any cervical spine trauma or a skull fracture. Standard concussion management protocol would apply. The ATs and team physician in consultation with the athlete would notify the coordinator for Student Disability Services and ADA Compliance for academic support throughout the recovery process. Routine testing included a daily checklist of symptoms that will be documented on the Sway balance mobile app, retest on ImPACT, and retest on the Sway app every two to three days until the patients were fully returned to activity. The physical activity progression can begin when the athlete became asymptomatic and post-concussion testing was within normal limits compared to their baseline testing. U1 implemented a six-step stepwise RTP progression.</p>
(U2)	<p>Athletes would go through baseline ImPACT and BESS (balance) testing. Any athlete who is suspected of sustaining a concussion will be removed from activity immediately and a sideline evaluation will be done to get an acute baseline of the athlete. The student-athletes are monitored by ATs. If the athlete shows any signs of deterioration, then they will immediately be referred to the emergency room. Daily symptom checklists must be filled out by the athletes, when that they come into the athletic training room. When the athlete has been asymptomatic for 24 hours, they would take ImPACT post-injury test and BESS testing for baseline comparisons. The athletes can be sent to the team physician for evaluation and clearance after their scores return to the baseline. U2 follows a 5-step RTP progression. No education components are specifically highlighted.</p>
(U3)	<p>All student-athletes, coaches, ATs and athletic directors are provided with the NCAA Concussion Fact Sheet and required to sign an acknowledgement annually during their pre-participation exams (PPE). All student-athletes go through at least one pre-participation baseline concussion assessment. The pre-participation assessment includes the following: brain injury and concussion history performed as part of the history portion of the PPE, symptom evaluation (symptom score), cognitive assessment (ImPACT testing), and balance assessment (Sway). U3's University Sports Medicine team physicians with training in diagnosis, treatment and initial management of acute concussion will be present at all NCAA competitions and practices. The initial concussion evaluation will include a symptom assessment, physical and neurological exam, cognitive assessment, and a balance exam. The return to learn portion of concussion management will be implemented with the support of a multidisciplinary team (including: faculty athletics representative (FAR), academic counselor, course instructor(s), college administrators, disability resource center, and coaches). The RTP (Five step) plan will be individualized and be supervised by someone from the sports medicine team, but the final clearance to return to full activity will be determined by the team physician or their qualified designee.</p>
(U4)	<p>U4's "Mild Traumatic brain Injury (MTBI) Evaluation and Return to Play Procedures" was a detailed, seven-page document that laid out the process athletic trainers should implement in diagnosing and treating a concussion and the protocol they must follow to help an athlete return to competition. Baseline testing included the Balance Error Scoring System (BESS) and Impact Testing. The management protocol also introduced concussion symptoms, warning signs for taking drastic measures and instructions for what to do (both 15 minutes and 24 hours following the injury). A U4's Head Injury Warning Form should be given to the athlete who has suffered the concussion. A set of return to learn guidelines were listed on the Athletics Academic Accommodations webpage. There is a very organized six-step Return to Play "Progression" in which a certified athletic trainer must sign off on every step for an athlete to progress to the next step.</p>
(U5)	<p>U5's protocol was a three-page document. The first page contained the "Post-Concussion Care Take Home Instructions." It provided typical symptoms of the concussion and recommendations for dealing with daily tasks. The second page is dedicated to the return to play protocol. The clearance for returning to competition being the responsibility of the team physician, which in U5's case is a neurologist, is an additional step to add safety for their student-athletes. The RTP protocol contained four phases. The protocol seemed to focus more on the wellbeing of the students.</p>

<p>National Football League (NFL)</p>	<p>All players and club personnel are required to review educational materials. All athletes undergo a preseason physical exam, neuropsychological testing and baseline examinations. Each athlete is tested at least once every three years. The NFL has many personnel as part of concussion diagnosis and management on game day (including neurotrauma consultant, video unaffiliated neurotrauma consultant, Booth certified athletic trainer spotter, and other neurologists).</p> <p>They follow the NFL concussion protocol and are responsible for monitoring all available video feeds and the network audio to identify players who may require additional medical evaluation. The NFL locker room comprehensive concussion exam is based on the SCAT 5. The NFL's RTP protocol also included five steps.</p>
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