The challenges of providing concussion education to high school football players

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BACKGROUND: Concussion education programs are becoming more widely available and are thought to aid in the prevention of concussions by increasing awareness through knowledge gain.
OBJECTIVE: To evaluate knowledge gain about concussion and its management by providing the Sports Legacy Institute Community Educator's (SLICE) program in 20 Miami-Dade County public high schools.
METHODS: A modified SLICE program was presented to 20 high school football teams in the 2013-2014 and 2014-2015 football seasons. Knowledge assessments were collected at pre, post and 6-month post-testing periods. The Intervention group scores were compared to the pre and 6 month post-testing scores of the Control group made up of 9 teams that did not receive the educational SLICE intervention.
RESULTS: Overall, mean test scores showed no significant knowledge gain across testing periods ($P<0.05$). However, differences in mean score were found to be statistically significant between pre and post-testing periods, for 3 test questions in the intervention group and 4 in the control group.
DISCUSSION: Many issues were reported in coordinating the intervention group presentations, including variation in player attitudes that were observed throughout the duration of the study.
CONCLUSION: Administration of the modified SLICE program resulted in some knowledge gain about concussion, but more importantly revealed the challenges in trying to educate high school football players. Future studies should consider educating athletes at a younger age, using electronic polling systems and a short video presentation.

Key Words: *Athletic trainers; Concussion; High school*

A concussion is a medical diagnosis that is induced by biomechanical forces, such as a bump, blow or jolt to the body, with an impulsive force transmitted to the head (1). Approximately 9% of all high school athletic injuries are concussions (2). However, the prevalence of youth concussions is reported to be greater. Roughly 50-75% of concussions among high school athletes go unreported (3). Thinner skulls, less myelination, and weaker neck muscles make youth more susceptible to concussions (4). With more than 7.5 million high school students participating in high school sports (5), the focus has shifted from the effects of concussions in professional and collegiate sports to how concussions affect the developing brain in high school and youth athletes. In comparison to other sports, American Football recruits approximately 1.1 million (5) athletes, the greatest number of high school student athletes, and holds the highest reported incidence rate of concussions (40.5%) in high school sports, followed by girls soccer (21.5%) and boys soccer (15.4%) (2).

With the increased incidence rate and growing awareness of concussions in the last decade, all fifty states and the District of Columbia have passed legislation to improve the treatment and management of concussions, especially as it is related to youth athletes. Most state laws require parents, coaches, athletic trainers and, in some states, athletes to certify their education about the symptoms and risks of sustaining a concussion. During athletic events, an athlete exhibiting concussive symptoms must be immediately withdrawn from play and is not allowed to return until they have received clearance from a medical professional (6).

Despite the significant attention given to concussions, athletes have demonstrated a lack of basic awareness in recognizing and appropriately responding to concussions (3,7). Only 61% of surveyed high school athletes could define the term concussion (8). 56% of surveyed college athletes reported no knowledge of the possible consequences of a mild head injury (9). An athlete's awareness of the signs, symptoms, and effects of a concussion is shown to be reflective of how they respond to a concussive event. Athletes reported difficulty in detecting the injury, often times feeling the injury was not severe enough and fearing removal from competition (3). Additionally, an athlete's pride, strength and toughness (10), along with the fear of missing the opportunity to be scouted can deter symptom reporting. In the event that an athlete is masking their concussive symptoms, proper education can help to ensure that the athlete is removed from play. Educating all parties, particularly athletes, has shown to increase concussion awareness and reporting (11,12), making it an important component of sports safety.

Recent efforts by different organizations across the United States have sought to provide concussion education to the public (13). The Center for Disease Control's (CDC) "Heads Up to Youth Sports" program provides online courses and assessments designed to educate and measure relevant concussion knowledge for a parent, coach or trainer. This program has been utilized as a national model for sports related concussion education. Additionally, the CDC recently released the "Heads Up mobile application" for parents, which explains how to identify and respond to a concussion (14). The Barrow Brainbook (2011), created by Arizona State University, uses a two-step approach to build a support network for an athlete recovering from a concussion (15). Brain 101: The Concussion Playbook (2011), developed by the Oregon Center for Applied Science (2011), educates coaches, educators, parents, and athletes to prompt a unified community response when an athlete suffers from a concussion (16). Think First (1986) utilizes the health belief model and utilizes a 50 minute classroom presentation with personal testimonies to instill safer play (17). Boston University's Sports Legacy Institute (SLI), now referred to as the Concussion Legacy Foundation, created the Sports Legacy Institute Community Educators program (SLICE) in 2009. SLICE utilizes a one hour interactive presentation geared towards athletes that includes discussions, videos, audio demonstrations and case studies from professional, collegiate and high school athletes (18). Bagley et al (2012) published the first study evaluating the SLICE program. This report found significant improvements in concussion knowledge in middle and high school athletes immediately following the SLICE

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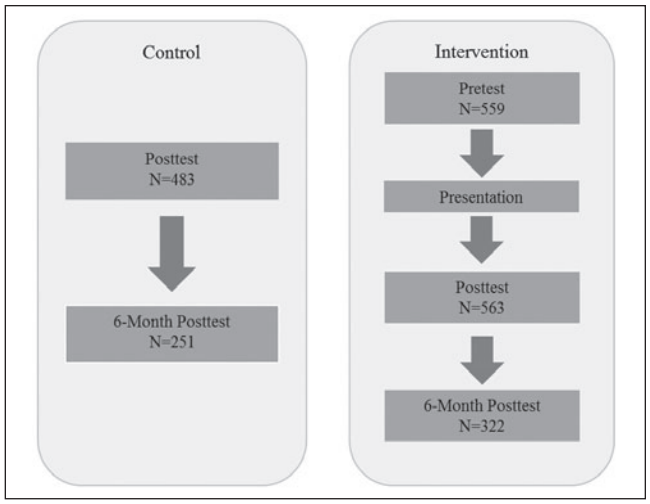

Figure 1) *Number of tests handed out during each session within the control group and the intervention group*

presentation, with the greatest improvement in knowledge seen in females and in athletes below 13 years of age (19). Conversely, Kurowski et al (2015) examined the impact of educational programming on concussion reporting and found minimal improvements in the number of reported concussions, putting the effectiveness of concussion education programs into question (20). Additional evaluations of all concussion educational programs are needed to further validate the accuracy and effectiveness of education programs (13).

In order to develop a comprehensive program for youth athletes in Miami-Dade County (MDC), the UHealth Sports Medicine Clinic and UConcussion (UC) program collaborated with the MDC public school board to plan concussion education for all certified athletic trainers (ATC) and Athletic Directors (AD). This was achieved with assistance from the MDC's Director of Athletics. UC worked directly with the school board and all 35 MDC public high schools to develop a concussion protocol targeting all athletes. This collaboration resulted in the creation of the Countywide Concussion Care Protocol (CCCP) and implementation of baseline ImPACT testing (21) for all athletes in MDC public high schools. Prior to being allowed to play, freshmen or any new players are required to receive baseline ImPACT testing and their parents must sign a waiver indicating that they understand the dangers of concussions in sports. Each Miami Dade County Public School (MDCPS) has a full-time ATC, which is integral for implementation of the CCCP (22). In 2014, UC initiated an annual seminar to educate ATCs and ADs in the county and provide USA Football Heads Up certification for players and coaches. In order to educate student athletes, UC partnered with SLI to evaluate the SLICE educational program. For the purposes of this study, a modified version of the SLICE program was administered to high school football players to evaluate their knowledge retention following the intervention. The intervention targeted high school football teams at 20 MDC Public High Schools.

METHODS

Participants

ATCs from 29 of the 35 MDC Public Schools volunteered their football programs to participate in SLICE concussion education over the 2013-2014 and 2014-2015 football seasons. The ATCs and coaches at each high school were present during the presentations. 20 high school football teams were elected to the intervention group (IG). The first 10 teams in the intervention group participated in fall 2013 and the 10 remaining teams participated in fall 2014. The intervention group received a pre-test, a 30 minute PowerPoint presentation, a post-test, and a 6-month post-test. In the fall 2014, 9 teams were elected to the control group (CG) and were administered a pre-test and 6-month post-test. The ages in both groups ranged from 13 to 18 years old.

TABLE 1
Description of Sample

Characteristic at Baseline	Experimental (n=59) M	Experimental (n=59) SD	Control (n=483) M	Control (n=483) SD	t	p-value
Age	15.9	1.18	15.9	1.17	-0.465	p=0.6423
	n	5	n	5	χ^2	
High School Grade						
Freshman	109	19	75	16		
Sophomore	147	26	127	26		
Junior	179	32	137	28	9.2265	p=0.06
Senior	123	22	143	30		
Unknown	1	0	1	0		
Race						
American Indian/ Alaska Native	6	1	4	1		
Black/African American	346	62	272	56		
Asian	1	0	1	0		
Pacific Islander/ Native Hawaiian	4	1	0	0	8.8812	p=0.18
White	128	23	141	29		
Other	45	8	41	8		
Unknown	29	5	24	5		
Ethnicity						
Non-Hispanic	355	64	292	60		
Hispanic	173	31	177	37	7.007	p=0.03
Unknown	31	6	14	3		
History of Concussion						
Yes	45	8	21	4		
No	513	92	460	95	6.5068	p=0.04
Unknown	2	0	2	0		

SLICE Intervention

SLICE is an interactive concussion education program that teaches student-athletes about concussions through discussion, video and interactive games (18). Each presentation included PowerPoint slides, video segments, demonstrations, interactive discussions with audience members, case studies of professional and high school athletes, personal testimonies from collegiate athletes, and a question-and-answer period. The content presented included the signs and symptoms of concussions, the potential short-term and long-term consequences of sustaining a concussion, and strategies for concussion management.

A modified version of SLICE, consisting of a 30 minute PowerPoint presentation, was administered to high school football players. The high schools were selected based on scheduling availability and their ATC's willingness to assemble players. Presentations were scheduled to occur either before or after football practice at each high school. Presentation content was compiled under the guidance of the SLI team, with age appropriate modifications made for football players with limited attention spans and distracting behavior.

To standardize the presentations, each presentation took place prior to the first game of the season in either a high school gym, classroom, or auditorium. All presentations and testing sessions were carried out by a former National Football League (NFL) player. Students were made aware of the presenter's NFL background to enhance attention rates. Involvement from the former NFL player was beneficial as it allowed students to relate to first hand athletic experiences. The use of projectors, a stage and microphones helped to facilitate full audience engagement.

Preseason/Postseason Testing

To assess the athlete's concussion knowledge, the same paper pencil test consisting of 17 questions was administered. The questions surveyed demographic information, age, and concussion related knowledge (See Appendix for Test). The Intervention Group (IG)

TABLE 2
Baseline Comparison of Mean Scores, Control vs. Intervention

	Pretest Control (n=483)			Pretest Intervention (n=559)				
Outcome measure	**M**	**SD**	**R**	**M**	**SD**	**R**	**F**	***p***
SLICE Mean Score	7.79	1.68	2-10	7.68	1.72	2-10	1.0112	0.3149

M: mean; SD: standard deviation; R: range

TABLE 3
Comparison of Mean Scores, 6-Month Post Control vs. 6-Month Post Intervention

	6-month Posttest Control (n=251)			6-month Posttest Intervention (n=322)				
Outcome measure	**M**	**SD**	**R**	**M**	**SD**	**R**	**F**	***p***
SLICE Mean Score	8.2	1.5	2-10	7.78	1.93	1-10	7.941	0.005

M: mean; SD: standard deviation; R: range

TABLE 4
Intervention Mean Scores Statistics and Analysis Results

	Pretest (n=559)			Posttest (n=563)			6-Month Post test (n=322)				
Outcome measure	**M**	**SD**	**R**	**M**	**SD**	**R**	**M**	**SD**	**R**	**F**	***p***
SLICE Mean Score	7.68	1.72	2-10	7.83	2.03	1-10	7.78	1.93	1-10	0.8564	0.4249

M: mean; SD: standard deviation; R: range

were administered these tests preceding the SLICE intervention, immediately following the intervention and 6-months following the intervention. The Control Group (CG) received tests prior to the start of the season and at 6-months later. Athletes were not made aware of the post-test and 6-month post-testing periods. Approval for this study was obtained from the MDCPS Department of Athletics and University of Miami Institutional Review Board.

Data Analysis

Pre-test and post-test responses were manually entered into Research Electronics Data Capture (REDCap) (23). Data was analyzed using R statistical software package version 3.1.2 (24). Descriptive statistics were used to summarize baseline demographic data for both the CG and the IG. Intergroup comparisons of categorical variables were assessed using Pearson's Chi-squared tests. Comparisons of quantitative variables were assessed using Welch Two sample t-tests. Intragroup performance on each of the 10 test items was assessed using Pearson's chi-squared tests. Comparison of test item mean score between pre-test, post-test and 6-month post-test was assessed using Multi-way ANOVA models. The interaction of test type and high school grade, as well as test type and history of concussion were considered.

RESULTS

Tests were administered to male high school football players from 29 MDCPS (Figure 1), with 20 schools receiving the SLICE intervention and 9 other schools serving as the control group. Incomplete tests (145 IG and 84 CG) from all testing periods were excluded from the analysis. There were 559 athletes in the IG and 483 in the CG who completed the pre-test. Post-test presentation participation increased in the IG (n=563), but decreased in the 6-month post-test (n=322). Participation also decreased in the CG from pre-test to 6-month post-test (n=251) (Figure 1).

Pre-test demographic characteristics of the athletes are presented in Table 1. A Pearson chi-squared test was utilized to analyze any differences between categorical variables of the IG and CG. The mean age (15.9 vs 15.9) and race between both groups were comparable ($p>0.05$). However, a significant difference was found in the history of concussions (8% vs 4%, $p=0.04$) and ethnicity (31% vs 37% Hispanic, $p=0.03$) between the IG and CG. There was no significant difference ($p>0.05$) for the distribution of academic years in the study.

A Welch two-sample t-test was conducted to compare the mean scores between the IG and CG for the pre-test and 6-month post-test. There was no significant difference ($p>0.05$) in the pre-test scores for the IG (M=7.68) and the CG (M=7.79), Table 2. However, there was a significant difference ($p<0.005$) in the 6-month post-test scores for the IG (M=7.78) and the CG (M=8.2), Table 3. These results suggest the intervention does not have an effect in increasing the student-athletes knowledge about concussions.

Additional analyses using a Multi-Way ANOVA model was conducted to examine the mean scores for the IG between the pre-test, post-test and 6-month post-test. There was no significant difference ($p>0.05$) between pre-test (M=7.68), post-test (M=7.83) and 6-month post-test (M=7.78) scores (Table 4). This result is consistent with the result of the Welch two-sample t-test, which showed that the intervention did not have an effect on the students-athletes knowledge.

The Multi-Way ANOVA model assessed the differences in the IG of the mean scores between academic year and the interaction between academic year and test point. There is a significant difference ($p<0.05$) in the mean scores between academic year, but the difference between test point and the interaction between academic year and test point is not significant ($p>0.05$). Interaction between test point and history of concussion was also assessed and no significant difference ($p>0.05$) in mean scores between athletes with and without a history of concussion was found.

A Pearson chi-square test was conducted on each question to analyze whether there was a difference between mean scores between the test points. In the IG, three SLICE questions showed a significant difference between the pre-test, post-test and 6-month post-test ($p<0.05$) (Table 5). The questions about Second Impact Syndrome and Chronic Traumatic Encephalopathy (CTE) had the largest increases between pre-test and 6-month post-test. There was a 10.2% increase in the number of athletes who were able to identify the incorrect statement about Second Impact Syndrome from pre-test to post-test. The improvement was not sustained at 6-months, when the percent correct dropped by 6.5%. There was a 13.6% increase in the number of athletes who were able to correctly answer that CTE is not temporary from pre-test to post-test. There was a 6.1% decrease in the number of athletes who answered this question correctly from post-test to 6-month post-test.

In the CG, four SLICE questions showed a significant difference between the pre-test and 6-month post-test ($p<0.05$) (Table 6). These four questions were different from the questions that showed a significant difference for the IG. The question with the largest increase in score from pre-test to 6-month post-test centered on concussion legislation. There was a 10% increase in the number of student-athletes who were able to correctly identify that blood tests are not required by concussion legislation for return to play clearance.

TABLE 5
Numbers and percentage of athletes' correct answers in the 10-item test for intervention group

Items in the SLICE test	% Correct Pre-Intervention	% Correct Post-Intervention	% Correct 6 month Post-Intervention	p-value
1. A concussion is	81%	79%	78%	0.57
2. Which of the following does NOT cause concussions?	99%	96%	97%	0.04
3. All of the following are symptoms of a concussion EXCEPT:	95%	94%	94%	0.8
4. Which of the following is NOT true about Second Impact Syndrome?	65%	75%	69%	0.009
5. Which of the following are potential long-term problems of having multiple concussions?	83%	85%	87%	0.2985
6. Chronic Traumatic Encephalopathy (CTE) is NOT:	38%	52%	46%	2.87E-05
7. Which of the following is NOT a major point in the concussion legislation?	69%	65%	70%	0.19
8. If you or your teammate has a concussion or concussion like symptoms, what should you do?	90%	87%	90%	0.13
9. After practice you feel dizzy. Later, you get an increasingly bad headache. What should you do?	85%	85%	86%	0.82
10. Once your concussion symptoms are gone you will:	63%	63%	61%	0.77

TABLE 6
Numbers and percentage of athletes' correct answers in the 10-item test for control group

Items in the SLICE test	% Correct Post-Intervention	% Correct 6 month Post-Intervention	p-value
1. A concussion is	77%	85%	0.01
2. Which of the following does NOT cause concussions?	98%	99%	0.34
3. All of the following are symptoms of a concussion EXCEPT:	93%	95%	0.2
4. Which of the following is NOT true about Second Impact Syndrome?	72%	74%	0.55
5. Which of the following are potential long-term problems of having multiple concussions?	86%	89%	0.27
6. Chronic Traumatic Encephalopathy (CTE) is NOT:	39%	37%	0.7
7. Which of the following is NOT a major point in the concussion legislation?	74%	84%	0.0028
8. If you or your teammate has a concussion or concussion like symptoms, what should you do?	92%	96%	0.03
9. After practice you feel dizzy. Later, you get an increasingly bad headache. What should you do?	84%	93%	0.00049
10. Once your concussion symptoms are gone you will:	65%	67%	0.46

DISCUSSION

With the increasing interest, research and media attention about young athletes that are affected by a sports-related concussion, there is an opportunity to improve education for these players. Limited concussion knowledge and lack of reporting in this age group suggests the need for a well-designed concussion education programs (7,8,13). When administering the SLICE program to 20 high school football teams, knowledge gain was observed for individual questions in both groups. However, there was no evidence of statistically significant knowledge gain or knowledge retention for the control or intervention groups. These results may be attributed to issues that were encountered during program administration, study design and the challenges associated with educating male high school football players.,

Due to the relationship between UC and the ATCs established through the concussion injury surveillance program (21,22), ATCs scheduled SLICE presentations at their respective schools. During the start of the football season, it became increasingly difficult to schedule presentations. Frequent miscommunication and coordination between ATCs and coaches caused teams to reschedule presentations. Coordination with the audiovisual staff at each school was also necessary to prevent technical difficulties. Once all coordination issues were resolved, the SLICE presentation was presented to the high school football teams.

Employing a retired NFL player to conduct the presentations led to a positive response and in some cases increased attendance from the high school football players. However, test administration was difficult because at some high schools the players would: (1) arrive late or leave early (2) demonstrate distractive behavior (3) not take the test seriously (4) skip questions (5) or not take the test at all. Despite the few who distracted the group, the live presentation format was an effective means of delivering this content for this group.

Coordination and administration of the 6-month post-test to football players at the intervention schools presented the greatest difficulty. ATCs had a difficult time gathering pre-tested football players for the 6-month post-test as several players were already participating in another sport, would leave campus when school ended, or had other commitments. Due to the ATCs' busy schedule, some elected to administer the 6-month post-tests without UC staff present. Some ATCs reported administering tests in the locker room or reported leaving the room rather than proctoring during their 6-month post-test. This created inconsistencies in testing conditions across the different high schools. Since the Youth Concussion Florida State Legislation was passed in February 2012 with more information about concussions was available through school athletic programs. This could explain why players in the CG had higher response scores from the pre-test to the 6 month post-test.

Although no statistically significant knowledge gain was observed in either group, athletes later anecdotally reported that they attended the UC clinic due to knowledge gained in the SLICE program. For example, one player said "It was just like he explained during the demonstration." This feedback has allowed the research team to better assess a strategy to increase awareness and educate high school football players about concussions. The paper format administered for the collection of the testing data was laborious and time consuming. Proctoring each test, and reviewing for completeness allowed for many interruptions and a less controlled testing environment. The ATC's suggested that incorporating more digital technology and shortening the presentation would be methodologies to evaluate in the future. Furthermore, a matched sample comparison across test types would allow a closer examination to the effect of a concussion education program on youth athletes and should be considered.

CONCLUSION

Implementation of the SLICE education program resulted in some specific knowledge gain regarding concussions in sports. However, the intervention, as a whole, was not found to demonstrate significant

knowledge gain. Despite these findings, some of the athletes who participated in the study responded that the presentation encouraged them to seek medical attention when they reported concussion symptoms. Coordination and administration of the program proved to have its limitations. These limitations should be taken into account for future studies. The study team in the future plans to use an electronic polling system that would increase compliance in question response periods. Additionally, a matched vs. unmatched sample comparison may have impacted study results.

The competitive nature of contact sports will always bring challenges to ensuring an athlete's safety. However, safety can be improved by educating players. Education at an earlier age can provide athletes more exposure to concussion education and may result in greater concussion self-reporting. Shortened presentations and allowing high school football programs the freedom to implement the program at their own convenience will likely improve retention. In addition to continuing the education of high-school football players, UC plans to modify the concussion education program for other high school sports and younger youth athletes to better assist in identifying and reporting concussions.

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APPENDIX
SLICE TEST

School Name: _____

Directions: Please answer the following questions to the best of your ability

1. How old are you? _____
2. Ethnicity:
   - ☐ Hispanic
   - ☐ Not Hispanic
3. What is your race? (Please check all that apply)
   - ☐ Caucasian ☐ American Indian/Alaska Native
   - ☐ African American ☐ Asian
   - ☐ Native Hawaiian or other Pacific Islander
   - ☐ Other: _____ (Please fill in if checked)
4. What grade are you in?
   ☐ 9th Grade ☐ 10th Grade ☐ 11th Grade ☐ 12th Grade
5. What sports do you play for your school?

☐ Baseball	☐ Basketball	☐ Cheerleading
☐ Cross Country	☐ Football	☐ Hockey
☐ Lacrosse	☐ Soccer	☐ Water Polo
☐ Softball	☐ Swimming & Diving	☐ Tennis
☐ Track & Field	☐ Volleyball	☐ Wrestling

   ☐ Other: _____
6. How many years have you been playing high school football? _____

Select the best answer choice for the following questions:

7. A concussion is:
   A. An injury to the brain
   B. Caused by a bump, blow, or jolt to the head
   C. An injury that always occurs when you lose consciousness
   D. A and B
8. Which of the following does NOT cause concussions?
   A. multiple hits to the head
   B. running sprints
   C. strong hit to your body that jolts your head backwards
   D. a helmet-to-helmet hit
9. All of the following are symptoms of a concussion EXCEPT:
   A. Headache
   B. Coughing
   C. Vomiting or nausea
   D. Dizziness
10. Which of the following is NOT true about Second Impact Syndrome?
    A. An injury to the brain
    B. Caused by a bump, blow, or jolt to the head
    C. An injury that always occurs when you lose consciousness
    D. A and B
11. Which of the following are potential long-term problems of having multiple concussions?
    A. memory loss
    B. irritability
    C. speech problems
    D. all of the above
12. Chronic Traumatic Encephalopathy (CTE) is NOT:
    A. An acquired brain disease
    B. Characterized by memory loss, depression, and personality changes
    C. Temporary
    D. Only diagnosed at autopsy
13. Which of the following is NOT a major point in the concussion legislation?
    A. Someone who gets a concussion during a game or practice must immediately stop and cannot go back to play that day
    B. Parents and athletes must sign a waiver that says they understand the risks of playing contact sports
    C. You need a blood test to be cleared to go back to play
    D. You need to see a medical professional to get cleared to go back to play
14. If you or your teammate has a concussion or concussion like symptoms, what should you do?
    A. Stay in the game and continue to play
    B. Tell the trainer or coach immediately
    C. Tell your teammate, but tell him not to tell anyone else
    D. Take a 10 minute break and then go back in
15. After practice you feel dizzy. Later, you get an increasingly bad headache. What should you do?
    A Tell your parents and go to the closest emergency room
    B. Go to sleep and tell your coach in the morning
    C. Take some medicine and ignore your headache
    D. Play video games to distract yourself from your headache
16. Once your concussion symptoms are gone you will:
    A. Play in the game the next day
    B. Gradually return to practice and then contact
    C. Wait one month until playing contact
    D. Play contact in practice but stay out of games for one month
17. Have you ever had a diagnosed concussion?
    A. Yes
    B. No
    A. If yes, then who did you report it to? (Check all that apply)
       ☐ Trainer ☐ Coach ☐ Nurse ☐ Parent ☐ Physician
    B. If yes, how many diagnosed concussions have you had playing high school football? _____

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