SPORTS-RELATED CONCUSSION TESTING AS UTILIZED BY CERTIFIED ATHLETIC TRAINERS IN NATA DISTRICT 2

A THESIS

Submitted to the Faculty of the School of Graduate Studies and Research
of
California University of Pennsylvania in partial fulfillment of the requirements for the degree of

Master of Science

by
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California, Pennsylvania
2010

CALIFORNIA UNIVERSITY of PENNSYLVANIA
CALIFORNIA, PA

THESIS APPROVAL

Graduate Athletic Training Education

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ACKNOWLEDGEMENTS

I would like to thank all of the people who have helped and inspired me during my study. My deepest gratitude goes to the most important people in my life: my mother and father; my sisters, Gwendolyn and Carlie; my grandmother; and especially my fiancé, Ryan. Mom and dad, you both have always been there for me, supporting me in every way possible and continuing to encourage me through my goals and dreams. Gwendolyn and Carlie, thank you for being there for me through my youth and helping me grow as a sister, a friend, and a person. I could not ask for more understanding and loving sisters. Grandmom, thank you for always being there for me when I need someone to talk to, showing me how to grow spiritually with God, and sending me all of those encouraging letters during my years away from home. Ryan, you have always been there with me through the good times and the bad. You are the one person I can count on in my life to always be there for me and let me know that everything is going to be okay. You are the most loving and kindest person I know, and I would not be where I am today without you. You will forever be my best friend, my other half, and I will love you always.

I would also like to thank all my peers and friends from home, Lynchburg, and Cal U. The constant support that I received from each of you means the world to me and I am lucky to have known you.

I want to say a special thanks my thesis chairperson, Dr. Carol Biddington, and other thesis committee members, Dr. Joni Roh and Dr. Jamie Weary. Carol, your support and drive to push me through this challenging time in my life as well as your motivation to advise me in whatever I need has been phenomenal. In addition, you were always accessible and willing to help me with my research and any questions that I had during my study. Joni and Jamie, your perpetual energy and enthusiasm in research has motivated me to make my study the best that it can be. As a result, research life here at Cal U has been smooth and rewarding. Thank you for everything.

Finally yet importantly, thanks to God for my life through all the challenges and tests in the past years. You have made my life more beautiful, showing me what is most important, staying healthy and happy. May your name be exalted, honored, and glorified.

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INTRODUCTION

Sports-related concussions are a major sports medicine issue in the current medical literature as well as popular media of today because of post-concussion syndrome (PCS) and second impact syndrome (SIS). There have been many guidelines constructed to allow for better identification, assessment, diagnosis, and management of return to play for athletes sustaining this serious injury. The tools used to better diagnose and assess sports-related concussions range from standard balance screening to computerized neurological testing, but there is still no gold standard of which is more suited for healthcare providers. The Center for Disease Control and Prevention (CDC) has revised educational materials for healthcare providers treating concussions and mild traumatic brain injuries (MTBI). As part of the revision of the CDC they have updated the definition of concussion to reflect current medical opinion.[1] The CDC defines concussion or mild traumatic brain injury (MTBI) as the following:

"The term mild traumatic brain injury (MTBI) is used interchangeably with the term concussion. This is defined as a complex pathophysiologic process affecting the brain,

induced by traumatic biochemical forces secondary to direct or indirect forces to the head. MTBI is caused by a blow or jolt to the head that disrupts the function of the brain. This disturbance of brain function is typically associated with normal structural neuroimaging findings (i.e., CT scan, MRI)".[1(p.2)]

Sports-related concussions also known as mild traumatic brain injury in athletics is a major sports medicine issue. Reports have shown concussion injuries in multiple sports and the trend of this traumatic brain injury has been increasing in occurrence over the past several years.[2] There has been great attention given to the research of this injury to form a better understanding in terms of athletes' health concerns. Still, many concerns remain in relation to the assessment and management of sports-related concussions.

The sideline examination is an important part of concussion management for the role of the healthcare provider. There have been a number of sideline assessment tools designed to help accurately assess and evaluate sports-related concussions.[3] A high-quality past medical history and injury history should be taken with each concussion. Additionally, the health care provider should also assess orientation, immediate memory, delayed recall,

concentration, and attention which are very important factors when evaluating a concussion.[3,4] Moreover, sports-related concussion assessments should include testing for postural stability, cognitive function, and self-reported symptoms.[5] Some examples of these cerebral concussion screening instruments include sideline evaluations such as: concussion grading systems like the grading scales of Cantu,[6] Colorado Medical Society,[7] and American Academy of Neurology,[8] as well as the pencil and paper assessment tests like that of the Standard Assessment of Concussion (SAC),[9] and the Balance Error Score System (BESS)[10] for mild traumatic brain injuries (MTBI).

Concussion grading systems are sets of criteria used in the sports medicine world to determine the severity (grade) of a sports-related concussion.[11] There are at least 16 different grading systems that exist, most which are out-dated and not as effective as the current assessment methods used by healthcare providers today. Several of these grading scales use loss of consciousness and amnesia as the primary determinates of the severity of the injury.[12] Three grading systems are among the more commonly known assessment methods are the following: 1) Cantu's guidelines (1986) which were updated in 2001, 2) Colorado Medical Society guidelines (1991), and 3) American

Academy of Neurology guidelines (1997).[11] An example of the grading scale used can be found in Appendix C1.[13(p.884)]

Computer-based concussion assessment tools, such as ImPACT, CogSport, and Headminder CRI have gained popularity in the sports medicine world over the last decade due to complications following concussions in athletics, such as SIS and PCS. All of these neurocognative tools assist the healthcare provider in evaluating and documenting memory, brain processing speed, reaction time, and postconcussive symptoms (PCS). The results of these tests should be interpreted in light of all the other factors pertaining to the injury, which may include physical exam, age, gender, and previous concussion history to help in return-to-play decision making. The more recently created computer based assessment tools have been found through research to be the most helpful and more effective in making critical return to play decisions.[14]

Most of the concussion injuries sustained by athletes involve relatively mild symptoms, and with the ability to use computerized tests, the factor of baseline testing of athletes has shown to be a very powerful assessment tool. When there is the ability to compare pre- and post-concussion neuropsychological data, there is also the ability to differentiate changes in the neurocognitive

status of an athlete with a sports-related concussion.[14] In addition, the healthcare provider is able to evaluate the degree of symptom resolution in the athlete. Computer-based assessment testing along with accurate timing of evaluation, may be the best suited tool to identify neurocognitive deficits, progress towards full recovery, and provide helpful assistance in return to play decisions.[14,15] Tests like ImPACT, CogSport, and HeadMinder CRI all provide most of these tactics within each assessment test.

The most challenging portion of the care for a concussion injury is making the return-to-play decision following this injury.[3,4] There can be a lot of external pressure from individuals such as coaches, parents, and the patient to return the athlete to competition early.[16] Preventing athletes from returning to their sport for unnecessarily long periods of time may also have a significant impact on the athlete's career, financial viability, and psychological functioning.[17] However, there is still a great importance in return-to-play decisions, a premature decision making puts the athletes' health at risk.[18]

Research on the topic of sport-related concussions has provided the athletic training profession, as well as other

medical professions, with valuable new knowledge over the last decade. The key to reducing the incidences and severity of these injuries, in addition to improving return-to-play decisions, is found in connecting the gap between research and clinical practices. The National Athletic Trainers' Association (NATA) has written a position statement about the management of sport-related concussion injuries, which provides information and recommendations for certified athletic trainers, physicians, and other health care providers who care for athletes in all levels of sports. These recommendations are derived from the most recent scientific and clinic based literature on sport-related concussions. The position statement is organized into several sections including: 1)defining and recognizing concussions, 2)evaluating and making return-to-play decision, 3)concussion assessment tools, 4)when to refer an athlete to a physician after concussion, 5)when to disqualify an athlete, 6)special considerations for the young athlete, 7)home care, and 8)equipment issues.[18]

In the section of Evaluating and Making the Return-to-Play Decisions, the NATA recommends the athletic trainers and team physician work together and agree on a philosophy for managing sport-related concussion injuries before the

start of the athletic season. Today, there are currently three approaches commonly used which include: 1) grading the concussion at the time of the injury, 2) deferring final grading until all symptoms have resolved, or 3) not using a grading scale but rather focusing attention on the athlete's recovery via symptoms, neurocognitive testing, and postural-stability testing.[18] Because there is such a high occurrence of SIS, it is important that ATs and other healthcare providers use the third approach recommended by the NATA and supported by the literature. Therefore, it is the intent of the NATA to get all health care professionals who work with athletes to focus attention on the athlete's recovery based on the athlete's symptoms, neurocognitive testing and postural-stability.[18] Another recommendation is that in addition to thorough clinical evaluation, formal cognitive and postural-stability testing should be done to assist in objectively determining injury severity and readiness to return-to-play.[18,19] It is suggested that no test should be solely used to determine recovery or return-to-play for this injury presents itself in many different ways. The suggestion for return to play decisions should be made after an incremental increase in activity followed by sport-specific activities that do not place the athlete at risk for additional concussions. This should all be

accomplished before the athlete is released into full participation as long as no recurrent signs or symptoms are present during this time and the process should all be agreed upon by all health care professionals involved with the athlete.[18]

In the Concussion Assessment Tools section of the NATA position statement, it is suggested that the use of objective concussion assessment tools will help athletic trainers more accurately identify deficits caused by injury and post-injury recovery. It is also recommended to protect the athletes from potential risks associated with prematurely returning to participation, potentially exposing them to another concussion. The concussion assessment tool should include the following: 1) combination of tests for cognition, 2) postural stability, and 3) self-reported symptoms. There are a combination of brief screening tools appropriate for use on the sport sidelines such as the SAC and BESS as well as more extensive measures like neuropsychological testing and computer based testing (ImPACT, CogSport, and Headminder CRI) to more precisely evaluate recovery after the injury has been sustained by the athlete. The NATA recommends that all evaluators be appropriately trained in the standardized instructions for test administration and

scoring before using any instrument for clinical purposes.[18] As with all clinical instruments used in healthcare, the results from assessment measures to evaluate these injuries should be integrated with all aspects of the injury evaluation to ensure the most effective approach to management and return-to-play decision making.[18,19] The position statement states that decisions about an athlete's return-to-play should never be based solely on the use of one concussion testing method.[18]

The assessment tools available to all healthcare providers, whether it paper and pencil or computer-based tests, should be used to evaluate each domain of the injury. These tests provide the highest sensitivity and specificity of concussion assessments and it also gives the healthcare provider the most information to make an informed decision for return-to-play.[20] Throughout the evaluation process the healthcare providers administering the assessment should be aware about the development, presence, intensity, and return of concussion related symptoms.[3,4,11] Under no circumstances should an athlete return to play if he or she reports a symptom that is categorized under a concussion.[11,21] Management of and return to participation following a sports-related concussion should involve a team approach. This includes educating

the athletes, parents, and coaches about the injury as well as collaboration with all other medical personnel involved in the injury.[21]

This study will attempt to answer the following question: 1) As per the NATA Position Statement, is there a preference for one of the methods currently being used to assess sport-related concussions?

METHODS

The main purpose of this study is to determine the common concussion assessment method used by certified Athletic Trainers (ATs) for sports-related concussions sustained by athletes. Through a survey, the different assessment tools and management guidelines used by ATs was determined for injury diagnosis as well as return to play decision making. These findings will help in determining the most common and effective way for concussion assessment testing and management of the injury based on the NATA's position statement of recommended approaches for concussion assessment. The methods section describes how this research was carried out and includes the following: research design, subjects, instruments, procedures, hypothesis, and data analysis.

Research Design

A descriptive research design was used by the researcher to conduct the study. The data was collected using an online server, Survey Monkey. The dependent variable was the concussion testing methods for assessment:

1) grading scale, 2) pencil and paper, and 3) computer-based neurocognitive testing. This survey will help determine whether ATs are assessing sports-related concussion based on the recommendations stated in the NATA position statement.

Subjects

The subjects used in this research study included a random sample of ATs (N = 152) from District 2 of the NATA which includes: Pennsylvania, Delaware, New Jersey, and New York. The reasons the researcher chose to survey District 2 members are the following:

1) California University of Pennsylvania is located in District 2.

2) Much of the research regarding computer-based assessments originated in Pennsylvania which is also in District 2.

Informed consent is implied when the subjects complete and return the survey to the researcher.

Instruments

The researcher created the Sports-related Concussion Testing as Utilized and Preferred by Certified Athletic Trainers Survey (Appendix C2) with demographics, which included the following: gender, years of experience as a certified athletic trainer, credentials, current occupation, and the level of education. Additional items related to assessment and return-to-play decision making of sports-related concussion injuries were addressed (Question 8 - Question 14).

Procedures

The Institutional Review Board of California University of Pennsylvania reviewed the study before it was sent to any participants. After approval from the IRB (Appendix C3) the researcher requested a contact list from the NATA Research and Graduate Study Department. In this form the district of interest was specified, a cover letter (Appendix C4) was sent, including a link to Survey Monkey for the questions to the survey. The form was then sent to the District 2 Secretary for processing. After approval from the District Secretary, the NATA sent the survey to a

random number of participants within District 2. A random sample of 152 members received the survey, electronically, via an e-mail cover letter, which was written by the researcher introducing herself to the sample and explaining the purpose of the study. The survey was designed to be completed in 20 minutes or less. The subjects then completed the survey over the internet and gave their consent by returning the survey anonymously.

Hypothesis

The following hypothesis was examined in this research study:

1) As per the NATA Position Statement, there will be a preference for one of the methods currently being used to assess sport-related concussions.

Data Analysis

The data was analyzed using SPSS version 17.0 with a significance level of 0.05.

H1: A chi-square analysis was completed to determine whether a majority of ATs in District 2 had a preference

for one of the methods currently being used to assess sport-related concussions.

RESULTS

Demographic Data

NATA District 2 ATs (N = 152) voluntarily participated in this study. Table 1 represents gender of ATs in District 2. A relatively equal number females (51%) and males (48%) were representative of the sample.

Table 1. Gender of ATs

Characteristic	**Frequency**	**Percent**
Female	78	50.6
Male	74	48.7

Table 2 represents the classifications of ATs highest educational level. A majority of the ATs surveyed have completed their master's degree (55.8%), followed by a bachelor's (36.4%), and finally a doctorate (5.8%).

Table 2. ATs Highest Educational Level

Classification	**Frequency**	**Percent**
Master's degree	86	55.8
Bachelor's degree	56	36.4
Doctoral degree	9	5.8

Table 3 represents the state in which the ATs are currently practicing. The majority of ATs were currently practicing in the state of Pennsylvania (50.6%), followed

by New York (22.1%), followed by New Jersey (15.6%), and then Delaware (4.5%). Other states included were California, Ohio, Nevada, Maryland, Hawaii, and Massachusetts.

Table 3. State Currently Practicing as ATs

Classification	Frequency	Percent
Pennsylvania	78	50.6
New York	34	22.1
New Jersey	24	15.6
Delaware	7	4.5
Other	8	1.3

Of the ATs surveyed a little over a third of the ATs did not have additional professional credentials (38.3%), followed by teacher certification (18.8%). Other professional credentials (14.6%) that ATs possess include SCS, personal trainer, nutrition specialist, MS, SES, NCSF-CPT, CMT, ROT, LAT, NSCA-CPT, CES, DPT, MEd, Speed and Explosion specialist, LMT, Registered Athletic Administrator, and CKTP. ATs with PES credentials (13.6%) were close, followed by CSCS (12.3%), followed by EMT (8.4%), and lastly PT (3.2%).

Table 4. Additional Professional Credentials

Classification	Frequency	Percent
None	59	38.3
Teacher Certification	29	18.8
Other	23	14.6
PES	21	13.6
CSCS	19	12.3
EMT	13	8.4
PT	5	3.2

Table 5 represents the years the participants have been working as an AT. On average, the sample of ATs have worked 13.37 years ± 11.087 years.

Table 5. Years Working as an AT

Classification	Min.	Max.	Mean	SD
Years	0	40	13.37	11.087

Table 6 represents the primary position of the ATs. A little over half (55.8%) of the ATs surveyed state their primary position as clinical. Other primary positions include high school outreach, secondary outreach, unemployed, teaching assistant, and athletic trainer substitute.

Table 6. ATs Primary Position

Classification	Frequency	Percent
Clinical	86	55.8
Other	36	23.4
Academic	18	11.7
Administrative	5	3.2
Student	5	3.2
Research	1	.6

Table 7 represents the current employment setting of the ATs in District 2. A majority of the ATs work in a High School setting (50%) followed by the College/University setting (29.9%). Other employment settings of ATs include physical therapy clinic, orthopedic

office, pediatric orthopedics department, unemployed, general therapy clinic, and rehabilitation clinic.

Table 7. ATs Employment Setting

Classification	Frequency	Percent
High School	77	50.0
College/University	46	29.9
Other	14	9.1
Sports Medicine Clinic	8	5.2
Professional athletics	4	2.6
General Hospital setting	1	.6
Academic department	1	.6
Corporate health (company)	1	.6

Table 8 represents the method currently being used by the ATs at their institution/job site based on the NATA Concussion Position Statement. Over three-fourths of the ATs surveyed in PA do not use a grading system, but use symptoms, neurocognitive testing, and postural stability testing which is supporting the NATA position statement. Approximately 18% of ATs in District 2 need to change their approach to concussion assessment according to the NATA position statement.

Table 8. Current Concussion Assessment Method

Classification	Frequency	Percent
No grading, but using symptoms, neurocognitive testing and postural stability testing	121	78.6
Grading the concussion	19	12.3
Deferring final grading until all s/s have resolved	8	5.2

Table 9 represents the following concussion assessment methods used by ATs during their career. The most common method used for concussion assessment is the ImPACT (53.2%), followed by SAC (35.7%), then BESS (2.6%) and HeadMinder CTI (1.3%).

Table 9. Concussion Assessment Methods

Classification	Frequency	Percent
ImPACT	82	53.2
SAC	55	35.7
BESS	4	2.6
HeadMinder CRI	2	1.3

Table 10 represents whether the ATs are the person responsible for making decisions about what concussion method to use. The majority of the ATs surveyed are responsible for making the decision as to what concussion assessment method should be used in their job setting (59.1%).

Table 10. Concussion Assessment Method Decision Making

Classification	Frequency	Percent
Yes	91	59.1
No	55	35.7

Table 11 represents the person who is responsible for the decision making of which concussion assessment method to utilize. The ATs surveyed state that the majority of concussion assessment method decision making is based on the athletic trainer (22.7%), followed by the Team MD (18.8%). Other includes program coordinator, sports medicine director, director of concussion clinic (PMR), clinical manager, athletic training supervisor, joint effort among all AT staff, league, both team MD and Head Athletic Trainer, ER doctor referral, clinical director, athlete's physician, and parents have the option of using ImPACT.

Table 11. Responsibility for Concussion Assessment Method Decision Making

Classification	Frequency	Percent
Athletic Trainer	35	22.7
Team MD	29	18.8
Other	22	14.3
Athletic Director	3	1.9

Table 12 represents the primary method typically used by the ATs for concussion assessment. The majority of the ATs surveyed in District 2 use computer-based

neurocognitive testing (45.5%), followed by pencil and paper (27.9%), and grading scale (21.4%).

Table 12. Concussion Assessment Method Utilized by ATs

Classification	Frequency	Percent
Computer-based Neuro-cognitive testing	70	45.5
Pencil and Paper	43	27.9
Grading Scale	33	21.4

Table 13 represents the method the ATs prefer to use when assessing concussion injuries. The majority of ATs surveyed prefer computer-based neurocognitive testing (65.6%), followed by grading scale (13%) and pencil and paper methods (13%).

Table 13. Concussion Assessment Method Preferred by ATs

Preference	Frequency	Percent
Computer-based Neuro-cognitive testing	101	65.6
Grading Scale	20	13.0
Pencil and Paper	20	13.0

Table 14 represents how the concussion assessment method used by ATs influenced them to use that method. Both experience (36.4%) and supported research (35.1%) is what influenced ATs to use the concussion assessment method of they are currently using.

Table 14. Method of Influence on ATs

Classification	Frequency	Percent
Experience	56	36.4
Supported Research	54	35.1
Cost	22	14.3

Hypothesis Testing

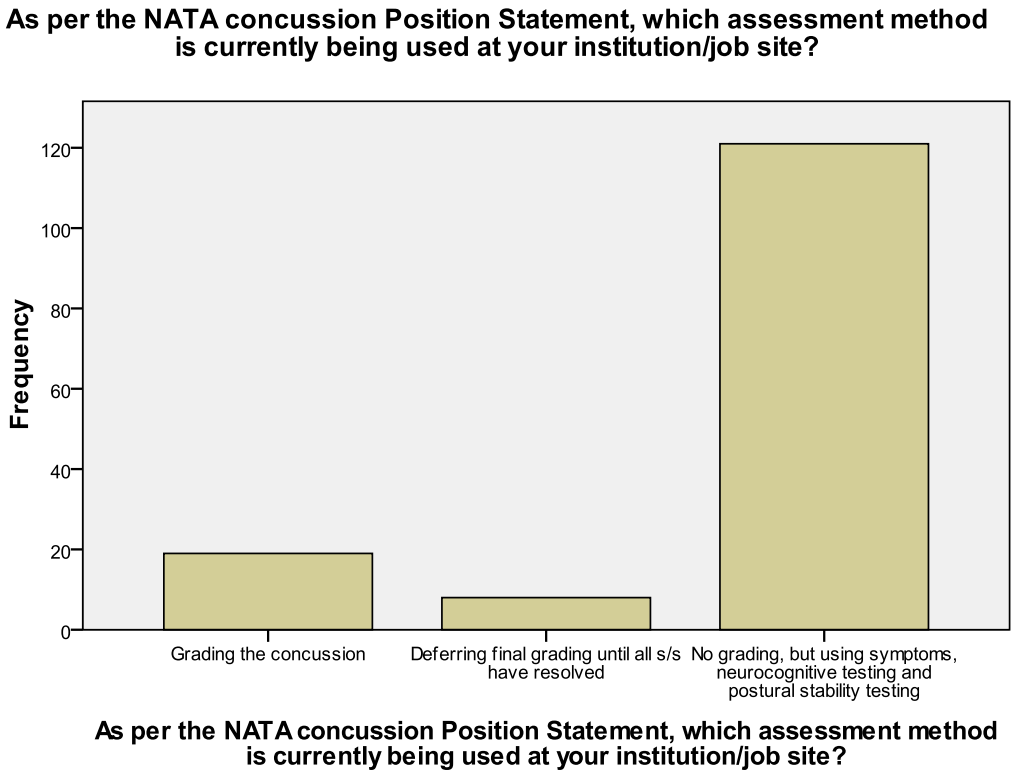
The hypothesis was tested at an alpha level of 0.05. Hypothesis 1: A chi-squared goodness of fit was used to determine utilization of concussion assessment methods. Significant deviation from the hypothesized values was found ($\chi^2_2 = 157.392$, $p < .001$).

Conclusion: The most used concussion assessment method was "No grading, but using symptoms, neurocognitive testing and postural stability testing" among the ATs in District 2 of the NATA (Table 15 and Figure 1).

Table 15. Chi-Square Goodness of Fit for Currently Used Concussion Assessment Method

Type	**n**	**χ^2**	***p* value**
No grading, but using symptoms, neurocognitive testing and postural stability testing	121	157.392	<.001
Grading the concussion	19		
Deferring final grading until all s/s have resolved	8		

Figure 1. Bar Chart showing which concussion assessment method is currently being utilized at institution/job site.



Additional Findings

In addition to hypothesis testing, a chi-square goodness of fit was calculated comparing the frequency of occurrence of each of the following values.

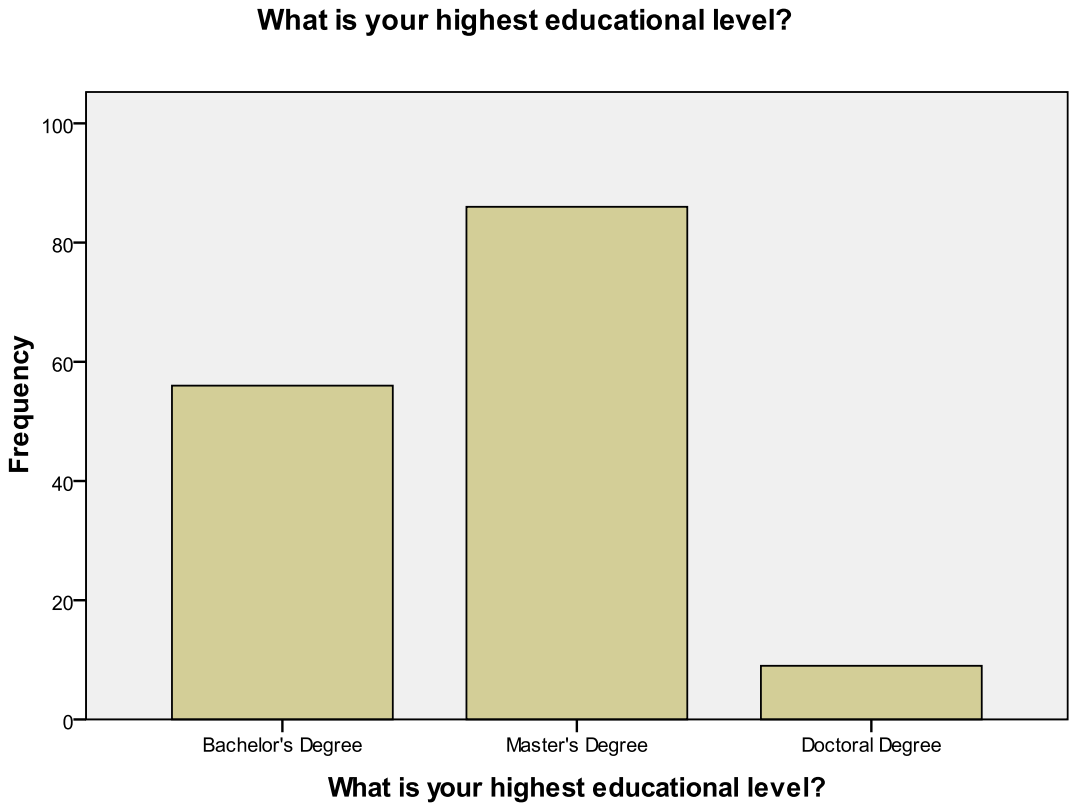
A chi-square goodness of fit was used to determine the frequency of occurrence among educational levels of ATs. Significant deviation from the hypothesized values was

found among the classifications of ATs Highest Educational Level ($\chi^2_2 = 59.854$, $p < .001$). Most ATs have obtained a Master's Degree as their highest level of educational which is significantly more than ATs with either a Bachelor's or Doctorate degree (Table 16 and Figure 2).

Table 16. Chi-Square Goodness of Fit for ATs Highest Educational Level

Type	**n**	**χ^2**	***p* value**
Master's Degree	86	59.854	<.001
Bachelor's Degree	56		
Doctoral Degree	9		

Figure 2. Bar chart showing highest level of education obtained by ATs.

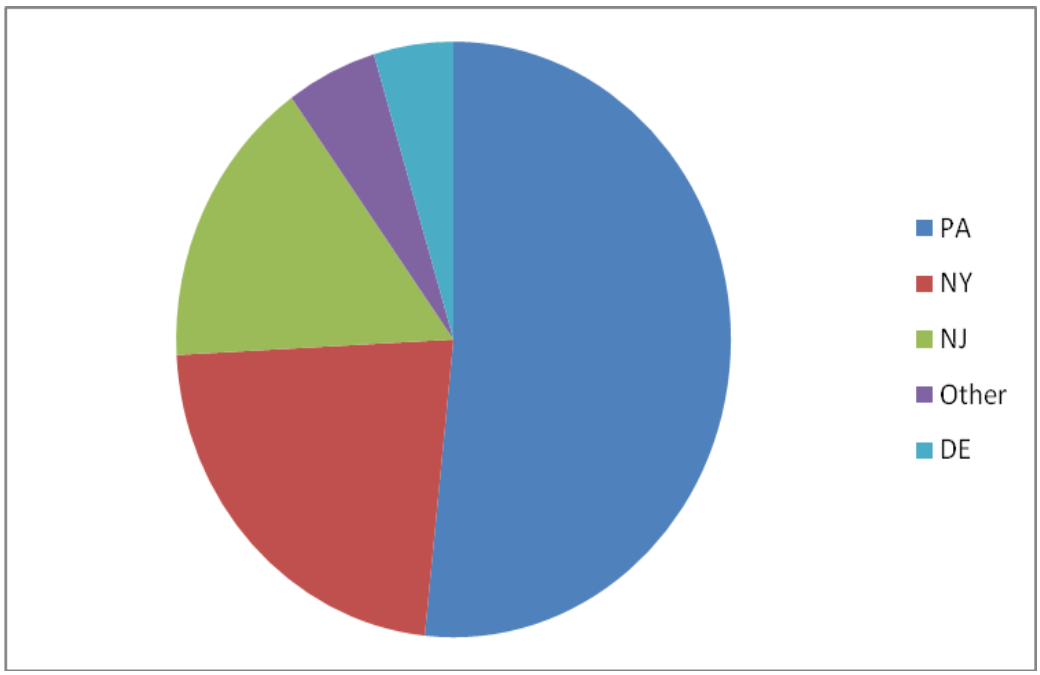


A chi-square goodness of fit was used to determine what state ATs are currently practicing in. Significant deviation from the hypothesized values was found among the classifications of State Currently Practicing (χ^2_3 = 111.550, $p < .001$). Other states included are California, Ohio, Nevada, Maryland, Hawaii, and Massachusetts. Most ATs are currently practicing in the state of Pennsylvania (Table 17 and Figure 3).

Table 17. Chi-Square Goodness of Fit for State Currently Practicing

Type	n	χ^2	*p* value
Pennsylvania	78	111.550	<.001
New York	34		
New Jersey	24		
Other	8		
Delaware	7		

Figure 3. Pie chart showing which state the ATs are currently practicing.



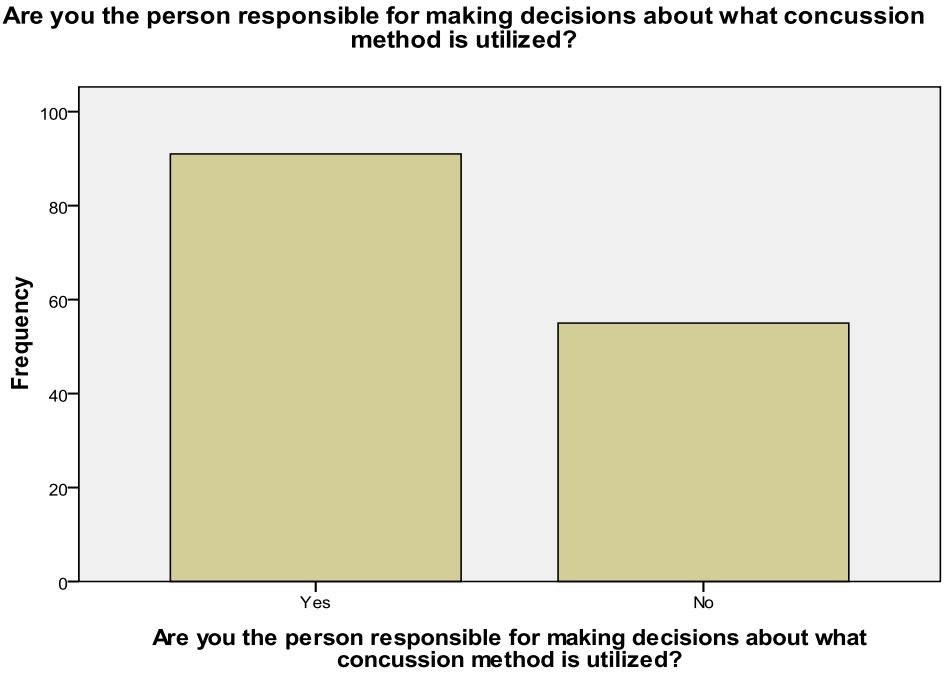
A chi-square goodness of fit was used to determine ATs responsibility for concussion assessment method decision making. Significant deviation from the hypothesized values was found among the classifications of Concussion Assessment Method Decision Making ($\chi^2_2 = 8.877$, $p < .01$). Most ATs are responsible for making decisions based on

which concussion assessment method is utilized (Table 18 and Figure 4).

Table 18. Chi-Square Goodness of Fit for Concussion Assessment Method Decision Making

Type	n	χ^2	*p* value
Yes	91	8.877	.003
No	55		

Figure 4. Bar chart showing if AT is responsible for making decisions about what concussion assessment method is utilized.



A chi-square goodness of fit was used to determine concussion assessment methods utilized by ATs. Significant deviation from the hypothesized values was found among the classifications of Concussion Assessment Method Utilized by

ATs (χ^2_2 = 15.055, p < .001). Most ATs utilize computer-based neurocognitive testing for concussion assessment (Table 19 and Figure 5).

Table 19. Chi-Square Goodness of Fit for Concussion Assessment Method Utilized by ATs

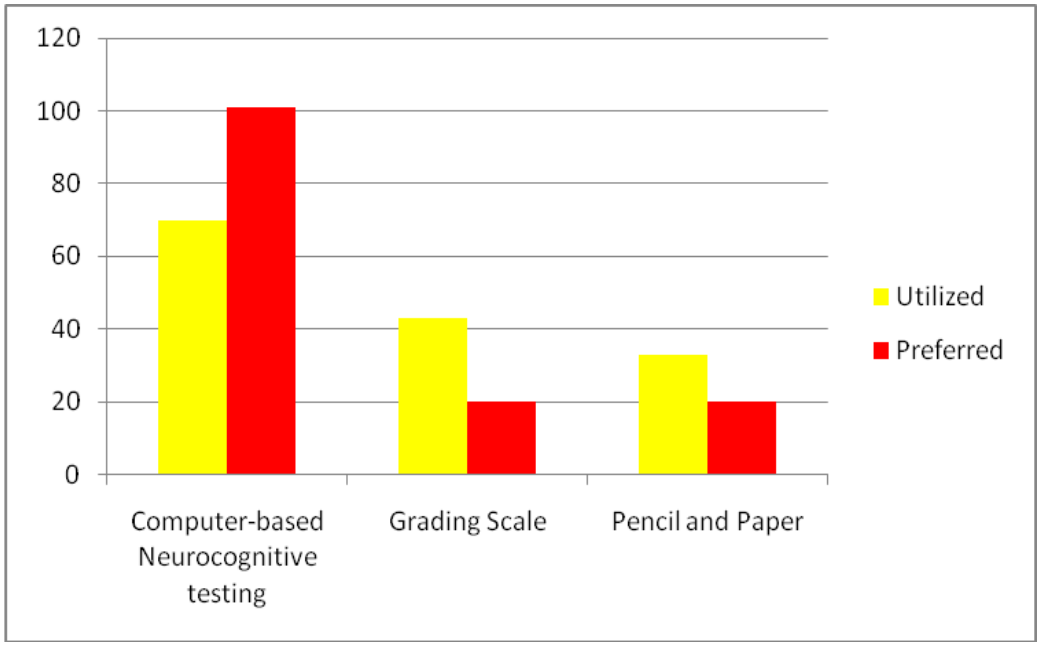
Type	**n**	**χ^2**	***p* value**
Computer-based Neuro-cognitive testing	70	15.055	.001
Pencil and Paper	43		
Grading Scale	33		

A chi-square goodness of fit was used to determine concussion assessment methods preferred by ATs. Significant deviation from the hypothesized values was found among the classifications of Concussion Assessment Method Preferred by ATs (χ^2_1 = 93.064, p < .001). Most ATs prefer to use computer-based neurocognitive testing for concussion assessment (Table 20 and Figure 5).

Table 20. Chi-Square Goodness of Fit for Concussion Assessment Method Preferred by ATs

Type	**n**	**χ^2**	***p* value**
Computer-based Neuro-cognitive testing	101	93.064	<.001
Grading Scale	20		
Pencil and Paper	20		

Figure 5. Bar chart comparing utilized concussion assessment method by ATs and preferred concussion assessment method by ATs.

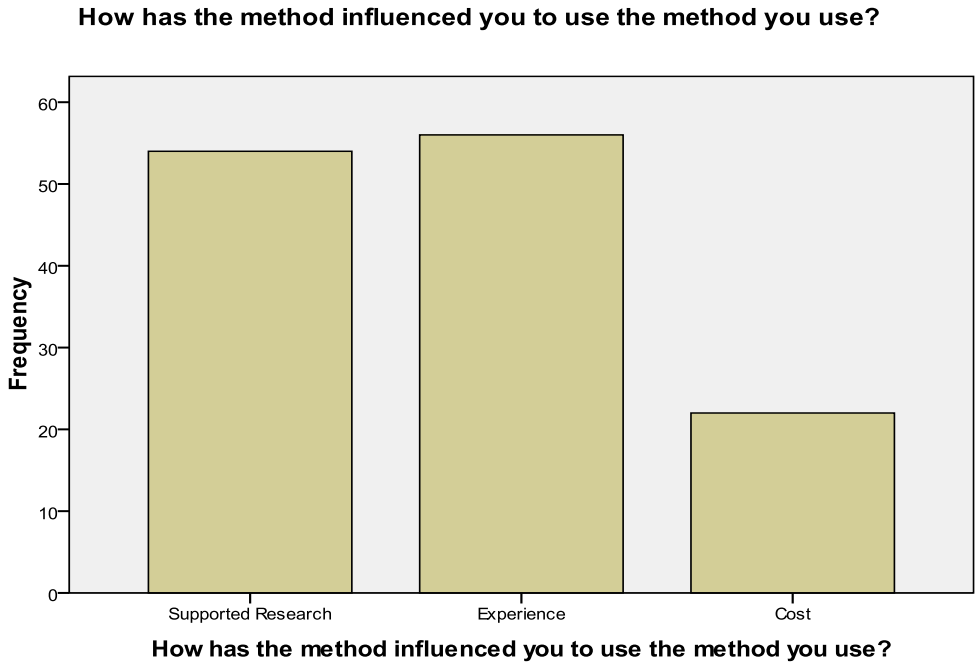


A chi-square goodness of fit was used to determine the method of influence on ATs. Significant deviation from the hypothesized values was found among the classifications of Method of Influence on ATs ($\chi^2_2 = 16.545$, $p < .001$). ATs state that they were most influenced by experience with the concussion assessment methods with supported research closely following (Table 21 and Figure 6).

Table 21. Chi-Square Goodness of Fit for Method of Influence on ATs

Type	**n**	**χ^2**	***p* value**
Experience	56	16.545	<.001
Supported Research	54		
Cost	22		

Figure 6. Bar chart showing method of influence on ATs to utilize concussion assessment method of choice.



Chi-square test of independence was performed among the following variables.

Table 22 displays a 2 (Gender – female or male) X 2 (Concussion assessment method decision making – yes or no) chi-square test of independence to determine if gender was dependent on the decision making process for what concussion assessment method to utilize. A significant interaction was found ($\chi^2_2 = 4.724$, $p < .05$). In District 2 of the NATA, men (50%) were more likely to be the person

responsible for making the decision as to which concussion assessment method should be utilized than women (41%).

Table 22. 2x2 Chi-Square Independence Test for Gender / Concussion Assessment Method Decision Making

Type	**Yes**	**No**	χ^2	***P* Value**
Male	50	20	4.742	.029
Female	41	35		

Table 23 displays a 4 (State Currently Practicing – PA, NJ, NY, or DE) X 3 (Concussion Assessment Method Utilized – Grading the concussion, deferring final grading until all symptoms have resolved, or no grading, but using symptoms, neurocognitive testing and postural stability testing) chi-square test of independence to determine if the state in which the AT is currently practicing was dependent on what concussion assessment method the AT utilizes. A significant interaction was found ($\chi^2_1 = 17.532$, $p < .05$). Athletic trainers within the state of Pennsylvania (47%) were more likely to utilize the third approach; no grading, but using symptoms, neurocognitive testing and postural stability testing; for concussion assessment recommended by the NATA position statement than New Jersey (9%), New York (10%), and Delaware (2%).

Table 23. 4x3 Chi-Square Independence Test for State Currently Practicing / Concussion Assessment Method Utilized

Type	**1**	**2**	**3**	χ^2	***P* Value**
PA	12	17	47	17.532	.025
NY	9	12	10		
NJ	6	9	9		
DE	1	4	2		

*There is < 5 in a cell.

Table 24 displays a 4 (State Currently Practicing – PA, NJ, NY, or DE) X 3 (Grading scale, pencil and paper, or computer-based neurocognitive testing) chi-square test of independence to determine if the state in which the AT is currently practicing was dependent on what concussion assessment method the AT prefers. A significant interaction was found ($\chi^2_1 = 17.734$, $p < .05$). Athletic trainers in the state of Pennsylvania (62%) were more likely to choose computer-based neurocognitive testing as their preference for concussion assessment over grading scale and pencil and paper than New Jersey (16%), New York (16%), and Delaware (4%). Computer-based neurocognitive testing is also the most preferred method of concussion assessment by all four states (PA, NJ, NY, and DE) than grading scales and pencil and paper testing.

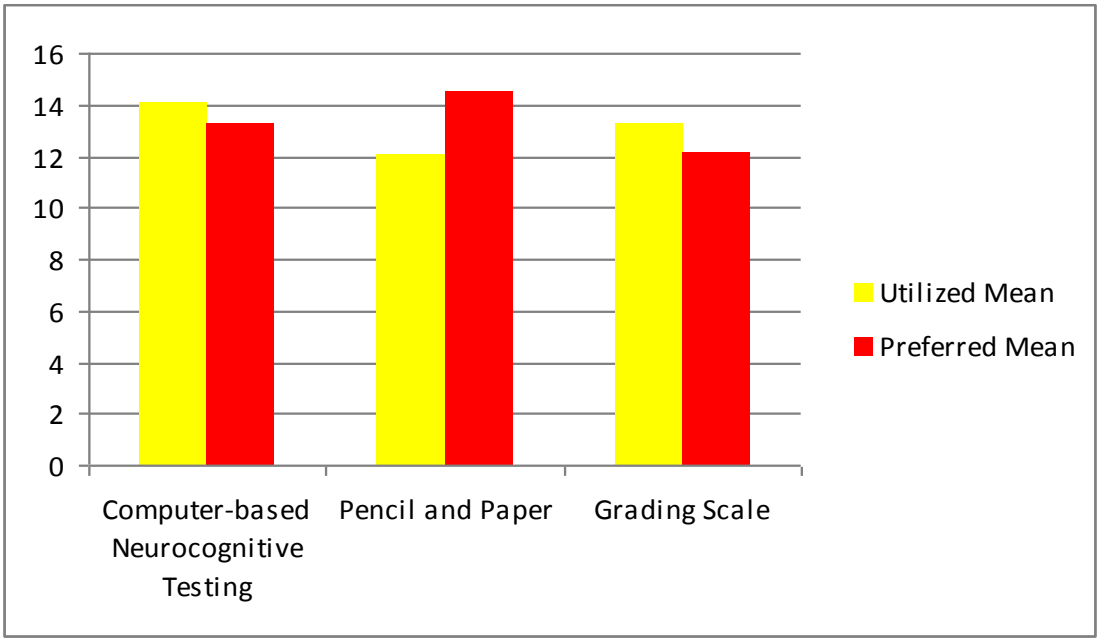
Table 24. 4x3 Chi-Square Independence Test for State Currently Practicing / Concussion Assessment Method Preferred

Type	**1**	**2**	**3**	χ^2	***P* Value**
PA	7	6	62	17.734	.023
NY	6	7	16		
NJ	5	3	16		
DE	0	3	4		

*There is < 5 in a cell.

A one-way ANOVA was completed to compare the means of ATs utilized concussion assessment methods and preferred concussion assessment method for years of certification. Figure 7 displays a higher utilized mean (14.05 ± 11.011) for computer-based neurocognitive testing than the preferred mean (13.28 ± 10.82). The utilized mean (12.06 ± 11.42) for the pencil and paper method is lower than the preferred mean (14.53 ± 13.138) and the utilized mean for grading scale (13.29 ± 11.153) is higher than the preferred mean (12.1 ± 10.857).

Figure 7. Bar chart comparing means between utilized concussion assessment methods and preferred concussion assessment method for ATs years of certification.



DISCUSSION

The following section will include: 1) Discussion of Results, 2) Conclusions, and 3) Recommendations.

Discussion of Results

This study focused on the most utilized tool for assessment of sports-related concussions by certified athletic trainers (ATs). The AT, along with other health care professionals, plays an important role in providing health care to the athletic population. Sports-related concussions are a major sports medicine issue in the current medical literature as well as popular media. There have been many guidelines constructed to allow for better identification, assessment, diagnosis, and management of return-to-play for athletes sustaining this serious injury. The tools used to better assess sports-related concussions range from standard balance screening to computerized neurological testing.

The position statement, written by the National Athletic Trainers' Association (NATA) about the management

of sport-related concussion injuries, provides information and recommendations for certified athletic trainers, physicians, and other health care providers who care for athletes in all levels of sports. These recommendations are derived from the most recent scientific and clinic based literature on sport-related concussions and should be followed by all health care providers.[20] The recommendation on evaluation and assessment of sports-related concussions is that the ATs and team physician work together and agree on a philosophy for managing sport-related concussion injuries before the start of the athletic season. The three most commonly used approaches include: 1) grading the concussion at the time of the injury, 2) deferring final grading until all symptoms have resolved, or 3) not using a grading scale but rather focusing attention on the athlete's recovery via symptoms, neurocognitive testing, and postural-stability testing.[18] The intent of the NATA is to have all health care professionals who work with athletes to focus their attention on the athlete's recovery based on the athlete's symptoms, neurocognitive testing, and postural-stability.[18] The third approach to assessing sports-related concussions is a method that is more than one simple method of assessment, but several methods. It is suggested that health care providers should not use just

one method for assessment and return-to-play criteria of sports-related concussions.[22] This study showed that the third approach is the most utilized among athletic trainers in District 2 of the NATA reflected by 70% of the sample. This finding reinforces the fact that using a multiple method approach to assessment of sports-related concussions is the most commonly utilized by ATs.

It was found that the third approach recommended by the NATA's position statement for concussion assessment, not using a grading scale but rather focusing attention on the athlete's recovery via symptoms, neurocognitive testing, and postural-stability testing, was the most commonly utilized by ATs that were surveyed in District 2. The third approach had the highest percentage (78.6%), which was statistically greater than the first approach, grading the concussion at the time of the injury (12.3%), and second approach, deferring final grading until all symptoms have resolved (5.2%).

The three different approaches to sports-related concussion assessment are not a requirement by the NATA, but it is highly recommended. Although there is no gold standard for assessing concussion injuries obtained by athletes the NATA has provided a position statement for ATs and other healthcare providers to use. District 2 has

demonstrated through this research that the most commonly used approach is the multiple method that includes signs and symptoms, neurocognitive testing, and postural-stability testing, which is stated as the most recommended approach of the three that are listed within the NATA position statement. The position statement states that decisions about an athlete's return-to-play should never be based solely on the use of one concussion testing method.[18] Under no circumstances should an athlete return to play if he or she reports a symptom that is categorized under a concussion.[11,21] Management of and return to participation following a sports-related concussion should involve a team approach. This includes educating the athletes, parents, and coaches about the injury as well as collaboration with all other medical personnel involved in the injury.[21]

An additional significant finding within this study dealt with the responsibility of concussion assessment method decision making and the influence behind concussion assessment methods used by ATs within District 2 of the NATA. It was found that the majority of the ATs surveyed within District 2 were responsible for making the decision about what method should be used in their clinical setting for concussion assessments. Among the 152 ATs surveyed, more than half replied "yes" (n=91) they were the person

responsible for concussion assessment methods decision making as to what method should be utilized compared to the "no" (n=55) responses. This is a very important responsibility for an AT, especially since they are usually the first person on site when a sports-related concussion occurs. The sideline examination is an important part of concussion management for an athletic trainer. The first item to determine during an evaluation is the mechanism of injury, which assists in finding the severity of the head injury.[23] There have been a number of sideline assessment tools developed, mostly for the use of athletic trainers, to help an AT more accurately assess sports-related concussions. Another important aspect of the concussion management is return-to-play decision making, which goes hand-in-hand with concussion assessment method utilization. Return-to-play following a sports-related concussion is the most challenging portion of the care for a concussion injury in making this decision.[23,24] Athletic trainers are the first on the field to assess the injury, they are the ones who evaluate the athlete, they are the person managing the athlete's injury, and they are the ones who return the athlete to play when ready. Therefore, ATs should be the person, or one of the people, in the healthcare team making

the decision about what concussion assessment method should be utilized at their clinical site.

An additional finding was found between the concussion assessment method utilized by ATs (Table 19) and the concussion assessment method preferred by ATs (Table 20) results. There is a distinct change in the number of ATs that use computer-based neurocognitive testing as their method of assessment and those ATs that would prefer to use computer-based neurocognitive testing as their method of choice, which can be seen in Figure 5. This is interesting information to the profession because not every AT is using computer-based neurocognitive testing for assessment of sports-related concussions, but the majority (n=101) of the population surveyed would prefer to use this form of concussion assessment methods. This should be brought to the attention of the profession, where there can be adjustments made to ensure that the majority of the ATs are using the method that they prefer to utilize when assessing sports-related concussions.

When looking at Figure 7 of the compared means of ATs utilized concussion assessment methods and preferred concussion assessment method for years of certification, there was no significance between the utilized and preferred choice for concussion assessments. The means for

all three concussion assessment methods; computer-based neurocognitive testing, pencil and paper, and grading scale; were very close for utilized and preferred based on the ATs years of certification. This suggests that there is no difference between how many years an AT has been certified and which assessment method they currently utilize or which method they would prefer to use in their job setting.

Another additional finding identified that athletic trainers stated that they were most influenced by experience (n=56) with the concussion assessment methods followed closely by supported research (n=54), then significantly less cost (n=22). Although many stated that supported research was their influence to concussion assessment methods, experience was claimed to have the most influence on ATs in District 2. Based on the research that was found there are many sources that support the use of different concussion assessment methods, whether pencil and paper or computer-based concussion testing. However, there is not much supported research about ATs experience in utilizing the different concussion assessment methods in their clinical settings. Athletic trainers, along with all other healthcare providers, learn from experiences during their educational years as well as professional years of

their careers. For a healthcare provider to fully understand the method that they are using and to determine which is best for them, as well as for the athletic population, they must experience each method. Once the AT becomes adjusted to the method and can perform the concussion assessment with ease, they develop a comfort level with that particular method of use. This is how experience works and suggests the reason the most stated influence for utilization of a concussion assessment method is through experience.

Conclusions

After reviewing the results for this study, it is concluded that athletic trainers within District 2 most commonly utilize the multiple method approach to assess sports-related concussion, not using a grading scale but rather focusing attention on the athlete's recovery via symptoms, neurocognitive testing, and postural-stability testing, which is recommended by the NATA position statement. Regardless of the different concussion assessment tools, pencil and paper or computer-based testing, there is not one test that should be used to assess sports-related concussion obtained by athletes. All

health care providers that handle sports-related concussion should use a range of different testing methods to determine orientation, immediate memory, delayed recall, concentration, and attention which are all very important factors when evaluating a concussion.[25,26] The tools used to better assess sports-related concussions range from standard balance screening to computerized neurological testing, and there is no gold standard of which is more suited for healthcare providers.

Research on the topic of sport-related concussions has provided the athletic training profession, as well as other medical professions, with valuable new knowledge over the last few years. The key to reducing the incidences and severity of these injuries, in addition to improving assessment of sports-related concussions and return-to-play decisions, is found in connecting the gap between research and clinical practices.

Recommendations

Further research recommendations for this study, first and foremost, include surveying other districts within the NATA. This would give a better picture of what would be the most commonly utilized approach to sports-related

concussion assessment among other ATs in many different locations.

Another possible area to be researched is educational background of concussion assessment methods indicates a difference in what recommended approach ATs prefer to utilize in their career settings. In addition, further research needs to be done regarding undergraduate and graduate exposure to concussion assessment methods.

Further research needs to be done in regards to the number of ATs who stated that they used computer-based neurocognitive testing and the ATs who preferred to use this same testing method. The reasons why these ATs are not using the computer-based neurocognitive testing when they would prefer to utilize this assessment method need to be determined.

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APPENDICES

APPENDIX A

Review of Literature

Review of the Literature

Sports-related concussions are a major sports medicine issue in the current medical literature as well as popular media of today.[1] There have been many guidelines constructed to allow for better identification, assessment, diagnosis, and management of return-to-play for athletes sustaining this serious injury. The tools used to better diagnose and assess sports-related concussions range from standard pencil and paper assessment testing to computerized neurological testing.

There are several sets of grading systems and guidelines for the management of sports-related concussions that have been published. In fact, there are over 16 grading scales and three of these are most commonly used by healthcare providers.[2] Therefore, the purpose of this review of the literature is to discuss sports-related concussion diagnosis, assessment, and concussion testing methods to determine which may be better suited for the athletes as well as the healthcare providers. The review of literature consists of the following sections and subsections: 1)Sport-related Concussion Injuries, 1a)Definition of Concussion, 1b)Sideline Evaluation,

1c)Management Guidelines, 1d)Return-to-Play, and 1e)When to Refer; 2)Concussions in Athletes, 2a)Contact Sports and Concussions, 2b)High School vs. Collegiate Level Sports; 3)Concussion Assessment and Diagnostic Tools, 3a)Computer Based Concussion Testing, 3b)ImPACT, 3c)CogSport, 3d)HeadMinders CRI, 3e)Glasgow Coma CRI, 3f)Sideline Assessment Testing, 3g)Standardized Assessment of Concussion (SAC), 3h)Balance Error Scoring System (BESS); and an overall summery.

Sports-related Concussions

Sports-related concussions or mild traumatic brain injury (MTBI) in athletics is a major issue in the world of athletics. Reports have shown concussion injuries in multiple sports and the trend of this traumatic brain injury has been increasing in occurrence over the past several years.[1] There has been great attention given to the research of this injury to form a better understanding in terms of athletes health concerns, from the time of injury throughout their lifetime. Still, many issues remain in relation to the diagnosis, assessment, and management of sports-related concussions. This review will discuss the anatomy and physiology of concussion injuries in addition

to the sideline evaluations, grading scales, management guidelines, and return to play criteria of sports-related concussions.

Definition of Concussion

There are numerous definitions of concussions in today's literature such as Dr. Robert Cantu's definition of "a traumatically induced alteration of mental status".[3(p75)] The term "concussion" comes from the Latin word *concutere*, meaning "to shake violently".[4-6] The Congress of Neurological Surgeons came to the following conclusion in 1966 that the definition of a cerebral concussion was "a clinical syndrome characterized by the immediate and transient posttraumatic impairment of neural function such as alteration of consciousness, disturbance of vision or equilibrium, etc. due to brain stem involvement".[4(p150)] The definition consensus of the American Academy of Neurology is "any trauma-induced alteration in mental status that may or may not include loss of consciousness".[7(p674)] In 2001 in Vienna, Austria, the First International Symposium on Concussion in Sport came to an agreement that concussions were defined as "a complex pathophysiological process affecting the brain, included by traumatic biomechanical forces".[8(p964)] It is stated that a concussion results in a

graded set of clinical symptoms that may or may not involve loss of consciousness.[5,9] Through all of these definitions and explanations of cerebral concussions there will be modifications made due to new research on this topic.[8] None of these definitions consider loss of consciousness as a defining characteristic of a concussion, but the loss of consciousness may or may not be present as one of the symptoms of a concussion injury.[7] This injury is characterized by a number of postconcussion symptoms, which include but are not limited to, headache, nausea, lightheadedness, amnesia, and confusion.[3] Other symptoms may present, such as loss of consciousness, blurred vision, attention problems, drowsiness, balance problems, sleep disturbance, photophobia, emotional liability, irritability, and vacant stare. Concussion injury may possibly result in neuropathological changes, although the acute clinical symptoms listed above do largely reflect the functional disturbance of the brain more so than the actual injury.[10]

The current and most recently updated definition of concussion is presented by the Center for Disease Control and Prevention (CDC). The CDC revised educational materials for healthcare providers treating concussions and MTBI and as part of their revision they have updated the

definition of concussion to reflect current medical opinion.[11] The CDC defines concussion or MTBI as the following: "The term mild traumatic brain injury is used interchangeably with the term concussion. This is defined as a complex pathophysiologic process affecting the brain, induced by traumatic biochemical forces secondary to direct or indirect forces to the head. MTBI is caused by a blow or jolt to the head that disrupts the function of the brain. This disturbance of brain function is typically associated with normal structural neuroimaging findings (i.e., CT scan, MRI)".[11]

Sideline Evaluation

The sideline examination is an important part of concussion management for an athletic trainer. If the environment or location where the athlete's injury occurred, such as the sideline of a sports field, is not appropriate for evaluating that athlete then they must be transferred to a different location, a locker room or any other facility that is available will be more suitable.[8,10] The first item to determine during an evaluation is the mechanism of injury, which assists in finding the severity of the head injury.[10] The most common mechanisms of concussions occur when the athlete has contact with either

another athlete, the playing surface, or some other component of the playing field. Concussion injuries will typically present as a period of confusion, amnesia, and possible disorientation. An athlete with a concussion may have a very obvious presentation, such as a direct blow to the head, loss of consciousness (LOC), and amnesia.[8,10] However, there are still those who have more subtle signs and symptoms after sustaining a head injury. A few individuals will experience ringing in the ears or seeing "stars", which occurs only for a few seconds or minutes and then vanish.[8]

There have been a number of sideline assessment tools developed, mostly for the use of athletic trainers, to help a more accurately diagnose sports-related concussions.[10] For example, online assignments should always include a high-quality past medical history and injury history taken with each concussion. Furthermore, the online assignment should include orientation, immediate memory, delayed recall, concentration, and attention are very important factors within a concussion evaluation.[8,10]

Management Guidelines

All athletes that sustain a concussion injury require a thorough evaluation followed by very close monitoring.

There are more than 18 different concussion grading scales that have been published in past literature. It is unfortunate that none of these 18 scales for concussion severity are solidly evidence-based, however they do represent the clinical opinions of experts.[10] It is exceedingly important for the healthcare providers of those with concussions to take the time to familiarize themselves with a single set of guidelines to help organize the injury evaluation process. The most common guidelines used by healthcare providers today were developed by Cantu, the Colorado Medical Society, and the American Academy of Neurology.[8,10] Each of these scales are based on the severity of the cerebral concussion due to the presence and length of any period of unconsciousness. The scale ranges from grade one and grade two, mild to moderate, and ends with grade three being severe.

When looking at the different symptoms linked to a sports-related concussion injury there are many to consider within the management guidelines. The most common postconcussion complaint is a headache. The symptom of a postconcussion headache can either be focal or generalized and may not fully manifest until hours or even days after the concussion occurred.[8] Most postconcussion headaches usually worsen during physical exertion because during

activity the brain moves within the skull causing more damage, which is why there is a great importance in assessing the athlete during rest as well as activity. If the headache continues to get worse or if it is accompanied by vomiting or deteriorating mentation, the athlete should immediately be referred to a hospital for further investigation and physician based medical care. Another common symptom is the complaint of vision disturbance, one that needs to be carefully assessed.[8,9] The athlete might have impaired vision tracking, loss of acuity, photosensitivity, and changes in peripheral vision. All of these symptoms should be fully resolved before the athlete can return-to-play.[8] The occurrence of seizures that present themselves immediately after impact are often benign and should not have a prolonged state. Medications are not usually warranted because the seizure is short lived and very rarely leads to more spontaneous seizures. One substantial concern in the management of concussions are multiple concussion occurrences. When this injury to the brain is repeated, it may cause cumulative cognitive effects and slower recovery of neurological functioning of the brain. There is not a consensus as to how many concussions are too many for an athlete to sustain.[6]

Since there are so many management guidelines out there to be used, not one has been decided on as the ultimate guideline in managing cerebral concussion injuries. This concludes that no real valid guidelines for management of sport-related concussions exist.[7] The CSG and the Canadian Academy of Sports Medicine has an outlined approach for immediate response following the recognition of any signs or symptoms of a concussion.[9] Their statement is that the player should not be allowed to return-to-play in the current game or practice, they should not be left alone and regular monitoring for deterioration is essential, they should be medically evaluated after the injury, and return to play must follow a medically supervised stepwise process.[7]

Return-to-Play

The most challenging portion of the care for a concussion injury is making the decision on return-to-play following the injury.[10,12] There can be a lot of external pressure from individuals such as coaches, parents, and the patient to return the athlete to competition early.[10] Preventing athletes from returning to their sport for unnecessarily long periods of time may have a significant impact on the athlete's career, financial viability, and

psychological functioning.[13] However, there is still a great importance in return to play decisions and there should be no rush in making a premature decision which puts the athletes health at risk. There are many clinicians that believe the return-to-play guidelines are too conservative and they choose to base their decisions on clinical judgment of individual cases instead of on the general recommendations.[14] Many of these return-to-play guidelines call for the athlete to be symptom free before they can continue their participation in a sport. Returning an athlete to participation should follow a progression that begins as soon as the athlete is completely free of concussion symptoms. All the signs and symptoms of the injury should be evaluated using a graded scale or checklist when performing any follow-up assessments and the athlete should be evaluated both at rest and after physical activity whether it be biking, jogging, sit-ups, or even push-ups. If the athlete does not reproduce symptoms after physical activity the athlete is then allowed to participate in sport-specific skills and eventually allowed to return to practice. The athlete should remain out of any activities or drills that would put him or her at risk for another head injury.

The Cantu guidelines on return-to-play following different types of concussion are widely recognized in the medical community as the most useful.[4,10,13] This scale was proposed in the year 1986 and was developed through clinical experience and uses of loss of consciousness and posttraumatic amnesia as the markers for concussion severity.[3,8,14] Athletes returning to play the same day they receive a concussion are allowed when the athlete sustains a grade 1, mild, concussion and only when they are asymptomatic at rest and with exertion.[3,14] The athletes that experience a grade 2, moderate, concussion are allowed to return-to-play in two weeks, but only if they are asymptomatic for one week.[3] With a grade 3, severe, concussion the athlete is allowed to return-to-play in one month, but only if they are asymptomatic for 1 week.[3,14]

When looking at the Sports Medicine Committee of the Colorado Medical Society, which was published in 1991, they are quite different compared to Cantu's.[10] The guidelines for a grade 2 concussion where the athlete does not sustain loss of consciousness (LOC), but suffer from confusion with amnesia, the athlete is allowed to return to play the same day as long as they are asymptomatic during 20 minutes of observation.[13,14] However, it is recommended that an athlete

experiencing a grade 2 with LOC or grade 3 concussion should be immediately referred to a hospital.[14]

There is also a great difference in the guidelines formed by the American Academy of Neurology, which put emphasis on the symptoms of confusion, amnesia, and loss of consciousness.[10,15] Return-to-play for an athlete with a grade 1 concussion is the same day, only if they are asymptomatic for 15 minutes during observation.[10,15,16] For those athletes with a grade 2 or grade 3 concussion, the minimum time recommended before return-to-play is one week and for those with multiple concussions the recovery period recommended is one to four weeks, depending on the grade.[15,16]

The gold standard for deciding return-to-play continues to be a clinical evaluation of symptoms and a complete neurological examination.[10] Neuropsychological testing, which is performed by the healthcare provider, is a valuable tool for objective evaluation of the athlete's cognitive function following a concussion injury.

When to Refer

Most sports-related concussions are considered mild head injuries, but there is still potential for more serious complications and other life-threatening injuries

to arise from a concussion.[14] Sports-related concussion injuries or MTBI can become very serious matters in some cases. The healthcare provider must base the need for referral on his or her own clinical judgment. Each provider should be concerned about the potential for the injury condition of an athlete to deteriorate. A downward spiral can occur within minutes or hours or even several days after an athlete sustains a concussion.[6] There must be a recognition that these injuries require further attention and the athlete should be provided with the appropriate referral for advanced care. Serial assessments and physician follow-ups are important factors of the evaluation process for an athlete with a concussion. These athletes are to be referred to medical personnel, who have the experience in managing sports-related concussions. Vital signs and level of consciousness should be monitored every five minutes after the injury and continued until the athlete's condition is stable and improves. The athletes should also be evaluated over the next few hours and days following the injury for any sign of delayed symptoms during the recovery period.

There is the possibility of a long-term neurocognitive impact on an athlete from a concussion injury, which can suggest a chronic traumatic brain injury.[10] This serious

injury has been studied over the years with no clear answer as what has to be done in this case. Some studies have provided some supportive information about chronic traumatic brain injuries, but further research needs to be done to answer the lingering question of whether these severe injuries occur as a result of concussions or that they are simply related to the athletes sport participation.

There are several indications for an acute concussion injury referral such as evidence of a subdural or epidural hematoma, suspected cervical spine injury, deteriorating level of consciousness, transient quadriparesis, and seizure activity.[10] Some other indications for referral are persistent headaches and other symptoms that linger for more than one week after injury, postconcussion syndrome two weeks following the injury, and pervious history of multiple concussions in playing career.

Concussions in Athletes

Incidences of sports-related concussions continue to increase, which is a factor for the number of the total sports activities, the number of previous sports years of adolescents, and the level of athletic participation that

also continue to increase.[17] Nearly 1.5 million head injuries occur in the United States each year and roughly 20% or 300,000 of these injuries are sports-related concussions.[18-21] About 19% of those injuries occur during contact sports participation, such as football and rugby.[12] Some other popular sports that hold a higher number of concussion incidences are soccer, wrestling, ice hockey, field hockey, snowboarding, martial arts, and lacrosse.[7]

Contact Sports and Concussions

Competitive sports participation has increased worldwide and the sports-related concussion injury represents a very significant health concern for all athletes participating in a contact sport.[1] The sports that involve impact to the head such as American football, rugby, boxing, martial arts, soccer, and ice hockey provide an opportunity to explore the effects of concussions as well as multiple concussions within contact sports.[22] Football and rugby are two big contact sports where there is body contact between opposing players, which occurs routinely during each game play.[23] The sports of boxing and martial arts involve forceful contact between opposing players because of the requirement for earning points during matches. When looking at ice hockey and soccer

there are special circumstances in each sport that may predispose a player to head injury. Ice hockey puts athletes at risk of concussion because of the speed at which body contact occurs as well as the surfaces that opposing players are checked against. The game of soccer includes heading of the soccer ball that also puts the athlete at risk for concussion.

Most of the head injuries in youth athletics are mild traumatic brain injuries and the highest amount of these injuries occur in the sport of American football.[7] It is stated that the risk of sustaining a concussion in football is four to six times greater if the player has already experienced a concussion.[22] Permanent brain injuries due to multiple concussions have been reported on both sports of ice hockey and football. There is a particular concern in the competition at the high school level, where at least 1.25 million athletes compete in a contact sport.[17]

High School vs. Collegiate level Sports

The rate of concussion injuries have appeared to increase in both collegiate athletes and high school athletes, high school athletes are sustaining concussions at a greater rate in sports compared to collegiate level playing.[17] Studies of high school and collegiate athletes

indicating that cumulative effects may result from three or more concussive episodes show the importance and seriousness of sports-related concussions.[20] The participation in high school and collegiate athletics continues to increase in numbers, with more than seven million high school students participating between the years of 2005 and 2006 and almost 385,000 collegiate students participating between the years of 2004 and 2005.[13] This indicates that the number of student-athletes sustaining concussions may also increase unless preventive measures continue to progress. The majority of these concussions happen at the high school level of athletics, where there are over one million high school students participating in the sport of football.[13] In the high school setting there are over 62,000 football players that receive a concussion injury every year, whereas only 34% of the collegiate football population have been diagnosed with one concussion and only 20% of those have been diagnosed with multiple concussion injuries.[12,22]

When discussing the brain injuries in children and adolescents there must be one factor taken into consideration, which is the inherent differences between children and adolescents and adults.[7] The higher incidence of concussion rates in adolescents may simply be a result

of younger, more susceptible brains.[17] Increased susceptibility to brain injuries in children and adolescents, compared to adults, has been linked to decreased myelination, greater head-to-body ratio, and thinner cranial bones, that all lead to less protection of the developing cortex of the brain. There is a developmental process and when comparing age and maturity there has to be some knowledge of how it may interact and affect the nature of the injury and its outcome.[7] It can be argued that most of the current management guidelines meant to handle this injury are not applicable to children and adolescents because the knowledge and research is limited.

A college sports arena is complicated when it comes to addressing concussions, but a high school sports setting is even more challenging.[1] In high school athletics there are coaching positions and sports medicine positions assigned to multiple sports teams and they may be performed by individuals who are only part-time. At the high school sports setting there may be concussions that go unnoticed or unmanaged and this is a huge concern because the typical high school athlete is at more risk for sustaining a concussion due to age and sports skill level. As the participation in high school athletics continues to

increase healthcare providers will continue to be heavily relied upon to diagnosis and treat concussion injuries.[20]

Concussion Assessment and Diagnostic Tools

Sports-related concussion assessments should include testing for postural stability, cognitive function, and self-reported symptoms.[18] Some examples of these sports-related concussion screening instruments include sideline evaluations, such as the Standard Assessment of Concussion (SAC) and the Balance Error Score System (BESS), and the most recent computer based concussion testing, such as IMPACT, CogSport, and Headminder CRI. These neurocognative tools assist the healthcare provider in evaluating and documenting memory, brain processing speed, reaction time, and postconcussive symptoms. The results of these tests should be interpreted in light of all the other factors pertaining to the injury, which may include physical exam, age, gender, and previous concussion history to help in return-to-play decision making. The more recently created assessment tools have been found through research to be the most helpful and more effective in making these critical return-to-play decisions.[24]

Sideline Assessment Testing

Once an athlete has been suspected of sustaining a sports-related concussion, a physician must be involved in the return-to-play decision, but the problem is that the AT is often the person that manages the injury alone on the sideline.[25] The sideline assessment for concussions begins before the competitive season has started. The nature of concussion injuries are highly variable and mandate an individualized approach to injury management. The use of baseline assessments of each athlete, when they are injury free, seem to give healthcare providers a step up on this injury's management. Regardless of the tests performed, the evaluation should include measures of concussion related symptoms, postural control, and neurocognitive function.[14,25] When an athlete is evaluated following a blow to the head, the previously collected data can be used to objectively identify post injury change that will support the decision for return-to-play based on the clinical examination.[25] There are many different sideline assessment tests that have been created to help the AT standing there alone on the sideline at a game and they all can be used to help the determination of return-to-play decisions.

Concussion Grading Systems

The concussion grading systems are sets of criteria used in sports medicine to determine the severity, or grade, of a concussion injury.[25] There are at least 18 such systems that exist, and several of the systems use loss of consciousness (LOC) and amnesia as the primary determinates of the severity of the concussion.[26] These systems were widely used to determine when it was safe to allow an athlete that had sustained a concussion to return to competition. The three most commonly known concussion grading systems were developed by Robert Cantu (Cantu guidelines), one by the Colorado Medical Society, and a third by the American Academy of Neurology.[26]

Cantu Guidelines

Robert Cantu published the Cantu guidelines in 1986 to classify an injury associated with no loss of consciousness (LOC) and less than 30 minutes of post-traumatic amnesia as grade I.[25] The Cantu grade II is determined when the patient loses consciousness for less than five minutes or experiences amnesia for between 30 minutes and 24 hours. In grade III, loss of consciousness (LOC) lasts longer than five minutes or amnesia lasts longer than 24 hours.[10]

In the year 2001 there was an update to the Cantu guidelines made to include other concussion signs and symptoms in addition to amnesia in the grading system.[10] Cantu also changed the grade II criteria to include only concussions with loss of consciousness (LOC) for less than one minute as well as those with loss of consciousness for greater than one minute, or with signs and symptoms lasting over one week, under the criteria of a grade III concussion.[25]

Colorado Medical Society Guidelines

The Colorado Medical Society guidelines were published in the year 1991 in response to the death of a high school athlete due to what was thought to be second-impact syndrome.[26] According to these guidelines a grade I concussion consists of confusion only whereas a grade II includes confusion and post-traumatic amnesia, and a grade III (LOC for seconds) and IV (LOC for minutes) all involve LOC.[26] By these guidelines, an athlete who had sustained a concussion may return to play after having been symptom free both at rest and during exercise.

Grade I states that for the first concussion the athlete should be held from participation for 15 minutes and for subsequent concussions for one week. For a grade

II concussion injury the athlete should be held from participation for one week for the first concussion and two weeks (with physician approval) for subsequent concussions. Grade III (LOC for seconds) has the athlete held from participation for one month for the first concussion and six months (with physician approval) for subsequent concussions. The final grade IV (LOC for minutes) the athlete is held from participation for 6 months with the first concussion and one year (with physician approval) for any subsequent concussions.[10,26]

American Academy of Neurology Guidelines

The American Academy of Neurology (AAN) published concussion grading guidelines in the year 1997, which are based on those by the Colorado Medical Society.[27] According to these guidelines, a grade I concussion is associated with no LOC and symptoms of confusion last less than 15 minutes. Grade II is the same, except that the symptoms last longer than 15 minutes. For grade III, loss of consciousness does occur and this can be divided further into grades IIIa and IIIb, with brief LOC (seconds) and prolonged LOC (minutes).[25] The AAN guidelines state that an athlete suffering from a single, grade I concussion is given a neurological evaluation every five minutes starting

immediately after the injury and may return-to-play if signs and symptoms resolve within 15 minutes.[27] Otherwise, the return-to-play guidelines are the same for the AAN and Colorado Medical Society guidelines.

Pencil and Paper Assessment Testing

There are many different versions of pencil and paper assessment testing, such as SAC and BESS, which were developed as sideline assessment tools to help ATs and other healthcare providers on the sidelines of athletic practices and competitions for quick initial concussion assessment.[6,7,24,29] These tests are standardized tools with which a sports-related concussion can be evaluated immediately after sustained by an athlete. Most pencil and paper tests are comprised of four components: orientation, immediate memory, concentration, and delayed recall.[7,17,24,29] The benefits of pencil and paper testing is ease and brevity of administration as well as scoring and alternate forms for follow-up assessments while tracking the athlete's recovery.[17]

Standardized Assessment of Concussion (SAC)

The popular computerized tests are purported to offer many advantages over paper and pencil test, but both

assessment techniques are limited to the athletic training room or other controlled environments.[28] To remedy this shortcoming of technology, the Standardized Assessment of concussion (SAC) was developed as a brief concussion screening tool for sideline administration and has proven to be effective in the assessment of acutely concussed athletes.[6,28] This assessment test is different from those of comprehensive paper and pencil or computer based neurocognitive assessments specifically for the purposes of administration as well as interpretation.[24] These characteristics make this evaluation process ideal for administration on the sidelines and only require about five to six minutes to complete.[6,23] This test consists of four different sections that evaluate the areas of orientation, immediate memory, concentration, and delayed recall, which makes it a brief screening and rules out gross neurological deficiencies.[7,24,29] There are alternate forms of the SAC test were designed and offered (A, B, and C) to minimize practice effects during follow up testing.[29] The SAC orientation section was assessed by asking the athlete to provide the day of the week, the date, the month, and the time.[29] A five word list of unrelated terms was used to measure the immediate memory and the list is read to the athlete, who then is to repeat the words back to the test

administrator during a total of three trials. The SAC concentration section is assessed by having the athlete repeat strings of numbers and by reciting the months of the year in a reverse order. The last section, delayed recall, goes back to the five word list that was previously used in the immediate memory, and the athlete is asked to deliver as many of the words from that list they can remember. It gives a numerical score, maximum of 30, that is compared with the athlete's baseline score and a player that has sustained a concussion will typically have scores below their baseline.[5] Another great characteristic of this sideline test is that it has been found effective and appropriate to use on youth, nine to fourteen year old, athletes.[29]

There has been an increase in use and application of computerized assessment in the evaluation and management of concussions, which include immediate sideline assessment of these injuries.[7] An electronic version of SAC, called eSAC, has been created by the people of Sideline Assistant and HeadMinder Inc., and can now be used for sideline assessment. This handheld device records symptoms and determines the return to play parameters. The information collected within the eSAC is later synchronized and integrated on an internet based computerized

neuropsychological assessment tool known as the Concussion Resolution Index, Headminder CRI.[29]

Balance Error Scoring System (BESS)

Recently, instrumented and non-instrumented postural control assessments have been used to evaluate sports-related concussions in athletes.[28] The Balance Error Scoring System (BESS) is a brief, non-instrumented assessment of balance. BESS was created as an objective postural control measure that can be implemented easily on the sidelines of a sports field as well as the athletic training room.[24,30,31] This test is a rapid and easy way to administer a sideline assessment and it is very inexpensive.[32] Following a sports-related concussion, the athlete being assessed will commonly commit more errors on the BESS test compared to their baseline evaluation, this indicating a decrease in postural control.[28] The primary objective of the BESS test is to provide healthcare providers with an immediate measure of postural control when assessing an athlete with a potential MTBI, during a sideline clinical evaluation.[31]

The BESS test is conducted under six stance conditions, a double-leg stance, a single-leg stance, and a heel to toe tandem stance, which are all performed on a

firm surface and then on a compliant foam surface.[24,29,32] Each of these three different stances are evaluated for 20 seconds and the athlete is required to place his or her hands on the hips with the eyes closed during this time. During the trials there are a number of errors that the athlete may commit and the errors are counted and the higher the number represents suppressed balance.[24] The errors include opening of the eyes, stepping, stumbling, and falling out of the test position, lifting the hands off the hips, lifting the toes or heels, moving the leg into more than 30 degrees of flexion or abduction, and remaining out of the test position for more than five seconds.[29] An increase of three counted errors or more over the baseline score may represent a significant change, which is indicative of a balance impairment.[24]

Researchers in sports medicine have reported that the BESS test performance can be influenced by a number of different factors.[32] The first factor of influence is that there can be performance differences attributed to the sport of the athlete, who is performing the assessment. For example, sports such as ice skating and gymnastics require their athlete to have excellent static balance compared to those involved in sports like football and basketball. The second factor is that the BESS performance

can be adversely affected by exertion and fatigue, but this factor is short lived with normal performance returning in roughly twenty minutes. The next factor is that the BESS performance is worse in athletes with a history of ankle injuries and ankle instability, which can greatly affect the final error score. The fourth and final factor is that the BESS performance can show a learning or practice effect, especially when the test is administered over and over again in brief re-test intervals. One very good effect of this postural control assessment test is that it has been proven to be effective and appropriate to use for youth athletes, ages nine to fourteen years old.[29]

Computer-Based Concussion Testing

The assessment of sports-related concussions have received an increasing amount of attention over the past few decades.[33] During this time neuropsychologists, athletic trainers, and other healthcare providers have tried to better understand and document the behavioral sequence that follows a cerebral concussion. Computerized testing plays a particularly important role in the sports related concussion arena in today's world. Most of the concussion injuries sustained by athletes involve relatively mild symptoms and with the ability to use these

tests the factor of baseline testing of athletes has shown to be a very powerful assessment tool.

When there is the ability to compare pre- and postconcussion neuropsychological data, there is also the ability to differentiate changes in the neurocognitive status of an athlete with a concussion injury.[33] In addition, the healthcare provider is able to evaluate the degree of symptom resolution in the athlete as well. Computer based assessment testing along with accurate timing of evaluation may be the best suited tool to identify neurocognitive deficits, progress towards full recovery, and provide helpful assistance in return-to-play decisions.

CogSport

This tool is operated through CogState Ltd., created in Victoria, Australia, and is a standalone computer software product that measures the reaction time and accuracy to evaluate the simple and complex attention of the athlete, as well as the working memory, short-term memory and new learning, incidental memory, adaptive problem solving, continuous performance, and spatial abilities of the athlete.[30,34-36] The task stimuli of this program is to take the form of playing cards to create a

game-like atmosphere, which are presented either as individually or grouped, with specific response requirements.[34,36] This administration takes only 15 to 20 minutes to complete and the results are submitted to CogState for scoring and analysis.[34,35] The program contains measures of speed, accuracy, and consistency for responses and there appears to be a total of eight scores produced from the domains of psychomotor, decision making, problem solving, and memory and no overall index score.[35] There are optional services as well that include customized reports, custom data that could be imported into popular statistical packages, storage and retrieval of data and results, as well as mirroring of stored data for increased security.[34] CogState also offers assistance in interpretation of the results used for publication or presentation and assistance in preparation of research protocols or IRB submissions.[29,34] The main reason for this program's design is to evaluate changes in cognitive function and for good test-retest coefficients and external validation.[34]

HeadMinder CRI

The Concussion Resolution Index, produced by the HeadMinder, Inc., located in New York, New York, and more commonly known as HeadMinder CRI, offers an online

neurocognitive and neurobehavioral assessment instrument in this form of sideline assistance to healthcare providers.[30,34-36] The CRI is internet based and all subtests that it offers are administered online through an internet browser.[34-36] The result of this is a program that is computer platform independent. CRI test takes approximately 20 to 25 minutes to complete and the measures are scored online and the results are then accessible for interpreting and discussion test results with the athlete.[34,35] This program, in 2003, was greatly used by numerous professional, semiprofessional, club, collegiate, and high school athletic programs.[34] The program's six subtests are designed to measure reaction time and speeded decision making, which reported a strong concurrent test validation.[34-36] There are two reaction time subtests and two memory subtests.[35] The other two subtests use a continuous recognition type of formatting where the subjects are presented with a series of pictures where some of the pictures are repeated. For these subtests the athlete is instructed to press the spacebar on the key board whenever they recognize a previously presented picture. However, the CRI was found to be sensitive in identifying post-concussion symptoms, if remained resistant to retest effects.[34,36] This computer-based program also

includes an internal symptom validity measure to screen for chance responding or any possible decreased baseline test performance that is significant.[34] The other down fall to this computer based program is that there is no overall index score presented in the results when the test is completed.[34]

Computerized assessment is not without its faults or disadvantages. Researchers have pointed out that these automated procedures are creating a false sense of ability such that anyone may be able to diagnose perceived neuropsychological deficits with the help of only a computer.[36] For healthcare providers, computerized assessment may encourage a passive stance during clinical evaluation, rather than taking an active role to present visual stimuli that can be verbally stated, such as words presented visually for recall or other cognitive comparisons. The research literature is not in complete agreement with respect to the psychometric equivalence of computerized versus the original paper and pencil assessment measures. Computer programs are able to analyze data, but they are not capable of interpreting the clinical meaningfulness of the data being collected.

The future of sports-related concussion assessments and diagnosis should and will include the use of

computerized baseline assessment of athletes.[34] The three main programs that were discussed above and currently on the market for purchase show the documentation of reliability and validity of assessment measures in today's research literature. These three computer based instruments, whether they are computer lab programs or web based programs, are very sensitive to neurocognitive functioning and they are all designed to augment, not supplant, clinical decisions on return-to-play.[6] These tests may represent the most critical issue for the long term success of computer-based assessment of sports-related concussion and in addition establish a utility and sensitivity to the sequence of cerebral concussion injuries.[34]

ImPACT

The Immediate Post Concussion Assessment and Cognitive Testing (ImPACT) is the most recent of the computer-based neuropsychological test batteries formed by the ImPACT Application in Pittsburgh, Pennsylvania.[18,30,37] This tool requires about 20 to 25 minutes to complete and it is designed to measure the attention, memory, processing speed, and reaction time of the athlete to 1/100th of a second.[6,12,18,35,37] It is a Windows based program that also

consists of a self-report system questionnaire and a concussion history form. There are six individual test modules, each with its own multiple associated scores, that measure aspects of cognitive functioning, including information processing speed, attention, memory, and reaction time.[12,20,21,35,37] The memory index is comprised of five subtest scores that measure the different aspects of memory including verbal learning and recognition memory, visual associative memory, visual working memory, and letter memory.[20,21,34,36] This composite index represents the average percent correct score for these five subtest scores.[21]

The ImPACT test battery is designed to minimize the practice effects by randomizing the stimuli being presented in the test.[11,21] Presentation of all stimuli within the test, except for the recognition of word memory, is varied automatically for each examination.[21,36] The verbal memory composite score of the ImPACT test represents the average percent correct for a word recognition task, a symbol number match task, and a letter memory task with an accompanying interference task.[38,39] This index yields the percentage of the correct recognition scores for both learning and delayed recognition.[21] During the visual memory composite, the “X” and “O” task, the athlete is

required to mouse click the left button if a blue square appears on the screen and right mouse click if a red circle appears.[21,35] This index score represents the average percent correct scores of 2 tasks, recognition memory and identification memory.[39] The reaction time index represents the average time, in seconds, the athlete takes to respond.[11,21,36-39] All stimuli are randomized, as well, to minimize practice effects.[21] There are three scores used to calculate the composite score of this index.[21,38] The processing speed composite represents the previously mentioned symbol match task also located in the verbal memory composite score.[37-39] In the impulse control composite the athlete is presented with three words (red, green, or blue) in the same color ink of the word or in a different color ink from the word.[21] The athlete is required to respond rapidly while inhibiting the impulse to respond to the non-target words. This composite is used to identify the athletes who are seriously confused about the test instructions or who might have made numerous right or left confusion errors.[37-39] There is a total of five index scores, but no overall index score, shown in the results of this test, but there is a self-reported symptoms scale that is included in this program.[12,26,35] The postconcussion symptom scale consists of 21 symptoms that are commonly

experienced with sports-related concussions.[11,21] The athlete is asked to choose, mouse click, the point on the scale that most accurately reflects his or her status with regard to each of the symptoms at that time.

In 2003, approximately 200 high schools, intercollegiate athletic programs, and professional teams were using ImPACT.[34] During this year IMPACT was utilized by 9 of the 11 Big Ten football teams, as well as teams in the Pacific-10, Southeastern Conference, and Big XII alone. When looking at the professional level of sports this program was used by teams in the National Football League, Major Baseball League, and the umpires of Major League Baseball, as well as the National Basketball Association starting in 2003.[34,35] There was also use of ImPACT in the Championship Auto Racing Teams and the United States Olympic Women's Hockey Team.[34]

Research evaluating the reliability and validity of change using ImPACT has shown this testing instrument to be an effective tool in concussion assessment and management.[20,37] The initial research on ImPACT reveals that the system produces strongly reliable and validated data.[34] The processing speed and reaction time composites of the ImPACT are found to correlate highly with a standard neuropsychological so called paper and pencil test of these

two domains.[38] Furthermore, test-retest coefficients for this the ImPACT composite scores indicated a high degree of reliability that is similar to other neuropsychological tests of today.[39]

The more recent research has focused on the sensitivity and specificity of the ImPACT tool and had indicated its utility as part of a formal concussion management program.[37] This test has demonstrated good sensitivity and specificity in prior studies done with young athletes.[20,38] There have been numerous testing and retesting done with this program and there is sure to be additional testing in future medical literature.

Summary

There is no doubt that sports-related concussions remain to be one of the most complicated injuries faced by athletic trainers and other healthcare providers.[24] The injury typically shows no visible signs, which leaves a heavy reliance on the watchful eye of medical professionals to detect subtle differences in the injured athlete.[7,24] Furthermore, there is no diagnostic test available for this injury, which leaves the clinical examination and a battery of indirect objective tests as the primary means of

clinical diagnosis.[24] This clinical examination of a concussion injury should follow the same systematic process used for all other orthopedic injuries. After conducting a primary survey, the examiner should obtain an injury history and observe and palpate the athlete for any indications of more severe trauma.[10,24] Special tests for mental status of the athlete as well as postural control and concussion related symptoms will provide objective information that supports the clinical examination.[24]

The assessment tools available to all healthcare providers, whether it concussion grading scales, paper and pencil, or computer-based tests, should be used to evaluate each domain of the injury. These tests provide the highest sensitivity and specificity of concussion assessments and it also gives the healthcare provider the most information to make an informed decision for return to play.[24] Throughout the evaluation process the people administering the assessment should be aware about the development, presence, intensity, and return of concussion related symptoms.[8,10,24] Under no circumstances should an athlete return-to-play if he or she reports a symptom that is categorized under a concussion.[13,24] Athletes playing with lingering symptoms can result in SIS or PCS, which poses a very serious situation. In conclusion, management of and

return-to-play following a sports-related concussion should involve a team approach, which includes educating the athletes, parents, and coaches about the injury as well as being on the same page as all of the other medical personnel involved in the injury.

APPENDIX B

The Problem

The Problem

Statement of the Problem

Sports-related concussions are a major sports medicine issue in today's world of athletics. There have been many guidelines constructed to allow for better identification, assessment, diagnosis, and management of return-to-play for athletes sustaining this serious injury. The tools used to better assess and diagnose sports-related concussions range from standard balance screening to computerized neurological testing and there is no telling which is more suited for healthcare providers.

Reports have shown concussion injuries in multiple sports and the trend of this traumatic brain injury has been increasing in occurrence over the past several years.[2] There has been great attention given to the research of this injury to form a better understanding in terms of athletes' health concerns. Still, many concerns remain in relation to the assessment and management of sports-related concussions.

Therefore, the purpose of this study was to determine the most commonly utilized method for concussion assessment by ATs. A survey was used to measure the most commonly

used method for assessment by those ATs, as per the NATA Position Statement.

Definition of Terms

The following definitions are provided, for clarification:

1) Assessment of Concussion- A process of observation and documentation of signs and symptoms in which the athlete is experiencing once they have sustained a concussion.

2) Certified Athletic Trainers (ATs)- health care professionals certified by the Board of Certification who specialize in preventing, recognizing, managing, and rehabilitating injuries that result from physical activity.[38]

3) Concussion- Any trauma-induced alteration in mental status that may or may not include loss of consciousness.[7]

4) Return to Play- The process of an athlete returning to full participation after cleared by the health care provider.

Basic Assumptions

The following assumptions were made in regards to this study:

1) All survey questions were answered honestly, correctly, and to the best of the ability of the athletic trainer.

2) The sample obtained for this research was a representation of the NATA District 2 population.

Limitations of the Study

The following are possible limitations of this study:

1) Subject contact information could contain incorrect names or email addresses of athletic trainers.

2) The subjects participating in the survey were volunteers who represented enthusiastic individuals within the athletic training population.

3) Only certified athletic trainers within the NATA District 2 were surveyed.

Significance of the Study

The sports-related concussion injuries are numerous and can be very overwhelming at times for health care providers. Each athlete that sustains a concussion deserves a thorough assessment and each health care provider should have the knowledge and access to the appropriate methods for concussion assessment as well as the ability to determine when the athlete is to return-to-play. The purpose of this study is to determine the most utilized tool for assessment of sports-related concussions by certified athletic trainers (ATs).

Sports-related concussions are very important and serious injuries in the world of athletics and the proper medical attention is necessary for each athlete who sustains such an injury. If these serious injuries are assessed and evaluated promptly and properly by the healthcare providers, then both the athletes and the AT, coaches, teammates, and parents of the athlete would greatly benefit. ATs are just one of the many health care providers who are critical aspects in the world of athletic healthcare. Having the correct knowledge and ability to assess and make important decisions about return-to-play after a concussion is sustained is key. The AT can also provide the athlete with the right concussion management

and progression to a safe return to participation of the athlete's sport. Management of concussion injuries and return-to-play following a concussion should involve a team approach, which includes educating the athletes, parents, and coaches about the injury as well as being informed as all of the other medical personnel involved in the injury.

APPENDIX C

Additional Methods

APPENDIX C1

CONCUSSION GRADING SYSTEM SCALES

CONCUSSION GRADING SYSTEM SCALES

Grade/ Level	Cantu	Colorado Medical Society	American Academy of Neurology
1	No LOC; posttraumatic amnesia lasting < 30 min or postconcussion s/s lasting < 24 hr	No LOC; confusion; no amnesia; RTP after 20 min with normal exam	Transient confusion; no LOC; symptoms & mental status abnormalities resolve in < 15 min
2	LOC lasting < 1 min or posttraumatic amnesia lasting 30 min-24 hr or postconcussion s/s lasting > 24 hr but < 7 days	No LOC; confusion; amnesia; no RTP that day	Transient confusion; no LOC; symptoms & mental status abnormalities last > 15 min
3	LOC lasting > 1	LOC; transport	Any LOC; brief

	min or posttraumatic amnesia lasting > 24 hr; or postconcussion s/s lasting > 7 days	to ER with full neck injury precautions, neurosurgical evaluation	(seconds) or prolonged (minutes)

APPENDIX C2

Concussion Testing as Utilized and Preferred by Certified Athletic Trainers Survey

Cerebral Concussion Testing as Utilized and Preferred by Certified Athletic Trainers Survey

Directions: Please answer all of the following questions as honestly as possible. Thank you.

1. Gender:

    a. Female

    b. Male

2. What is your highest educational level?

    a. Bachelor's degree

    b. Master's degree

    c. Doctoral degree

3. What state do you currently practice in?

    a. Pennsylvania

    b. New Jersey

    c. New York

    d. Delaware

4. In addition to the ATC credential, please indicate below all other professional credentials that you possess (Please select all that apply):

    a. PT

    b. PTA

    c. PA

    d. MD

    e. OT

    f. OTA

    g. EMT

h. RN

i. Teacher Certification

j. ACSM-HFS

k. CSCS

l. PES

m. None

n. Other _____ (please specify)

5. How many years you have been working as a Certified Athletic Trainer? _____ years

6. What is your current primary position?

a. Clinical

b. Academic (Teacher/Professor)

c. Research

d. Administrative

e. Student

f. Other _____ (please specify)

7. What is your current employment setting?

a. College/University

b. Professional athletics

c. High school

d. Sports Medicine Clinic

e. General Hospital setting

f. Academic department

g. Fitness Center

h. Personal Trainer

i. Corporate health (company)

j. Other _____ (please specify)

8. As per the NATA Concussion Position Statement, which method is currently being used at your institution/job site?

a. Grading the concussion

b. Deferring final grading until all symptoms have resolved

c. No grading, but using symptoms, neurocognitive testing and postural stability testing.

9. Which of the following concussion methods tools have you utilized during your career (choose all that apply)?

a. Standardized Assessment of Concussion (SAC)

b. Balance Error Scoring System (BESS)

c. ImPACT (Immediate Post Concussion Assessment and Cognitive Testing)

d. CogSport

e. HeadMinder CRI (Concussion Resolution Index)

f. Other _____ (please specify)

10. Are you the person responsible for making decisions about what concussion method is utilized?

a. Yes

b. No

11. If you are not responsible for making decisions about what concussion method is utilized, who is responsible?

a. Team MD

b. Athletic trainer

c. Athletic Director

d. Other _____ (please specify)

12. What primary method/tool do you typically **utilize** to assess concussions?

a. Grading Scale (ex. Cantu or Colorado)

b. Pencil and paper (ex. SAC or BESS)

c. Computer based Neurocogitive Testing (ex. ImPACT, CogSport, or HeadMinder CRI)

13. What method/tool would you **prefer** to use when assessing concussion injuries?

a. Grading Scale (ex. Cantu or Colorado)

b. Pencil and paper (ex. SAC or BESS)

c. Computer based Neurocogitive Testing (ex. ImPACT, CogSport, or HeadMinder CRI)

14. How has the method influenced you to use the method you use?

a. Supported research

b. Experience

c. Cost

d. Other _____ (please specify)

Appendix C3

Institutional Review Board

Institutional Review Board
California University of Pennsylvania
Psychology Department LRC, Room 310
250 University Avenue
California, PA 15419
instreviewboard@cup.edu
instreviewboard@calu.edu
Robert Skwarecki, Ph.D., CCC-SLP,Chair

Dear Bethany,

Please consider this email as official notification that your proposal titled "Cerebral Concussion Testing as Utilized and Preferred by Certified Athletic Trainers in District 2" (Proposal #09-038) has been approved by the California University of Pennsylvania Institutional Review Board as submitted.

The effective date of the approval is 01-28-2010 and the expiration date is 01-28-2011. These dates must appear on the consent form .
Please note that Federal Policy requires that you notify the IRB promptly regarding any of the following:

(1) Any additions or changes in procedures you might wish for your study (additions or changes must be approved by the IRB before they are implemented)

(2) Any events that affect the safety or well-being of subjects

(3) Any modifications of your study or other responses that are necessitated by any events reported in (2).

(4) To continue your research beyond the approval expiration date of 01-28-2011 you must file additional information to be considered for continuing review. Please contact instreviewboard@calu.edu

Please notify the Board when data collection is complete.
Regards,
Christine Gorby
IRB Graduate Assistant

Appendix C4

Subject Cover Letter

Date: Thursday, November 12, 2009

Dear Fellow Certified Athletic Trainer:

My name is Bethany Arbaugh and I am currently a graduate student at California University of Pennsylvania pursing a Master of Science in Athletic Training. Part of the graduate study curriculum is to fulfill the thesis requirement through conducting research; mine will be survey research, and I am working with my Thesis Chair, Dr. Carol Biddington to investigate my research question. The primary purpose of this thesis study is to determine the most utilized and preferred cerebral concussion assessment and management tools in terms of diagnosis and return to play decision making. This model will predict the usage of different cerebral concussion testing tools based on what is used and preferred by certified athletic trainers (ATCs). If an effective study can be predicted it will affect ATCs, which will enhance the future of cerebral concussion testing used in the careers of athletic trainers.

Certified athletic trainers within District 2 are being asked to participate in this research survey however, your participation is voluntary and you do have the right to choose not to participate. You also have the right to discontinue participation at any time during the survey completion process at which time your data will be discarded. The California University of Pennsylvania (CalU) Institutional Review Board has reviewed and approved this project. The approval is effective 01/28/2010 and expires 01/28/2011.

All survey responses are anonymous and will be kept confidential, and informed consent to use the data collected will be assumed upon return of the survey. Aggregate survey responses will be housed in a password protected file on the CalU campus. Minimal risk is posed by participating as a subject in this study. I ask that you please take this survey at your earliest convenience. The questionnaire will take approximately 15 minutes to complete. If you have any questions regarding this project, please feel free to contact the primary researcher, Bethany Arbaugh at arb4954@calu.edu. You can also contact the faculty advisor for this research, Dr. Carol Biddington, 724-938-4356, Biddington@calu.edu. Thanks in advance for your participation. Please click the

following link to access the survey or copy the link and paste it as a URL: http://www.surveymonkey.com/s/G5S3ZHF

Thank you for taking the time to take part in my thesis research. I greatly appreciate your time and effort put into this task.

Sincerely,

Bethany J. Arbaugh
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ABSTRACT

Title: SPORTS-RELATED CONCUSSION TESTING AS UTILIZED BY CERTIFIED ATHLETIC TRAINERS IN NATA DISTRICT 2

Researcher: Bethany J. Arbaugh, ATC, PES

Advisor: Dr. Carol Biddington

Date: May 2010

Research Type: Master's Thesis

Context: Sports-related concussions are a major sports medicine issue in the current medical literature as well as popular media. There have been many guidelines constructed to allow for better identification, assessment, diagnosis, and management of return-to-play for athletes sustaining this serious injury. The tools used to better assess and diagnose sports-related concussions range from standard balance screening to computerized neurological testing and there is no telling which is more suited for healthcare providers.

Objective: The purpose of this study was to determine the most commonly utilized method for concussion assessment by certified athletic trainers (ATs).

Design: Descriptive research design.

Setting: Controlled setting.

Participants: Certified athletic trainers (N=152), who volunteered, within the NATA District 2 were participants.

Interventions: Subjects were sent a survey asking demographics, which included the following: gender, years of experience as a certified athletic trainer, credentials, current occupation, and the level of education. Additional items related to assessment and

return-to-play decision making of sports-related concussion injuries were addressed. The survey was designed to be completed in 20 minutes or less. The subjects then completed the survey over the internet and gave their consent by returning the survey anonymously.

Main Outcome Measures: The ATs preference for utilizing one of the three recommended concussion assessment methods stated in the NATA position statement.

Results: The results showed that there was a significant deviation from the hypothesized values found. The most used concussion assessment method was "no grading, but using symptoms, neurocognitive testing and postural stability testing" among the ATs in District 2 of the NATA.

Conclusions: Athletic trainers within District 2 most commonly utilize the multiple method approach to assess sports-related concussion, not using a grading scale but rather focusing attention on the athlete's recovery via symptoms, neurocognitive testing, and postural-stability testing, which is recommended by the NATA position statement.

Word Count: 299