Spring 2007

An Assessment of High School Coaches Knowledge of Sport-Related Concussion

Erin M. O'Donoghue
Old Dominion University

AN ASSESSMENT OF HIGH SCHOOL COACHES KNOWLEDGE OF SPORT-RELATED CONCUSSION

by

Erin M. O'Donoghue
B.A. May 2005, The University of North Carolina, Chapel Hill

A Thesis Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirement for the Degree of

MASTER OF SCIENCE IN EDUCATION

ATHLETIC TRAINING

OLD DOMINION UNIVERSITY
May 2007

Approved by:

James A. Onate (Director)

Bonnie L. Van Lunen (Member)

Connie L. Peterson (Member)

Sharan Zirges (Member)

ABSTRACT

AN ASSESSMENT OF HIGH SCHOOL COACHES KNOWLEDGE OF SPORT-RELATED CONCUSSION

Erin M. O'Donoghue
Old Dominion University, 2007
Director: Dr. James A. Onate

Sport-related concussion is a common occurrence in high-risk sports and can occur during participation in all sports. The purpose of this study was to assess the knowledge base high school athletic coaches possess about concussion signs and symptoms in regards to recognition, management, and prevention of this condition. A 25 question demographic questionnaire was used to gather background information and a 24 question multiple-choice assessment was used to determine knowledge of recognition, management, and prevention of sport-related concussion. A panel of eight experts in the fields of sport-related concussion and/or survey research reviewed and modified the survey instrument, which were piloted by eight local high school athletic coaches prior to distribution. The survey was distributed to 221 high school coaches in the Hampton Roads area during the winter sport season and completed by 126 (57% return rate). The mean total score for the knowledge assessment was 20.270/24±2.099, with a range of 12 to 24. Multiple analyses of variation (MANOVA) were used to determine the effect that selected demographic data had on knowledge of concussion. Males scored higher on the assessment ($p < 0.01$), as did coaches with a personal history of concussion ($p = 0.042$), and coaches who attended a workshop on concussion ($p = 0.019$). A chi-square analysis revealed an association between gender and coaching a high-risk sport ($p < 0.01$) as well as discussing concussion with an athletic trainer ($p = 0.019$), therefore possibly

explaining observed gender differences. No difference was found for coaches' knowledge based on higher education degree, health-related major, first-aid certification, coaching experience, or discussion with an athletic trainer. Our results support the need for additional education about sport-related concussion for coaches; however, the survey instrument may have been too easy for the intended audience. Further research should examine the effectiveness of sport-related concussion educational intervention methods and the retention of knowledge in coaches following an intervention.

I would like to dedicate this work to
all of those who have supported me over
the last two years, my friends, family, and colleagues.
Your constant encouragement,
challenging, and willingness to listen have served
to keep me going and make this a truly great project.

Particular thanks to Jimmy, as your mentorship
over the last 10 years has helped to make me
who I am personally and professionally.

Thank you again for all of your love and support.

TABLE OF CONTENTS

Page

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER I

INTRODUCTION

The formal education and certification of athletic coaches has been a concern of the athletic world for over half a century when concerns about coaching qualifications that began in the 1950s led to the development of a task force in the 1960s that concluded standards and certification program should be implemented to ensure a minimal degree of competence among qualified athletic coaches. (Sisley B, Wiese DM 1987; Schweitzer C 1989) Coaching remains a unique profession as it still has no standardized certification requirements and each state, sport, and/or governing body is responsible for establishing and maintaining its own coaching certification requirements. (Hoch D 2004; Coach Education (NFHS); Bureau of Labor Services, US Dept. of Labor 2006) The National Association for Sport and Physical Education (NASPE) has developed eight domains, including a domain dedicated to safety and injury prevention, outlining their national standards for athletic coaches. While these standards are a step in the right direction, more efforts need to be made in establishing a national certification process for all youth sport athletic coaches that provides coaches education not only in basic coaching principles, but also on injury prevention and management including risks associated with returning injured athletes to sports participation. (Ransone J and Dunn-Bennett LR 1999)

Concussion in sports has become an issue at the forefront of many health related organizations as sports have become a greater part of the American lifestyle. Approximately 300,000 sports-related head injuries occur annually with a reported incidence of injury per total athletes at the high school level of sport is 5.6%. (Sosin DM, Sniezek JE, Thurman DJ 1996; Guskiewicz KM, Weaver NL, Padua DA, Garrett WE

2000) Some of the more common signs and symptoms occurring with concussion are headache, dizziness, blurred vision, confusion, and disorientation as well as amnesia and loss of consciousness, though these last two occur less often than previously thought. (Guskiewicz KM, et al. 2000) Concussion in youth athletes is further complicated by the increased risk of second impact syndrome as part of a complex neurologic sequela due to repeated head injury. (Guskiewicz KM, Bruce SL, Cantu RC, Ferrara MS, Kelly JP, McCrea M, Putukian M, Valovich McLeod TC 2004; Guskiewicz KM, et al. 2000)

The National Athletic Trainers' Association published a position statement on the management of sport-related concussion concluding that more research needs to be conducted in coming to a definite consensus about return-to-play decisions. (Guskiewicz KM, et al. 2004) The symptoms of concussion gradually improve over the course of a week, leaving the athlete at an increased risk for a second injury over the period of seven to ten days. (McCrea M, Guskiewicz KM, Marshall SW, Barr W, Randolph C, Cantu RC, Onate JA, Yang J, Kelly JP 2003; Guskiewicz KM, McCrea M, Marshall SW, Cantu RC, Randolph C, Barr W, Onate JA, Kelly JP 2003) As athletic trainers or other medical personnel are not always present at every practice or game, coaches may be the first line of contact in an injury situation. The importance of recognition and early management of concussion needs to be understood by the athletic coaches who are responsible for the care and health of their athletes as part of the sports medicine team. Education of coaches about the signs and symptoms as well as some basic management strategies to help improve the reporting of concussion injuries as well as improving the care provided to the athletes for which both athletic coaches and certified athletic trainers are responsible is paramount.

Statement of the problem

The purpose of this study was to assess high school athletic coaches' knowledge base of concussion signs and symptoms in regards to recognition, prevention, and early management of injury.

Experimental Hypotheses

1. *Research Question #1:* Does a coach's educational background influence his or her knowledge of concussion as assessed by the concussion knowledge assessment?
    a. *Research Hypothesis #1A:* Athletic coaches who have a higher education degree will score higher on the sport-related concussion knowledge assessment than other coaches.
    b. *Research Hypothesis #1B:* Athletic coaches holding a degree in a health related field will have a higher score on the sport-related concussion knowledge assessment than other coaches.
    c. *Research Hypothesis #1C:* There will be no difference between athletic coaches with first aid and CPR certification and those coaches who do not have first aid and CPR certification.
    d. *Research Hypothesis #1D:* Athletic coaches who reviewed an informational brochure, such as the Heads-Up: Concussion in Sports material from the Centers for Disease Control and Prevention will score higher on the sport-related concussion knowledge assessment than coaches who did not take time to review the material.

2. *Research Question #2:* What influence does coaching experience have on a coach's knowledge of concussion as scored by the assessment?
    a. *Research Hypothesis #2A:* Athletic coaches with more years of experience will score higher on the sport-related concussion knowledge assessment than coaches with less experience.
    b. *Research Hypothesis #2B:* Athletic coaches who work with high risk sports will score higher on the sport-related concussion knowledge assessment than coaches who work with low risk sports.
    c. *Research Hypothesis #2C:* Head coaches will score higher on the sport-related concussion knowledge assessment than other coaches affiliated with the team.
3. *Research Question #3:* Does having discussed concussions with a Certified Athletic Trainer (ATC) influence a coach's score on the concussion knowledge assessment?
    a. *Research Hypothesis #3A:* Athletic coaches who have discussed sport-related concussions with an ATC will score higher on the sport-related concussion knowledge assessment than athletic coaches who have not discussed sport-related concussion with an ATC.
4. *Research Question # 4:* What influence does a coach's personal history of concussion have on the coach's score on the assessment?
    a. *Research Hypothesis #4A:* Athletic coaches with a personal history of sport-related concussion will score higher on the sport-related concussion

knowledge assessment than those without a personal history of sport-related concussion.

5. *Research Question #5:* What role does attendance at a workshop or in-service have on coaches' knowledge of concussion as scored by the assessment?
    a. *Research Hypothesis #5A:* Those athletic coaches who have attended a workshop on sport-related concussion will score higher on the sport-related concussion knowledge assessment than athletic coaches who have not attended a workshop on sport-related concussion.
6. *Research Question #6:* What effect does a coach's gender have on sports-related concussion knowledge as determined by the coaches' knowledge assessment?
    a. *Research Hypothesis #6A:* There will be no gender differences observed in coaches' knowledge scores as determined by the concussion knowledge assessment.
7. *Research Question #7:* Does the type of school that a coach works at influence the knowledge that coaches have regarding sport-related concussion?
    a. *Research Hypothesis #7A:* There will be no difference between scores of coaches who are employed at a private school and coaches who are employed at a public school.

Null Hypotheses

1. *Research Question #1*
    a. *Null Hypothesis #1A:* There will be no statistical difference in sport-related concussion knowledge scores between the education levels of the coaches according to the degree earned.

b. *Null Hypothesis #1B:* There will be no statistical difference in sport-related concussion knowledge scores between coaches with a degree in a health related field and coaches with a degree in another field or only a high school diploma.

c. *Null Hypothesis #1C:* There will be no statistical difference in sport-related concussion knowledge scores between coaches with first aid and CPR certification and coaches without first aid and CPR certification.

d. *Null Hypothesis #1D:* There will be no statistical difference in sport-related concussion knowledge scores between coaches who reviewed an informational brochure, such as the Heads-Up: Concussion in Sports material from the Centers for Disease Control and Prevention and those coaches who did not take time to review the material.

2. *Research Question #2*

a. *Null Hypothesis #2A:* There will be no statistical difference in knowledge assessment scores between coaches with more years of experience and coaches with less years of experience.

b. *Null Hypothesis #2B:* There will be no statistical difference in sport-related concussion knowledge scores between coaches working with high risk sports and those working with low risk sports.

c. *Null Hypothesis #2C:* There will be no statistical difference in sport-related concussion knowledge scores between head coaches and other coaches affiliated with the team.

3. *Research Question #3*
    a. *Null Hypothesis #3A:* There will be no statistical difference in sport-related concussion knowledge scores between coaches who have discussed sport-related concussion with an ATC and those who have not discussed sport-related concussion with an ATC.
4. *Research Question #4*
    a. *Null Hypothesis #4A:* There will be no statistical difference in sport-related concussion knowledge scores between coaches who have a personal history of sport-related concussion and those who have never sustained a sport-related concussion before.
5. *Research Question #5*
    a. *Null Hypothesis #5A:* There will be no statistical difference in sport-related concussion knowledge scores between coaches who have attended a workshop on sport-related concussion and those who have not attended a workshop on sport-related concussion.
6. *Research Question #6*
    a. *Null Hypothesis #6A:* There will be no statistical difference in sport-related concussion knowledge scores between genders of coaches.
7. *Research Question #7*
    a. *Null Hypothesis #7A:* There will be no difference in sport-related concussion knowledge scores between public school and private school coaches.

Independent Variables

The independent variables in this study are comprised of the demographic categories gathered from the Coaches Knowledge of Concussion (CoKC) survey instrument: degree received, major, age, gender, years coaching, sport coached, coaching position, having discussed concussion with ATC, personal history of concussion, having attended a workshop on concussion, certification in First Aid and/or CPR, and receipt and review of informational brochure material.

Dependent Variables

The dependent variable in this study is the coaches' knowledge score of concussion as demonstrated by the CoKC.

Operational Definitions

1. Concussion – an injury to the brain after a blow to the head resulting in transient alterations of neurologic functioning that may or may not result in loss of consciousness (Aubry M, Cantu R, Dvorak J, Graf-Baumann T, Johnston K, Kelly J, Lovell M, McCrory P, Meeuwisse W, Schamasch P 2002)
2. Higher education degree – coaches who have completed a Masters' degree or higher
3. Health related field – any field of study within the allied health professions (nursing, athletic training, etc.), exercise science, physical education, etc.
4. Years of experience – the amount of time that a coach has been actively coaching a specific sport (For the purposes of this study, years of experience was determined after the data collection by using a quartile system with the lowest

25% representing coaches with less experience and the upper 25% representing coaches with more experience)

5. High Risk Sport – any sport with increased risk for head injury: football, lacrosse, ice hockey, soccer, gymnastics, rodeo, basketball (Guskiewicz KM, et al. 2000; Schulz MR, Marshall SW, Mueller FO, Yang J, Weaver NL, Kalsbeek, Bowling JM 2004)
6. Low Risk Sport – any sport not defined as a high risk sport
7. Coaching position – the role a coach has on a sport team's staff, such as head coach, assistant coach, or volunteer
8. Certified Athletic Trainer (ATC) – an individual who possesses the credentials given by the National Athletic Trainers' Association Board of Certification for the treatment and care of physically active people
9. Personal History of Concussion – having experienced at least one sport-related concussion during one's athletic career
10. Workshop on Concussion – any educational information session (class, in-service, workshop, etc.) attended on the topic of concussion in sports

Basic Assumptions

The following is a list of basic assumptions about the project:

1. Coaches will understand and truthfully answer all questions on the instrument.
2. The instrumentation used in the study is valid and reliable.
3. Coaches' answers on the assessment will strictly be due to their own knowledge and not external sources.

4. Coaches' attitudes or other influences (internal or external) will not influence their scores on the assessment.

Limitations

1. The subjects for this study will not be randomly selected.
2. The researcher is unaware of the coaches' training or knowledge of concussion prior to the study.
3. This study has a limited ability to be generalized to a larger coaching population beyond high school athletic coaches.

Delimitations

1. The study will be delimited to high school athletic coaches working in either public or private high schools in the Hampton Roads area of the Commonwealth of Virginia: Chesapeake, Newport News, Norfolk, Portsmouth, Suffolk, Virginia Beach, and Williamsburg.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter is to present a detailed review of the literature in regards to sport-related concussion. This chapter has been divided into the following sections concerning coaches' knowledge of concussion in sport, coaches' education, coaches' knowledge of health issues, background information, diagnosis and recognition, treatment and management, prevention, and current knowledge.

Coaching Education and Certification Requirements

The professional preparation of high school athletic coaches has been a concern of parents, governing bodies, coaches, and administrators alike for approximately a half century now. (Schweitzer C 1989) In the 1960s, the Division of Men's Athletics, a subunit of the American Association of Health, Physical Education, Recreation, and Dance, established a task force to evaluate coaches' educational requirements. (Schweitzer C 1989; Sisley B and Wiese DM 1987) This task force concluded that specific standards for coaching certification be established and that coaching certification programs should be implemented in conjunction with local colleges and universities to ensure a minimal level of competence for teachers who wanted to coach. With the ever increasing popularity of athletics among youth, a plethora of coaching positions are available, however, there are not as many qualified candidates to fill the positions. Given the increasing demand for athletic coaches, many coaching policies have been changed and adapted to meet the coaching needs. Although coaching education has been a concern since the 1950s and 1960s and came to a forefront in research during the mid to late 1980s, little progress has been made in formalizing a required coaches education

certification. (Schweitzer C 1989; Sisley B and Wiese DM 1987; Brylinsky J 2002; Clark MA 2000) Approximately 3.1 million youth sports coaches, of which 500,000 are high school coaches were actively coaching in 2000 with an estimated eight percent of them having significant sports-related education. (Clark MA2000; Brylinsky J 2002) As athlete participation continues to increase, the importance of having qualified coaches to instruct athletes in the skills of the sport becomes increasingly apparent.

With the number of teacher-coaches available waning, schools are being forced to hire coaches outside of the academic realm who may have little to no formalized education or coaching training. (Hoch D 2004; Schweitzer C 1989) The issue of certification in the field of coaching remains unique as most other professionals – teachers, doctors, athletic trainers, nurses – have a regulated certification process individuals must complete before beginning a career in that field; however, no formal certification procedure exists for the coaching profession, and each state, sport, and/or governing body is left to create its own requirements for coaches to become certified. (Hoch D 2004; Coaching Education (NFHS); Bureau of Labor Statistics, US Dept. of Labor 2006)

Further, training and education in the coaching profession ranges from no specific education requirements, other than possibly prior participation in that sport to a bachelor's degree in a coaching-related field, such as exercise and sports science, kinesiology, and physical education. Additional courses may be required of individuals before certification is obtained at the discretion of the regulating body overseeing the coaches credentialing. (Bureau of Labor Statistics, US Dept. of Labor 2006) Sage (1989) noted that often the only form of professional socialization in the coaching world

involved either coaching youth sports or student teaching involving a coaching aspect. The majority of the knowledge that coaches receive about the profession comes from the former athlete's observation of previous coaches. (Sage 1989, Bureau of Labor Statistics, US Dept. of Labor 2006) In light of the lack of formal training and education of coaches, the National Association for Sport and Physical Education (NASPE) developed eight domains of the coaching profession: philosophy and ethics, safety and injury prevention, physical conditioning, growth and development, teaching and communication, sport skills and tactics, organization and administration, and evaluation.

It has long been accepted that care and prevention of injuries of athletes is one of the domains of the coaching profession, and this duty is of particular importance when an athletic trainer is not present at practices and games. (Ransone J, Dunn-Bennett LR 1999; NASPE 2006) It has been suggested that coaches need to demonstrate a minimal level of competence in sports medicine as well as being certified in first aid, CPR, and the use of an automated external defibrillator (AED). While this training does prepare coaches in how to deal with injuries athletes may incur, especially in the absence of qualified medical personnel such as a certified athletic trainer, physician, or emergency medical personnel, it does not replace the need for an athletic trainer in all secondary schools. Not only do coaches need to know how to treat and manage injuries and illnesses of athletes, but they must also be educated about the risks inherent in returning injured athletes to sports participation. (Ransone J, Dunn-Bennett LR 1999) Nevertheless, formal coaching certification requirements remain an issue among high-school and youth sport coaches.

National Certification Requirements

While having a formal national certification requirement of all youth sport coaches would be ideal and could have many benefits, none currently exists. (Bureau of Labor Statistics, US Dept. of Labor 2006; Coach Education (NFHS)) Several programs do offer a national certification following completion of their coach education program, such as the NFSH's coach education program, the American Sport Education Program, which offers several levels of coaching certification and the United States Sports Academy national coaching certification program; however, these courses can be costly and may carry little weight since there is no national standard for coaching education. These curricula often include courses on coaching fundamentals as well as injury prevention and management through sport first aid classes. With the NASPE developing national standards for sport coaches, some progress has been made in establishing standards for coaching education, but there is still a long way to go.

State Certification Requirements

Currently, each state sets its own certification requirements for athletic coaches and state requirements range anywhere from filling out an application to certain requirements for those coaches who do not have a state board of education teaching certification in physical education to extensive prerequisites for all coaches. (State-by-State Requirements for Athletic Coaches 30 Jan 2007) Additionally, some states also require coaches to maintain their coaching credentials by completing professional development courses.

In Arizona, coaches who are not certified in elementary, secondary, or special education must obtain certification through the state board of education by meeting the

following requirements – certification in first aid and CPR, completion of 15 semester hours in five different courses related to the national coaching standards, documentation of 250 hours of coaching experience, and a finger print clearance card as well as completing professional development to maintain certification. In Illinois, all non-faculty coaches must complete the bronze level certification as provided through the American Sport Education Program, which includes a coaching principles course and a sport first aid course. In New York, there are three separate requirements for athletic coaches depending on levels of teaching certification. Certified physical education teachers must simply maintain certification in first aid and CPR. Certified classroom teachers in subjects other than physical education must maintain certification in first aid and CPR and additionally complete a Philosophy, Principles, and Organization of Athletes course. Further, for coaches of strenuous or contact sports, this includes all sports except for bowling and golf, completion of two additional courses: Theory and Techniques of Coaching and Health Science Applied to Coaching are required. The hiring of non-teacher coaches is allowed, but only as a last resort when no certified teachers with experience and qualification to coach a team are available. In this case, the superintendent of schools must submit an application for a temporary coaching license to the commissioner, who then must approve the application before an eligible coach may apply with a temporary coaching license in addition to maintaining certification in first aid and CPR. These coaches must also meet all of the same course requirements as the certified classroom teacher-coach and complete additional courses in child abuse identification and violence prevention. The states mentioned above are examples of the more stringent coaching certification requirements. On the other hand, the Virginia High

School League (VHSL) only requires that at least one member of an activity's coaching staff attend a VHSL sponsored rules clinic each year. Interestingly, the VHSL was the first high school state association to be granted the prestigious accreditation by the National Council of Accreditation of Coaching Education (NCACE); however, this coaching education course is not a mandatory requirement for coaches in the VHSL. Rather, each local school system establishes its own requirements of coaches, generally regarding the requirement of first aid and CPR certification. For example, all athletic coaches in Norfolk City Public Schools must be first aid and CPR certified, yet Virginia Beach City Public School coaches are not required to be first aid or CPR certified.

Sport Specific Certification Requirements

Some sports associations, such as USA Swimming, USA Volleyball, National Soccer Coaches Association of America, Babe Ruth League Baseball and Softball, and USA Hockey, have set forth requirements that coaches must meet in order to be certified to coach within that organization. USA Swimming requirements mandate that coaches must complete three steps to become certified: safety certifications, a background screening, and an educational requirement. The safety certifications a coach must obtain include CPR, first aid, and safety training for swim coaches. Once a potential coach has completed the safety certification courses and passed a background screening, the coach may then register for the educational requirement, which is completion of the Foundations of Coaching course and passing the test following the exam with a minimal score of 160/180. (Education Requirements; New Coaches 2004)

The USA Volleyball Coaching Accreditation Program (USAV-CAP) has been in place for 17 years and provides a continuous education program intended to keep coaches

abreast of the changing nature and technology of the sport. At the heart of the USAV-CAP are seven basic principles: coaching philosophy and ethics, motor learning, skills development, tactical systems, physical training, sports psychology, and program administration. These principles mirror the national standards established by NASPE with the notable exception of an element regarding injury prevention and management.

There are several organizations that offer certification for soccer coaches including the National Soccer Coaches Association of America (NSCAA), the United States Youth Soccer Association (USYSA), and the American Youth Soccer Organization (AYSO). The NSCAA offers non-residential certifications at a state and regional level with course content specific to the age group that a coach is working with. Additionally, the NSCAA offers residential certification training at the national, advanced national, and premier levels for coaches working with more elite athletes. The USYSA also offers both state and national certifications. The lower levels of certification, U6/U8 and U8/U10 youth modules, are designed to be age-specific training for coaches. The upper state levels, E and D certifications focus on training the individual soccer player and integrating individual play into team play. National certifications, C, B, and A licenses, also provide age-specific training and are building licenses. Coaches with A licenses must participate in a United States Soccer Federation license maintenance program to maintain licensure. The AYSO offers various coaching courses with age-specific content beginning at the U6 coaching level and building all the way up to national certification.

The Babe Ruth League has recently approved a coaching education program, requiring all coaches affiliated with the league, either in softball or baseball, to become

certified by July 31, 2008. Two courses have been designed for certification of Babe Ruth League coaches in collaboration with ASEP: Coaching Youth Baseball: The Ripken Way for Babe Ruth Baseball Coaches and Coaching Youth Softball: The Ripken Way for Babe Ruth Softball Coaches. The courses contain ten educational units focusing on coaching responsibilities, rules of the game, planning practices and games, skill development, and safety and fitness of athletes. (ASEP Marketing 18 Jan 2007) Certification through this program is valid for three years after which coaches will have to take a renewal course that is yet to be developed.

USA Hockey has coaching education requirements that are explicitly laid out and enforced both at the district level and also monitored by referees. Certification level is determined by a coach's entry level and rigorous continuing education requirements are associated with all levels leading up to the final level (Level 4 certification) on a three-year schedule. Coaching levels of certification are laid out according to the age of the athletes a coach will be instructing during the current season. At a minimum, all coaches below Level 4 certification must progress through the coaching education program attending advanced level course every three years. Once a coach has earned the Level 3 certification, attendance at either another level 3 course, a USA Hockey continuing education course, or attendance at a level 4 course is required within three years of the initial Level 3 certification. No further requirements are necessary for recertification once a coach has earned the Level 4 certification. Additionally, all coaches from both teams must provide proof of coaching education level before each game by producing their USA Hockey Coaching Education cards with appropriately dated verification stickers in the presence of each other and the officials presiding over the game. Each

district is responsible for monitoring their coaches' education requirements and assessing any penalties associated with a coach's lapse of certification. Additionally, USA Hockey has adopted the Concussion in Sport Group Protocol return to play guidelines for head injured athletes based on the Summary and Agreement Statement of the First International Conference on Concussion in Sport, Vienna 2001, which was upheld in the Summary and Agreement Statement of the Second International Conference on Concussion in Sport, Prague 2004. (Aubry M, et al. 2002; McCrory P, Johnston K, Meeuwisse W, Aubry M, Cantu R, Dvorak J, Graf-Baumann T, Kelly J, Lovell M, Schamasch P 2005) This protocol explains briefly basic management techniques for coaches, lists signs and symptoms of concussion that a coach may notice players experiencing following a concussion, and an explicit stepwise progression for an athlete's return to play following concussion.

Youth Sports Coaching Certification Requirements

Coaching education requirements and certification at the youth sports level is less enforced and not as widely available as at the high school level. The National Youth Sports Coaches Association (NYSCA) offers a membership certification course covering topics such as sports psychology, dealing with special needs children, communication, child abuse, injury prevention, and hydration. This membership, however, is not required for a coach to participate in youth sports. Each organization individually is responsible for establishing coaching requirements, and often no requirements are given at all.

The state of New Jersey passed a "Little League Law" in 1986 granting partial civil immunity to volunteer coaches who have attended a safety orientation and training skills program. Additionally, the Youth Sports Research Council (YSRC), which is an

affiliate of Rutgers University, has developed the coaches' "S.A.F.E.T.Y. Clinic" aimed to educate coaches on legal aspects of coaching, sport psychology, general concepts, training and conditioning features, and medical/first aid aspects. Since 1986, when the Little League Law was passed, the YSRC has collaborated with the New Jersey Recreation and Park Association to train over 140,000 youth coaches. One specific example of local-level implementation of the S.A.F.E.T.Y Clinic is in Lumberton, New Jersey where the town requires that all volunteer youth coaches pass the course, which the town pays for. Additionally, coaches must also pass a state and federal background check. (Coaching Requirements)

Other examples of youth sports coaching certification requirements can be found at local levels across the United States, though they can be few and far between. The Army mandated that all volunteer coaches working with youth sports offered on military bases attend training and receive credentialing through the National Alliance for Youth Sports in addition to passing a background check. (APG Youth Sports 10 Most Asked Questions) The Hays Recreation Commission in Hays, Kansas requires that at least one coach from every youth sports team has to be certified by the NYSCA. (National Youth Sports Coaches Association 2007) As part of the certification process, the commission pays the registration fee for the certification course and additionally provides certified coaches with liability insurance and a membership card. The Barrington Youth Football league in Illinois recently teamed with ASEP to provide program specific training as a requirement for all flag and tackle football coaches in the league. (Barrington Youth Football) All head tackle football coaches, and optionally assistant coaches, must

complete the Illinois High School Association ASEP coaching principles training course to be certified to coach in the BYF program.

Coaches do not seem to be against the concept of formalized training; actually some studies show that they express a desire for formal coaching instruction. (Wiersma LD, Sherman CP 2005; Langford Bedgood B, Tuck MB 1983; Turk JC, Prentice WE, Chappell S, Shields EW 1999; Sossin K, Gizis F, Marquart LF, Sobal J 1997; Cooney M, Coleman F, Flynn A 2000) In a study evaluating the perspectives of volunteer youth sport coaches regarding coaching education and certification, researchers found that volunteer coaches, as a whole, recognize a lack of formal training and expressed a need and desire for formal training. (Wiersma LD, Sherman CP 2005) Specific areas of educational content that coaches felt they were lacking ranged from skill level diversity and administrative issues to safety/injury prevention and child psychology. Interestingly, the areas these coaches identified as needing more training in are all addressed in the National Standards for Athletic Coaches. Additionally, coaches mentioned that leagues could help coaches to stay abreast of educational issues by offering informal education methods such as making books and newsletters available to coaches as well as providing links to websites that include coaching tips, sports drills, and instruction techniques for volunteer coaches who may have little or no formal sports coaching training. Other educational programs that coaches mentioned would be helpful include a mentorship program for less experienced coaches to be paired with veteran coaches and offering recurring training for coaches over the course of the season rather than a single training program offered at the beginning of season efforts that would allow coaches to absorb more of the information taught to them and may include hands-on workshops and other

continuing education opportunities. Progressive certification programs that offered age-specific training for the various levels of volunteer coaches were another recommendation the coaches had for researchers. (Wiersma LD, Sherman CP 2005)

It is evident that a national certification program for coaches at all levels is greatly needed. While several steps have been taken towards making this a reality – National Standards for Athletic Coaches, national certification agencies, various state and organizational coaching requirements – there is still much development that needs to be done before a national program can be implemented as many states and youth sports organizations still have no formal requirements for athletic coaches at either the high school or volunteer youth sport levels.

Coaches' Knowledge of Health-Related Issues

Coaches are often one of the more influential people in an athlete's life and are also responsible for the health and safety of their athletes, thus their knowledge of health-related issues that may face their athletes is of utmost importance. A study of high school athletic coaches' knowledge of first aid found that although a majority of the coaches in the study were certified in first aid (92%), only 35% of the coaches passed the first aid test again when participating in the study. (Ransone J, Dunn-Bennett LR 1999) This shows that simply requiring coaches to be first aid certified does not ensure that coaches will retain or even possibly acquire the information these first aid courses provide about the care and management of athletic injuries. Researchers also found that the coaches in the study who did pass the first aid assessment were more likely to return an injured athlete to a game as assessed by the Game Situation Data Sheet, suggesting that coaches who were confident about their first aid knowledge felt comfortable enough to send an

injured play back to play. These results indicate the need for coaches to not only be certified in first aid, but also to be educated about the potential risks associated with returning an injured player back to competition thereby enabling coaches to objectively assess a players ability to continue with participation. (Ransone J, Dunn-Bennett LR 1999)

One topic that has been rather pervasive in coaches' knowledge assessment studies is nutrition and associated issues. (Juzwiak CR, Ancona-Lopez F 2004; Turk JC, et al. 1999; Sossin K, et al. 1997; Langford Bedgood B, Tuck MB 1983) When assessing collegiate coaches' knowledge of eating disorders, Turk et al. (1999) found that knowledge of eating disorders is not the only factor to consider when assessing a coaches' knowledge, but their confidence in their knowledge is a key component to consider. Coaches with a high confidence, but low knowledge level pose a greater threat to athletes than coaches with low confidence and high knowledge and those coaches with a higher confidence in their knowledge are more likely to share the knowledge they do possess, which could provide the athlete with potentially harmful wrong information. (Turk JC, et al. 1999) The conclusions from this study are similar to those made by Ransone and Dunn-Bennett regarding more confident coaches' likelihood to return injured players to games. Of concern is that despite having a lack of knowledge regarding nutrition and nutritional issues, coaches continue to dispense nutrition information to athletes on a regular basis. (Juzwiak CR, Ancona-Lopez F 2004; Sossin K, et al. 1997; Langford Bedgood B, Tuck MB 1983) In studies that assess sources of nutrition knowledge, high school coaches most frequently report magazines and other sources of popular literature as well as professional journals as their sources of

information. (Langford Bedgood B, Tuck MB 1983; Sossin K, et al. 1997; Juzwiak CR, Ancona-Lopez F 2004) Of particular note is the fact that Langford Bedgood and Tuck (1983) reported that 49% of the coaches in their study held master's degrees and 69% had majored in a health-related field, yet 25% of the coaches in the study reported that nutrition had not been a part of their college training. Similarly, Juzwiak and Ancona-Lopez (2004) found that 82% of the coaches in their study held a college certificate and 92% of those were physical education majors, yet 41% of the coaches reported having attended a nutrition course. These studies concluded that effective nutrition education was imperative for coaches and suggested that local training programs available to school administrators, coaches, and parents as well as dissemination of educational newsletters and handbooks to coaches, parents, and athletes would be helpful in increasing knowledge and awareness of sports nutrition and associated nutritional concerns. (Langford Bedgood B, Tuck MB 1983; Sossin K, et al. 1997)

Survey research to determine coaches' knowledge about head injuries in sports can be equally valuable to athletic trainers as coaches can be a powerful ally to an athletic trainer. In a survey of Canadian rugby coaches, most coaches were not convinced that headgear might prevent concussion, but rather, felt that the protective equipment might lead to players playing recklessly and thinking they could lead with their heads putting the athletes at a greater risk for head injury. (Pettersen JA 2002) Cooney et al. (2000) found that while half of the coaches in the study were first aid certified, coaches were not able to adequately identify the major signs and symptoms of a severe neck injury. A majority of the coaches knew that a player with a suspected severe neck injury should not be moved and that emergency medical support needed to be summoned, however, less

than 20% of the coaches knew to immobilize a player's head and neck in the event of an injury or that they should check to make sure that the player's airway was open. Additionally, the survey found that most coaches were not adequately trained or equipped to deal with a severe neck injury in the event that one should occur at either a practice or a game. The majority of the coaches (94%) in this study reported a willingness to attend a workshop on the prevention and management of severe neck injuries. (Cooney M, et al. 2000) Another survey of secondary-school coaches in Nigeria found that coaches reported needing to be educated about mouthguards in their role to prevent oro-facial injuries. (Onyeaso CO, Adegbesan OA 2003) These studies highlight the need for education intervention with coaches to give coaches information about the benefits of protective equipment, such as mouthguards and headgear, as well as rule changes in the sport that are designed to keep athletes healthy and aid in reducing the risk of potential head injuries, such as no spearing in football. As an example of effective educational intervention, a pilot study conducted by Parrott et al. (1999) designed to educate youth soccer coaches about the risks associated with sun exposure found improvements in coaches' knowledge of correct procedures for applying sunscreen with pre-test results finding that only 50% knew the correct procedures and at post-test, 100% of the coaches knew the correct procedures. Additionally, the researchers found that educated coaches and subsequently, educated parents, were enthusiastic about the sunscreen education intervention and shared the knowledge they obtained through the seminars with other team parents and children. The research team concluded that the new sun protection information was able to be successfully integrated into existing programs. (Parrott R, Duggan A, Cremo J, Eckles A, Jones K, Steiner C 1999)

Similarly, a survey of lay people found that there is gross misunderstanding of the cognitive symptoms of concussion, but a layperson is more likely to expect associated symptoms if a patient experiences loss of consciousness. (Aubrey JB, Dobbs AR, Rule BG 1989) A later study conducted in 2005 similarly found that there was a general lack of knowledge regarding post-concussional symptoms among general practitioner, mild traumatic brain injury (MTBI) patients, and lay-people alike. (Mackenzie JA, McMillan TM 2005) Researchers also noted an indication that symptom knowledge may be due in part to a personal history of MTBI, as the MTBI patients that reported a higher number of symptoms and more severe symptoms on the self-report symptom checklist also selected more symptoms on the identification checklist. These studies show that the average person, perhaps a coach or parent/guardian, and even those who have experience with MTBI do not know about the signs and symptoms of a mild head injury and points to the need for education even in a general population.

Background Information on Concussion

Definition of Concussion

A consensus among medical personnel from all fields in regards to an exact definition of concussion remains one of the challenges of concussion research to date. The complexity of the injury does not lend itself to easily being defined. One definition suggests that patients must present with a Glasgow Coma Scale (GSC) of 13 to 15 and post-traumatic amnesia among many other factors to be diagnosed with a concussion. (Alexander M, 1995) The definition most commonly cited by researchers (Aubry M, et al. 2002; Guskiewicz KM, et al. 2000; Guskiewicz KM, Riemann BL, Perrin DH, Nashner LM 1997; Johnston KM, McCrory P, Mohtadi NG, Meeuwisse W 2001; Longhi

L, Saatman KE, Fujimoto S, Raghupathi R, Meaney DF, Davis J, McMillan A, Conte V, Laurer HL, Stein S, Stocchetti N, McIntosh TK 2005; McCrory P, et al. 2005; Powell JW, Barber-Foss KD 1999), despite a number of recognized limitations, comes from the Congress of Neurological Surgeons Committee on Head Injury Nomenclature describing concussion as "a clinical syndrome characterized by immediate and transient impairment of neural functions, such as alteration of consciousness, disturbance of vision, equilibrium, etc, due to mechanical forces". (Congress of Neurological Surgeons, 1966) Although this definition is frequently used and is widely accepted, a more recent and updated definition has been published as a result of the First International Conference on Concussion in Sport, which describes concussion as a complex pathophysiologic process affecting the brain sustained after a traumatic force to the brain, resulting in transient alterations of neurologic functioning that may or may not result in loss of consciousness and often presents itself through various hallmarks such as headache, confusion, and amnesia representing a functional disruption rather than structural damage. (Aubry M, et al. 2002) At the Second International Conference on Concussion in Sport, the definition proposed by the first conference was not changed; however, it was noted that post-concussive symptoms may be prolonged or persist after the initial injury. (McCrory P, et al. 2005) Despite the relative disagreement as to an exact definition, agreement does exist that concussion must be defined by acute symptomology, may be caused by a direct or indirect blow to the head, results in short-term disruption of neurological function, and that neuroimaging studies are most often found to be normal in individuals with mild concussion. (Aubry M, et al. 2002)

Theories of Pathophysiology of Concussion

Given that sports-related concussions are closed head injuries and that traditional neuroimaging techniques most often are normal on patients with mild concussions, determining the pathophysiology of sports-related concussions is difficult. Two theories have been proposed, based on animal modeling and experimental laboratory tests. It should be noted; however, that to date no model (animal or experimental) accurately depicts what occurs following a sports-related concussion. (McCrory P, et al. 2005)

One initial theory concerning the pathophysiology of concussion proposed by Alexander (1995) suggests that the deficits caused by a concussive injury are due to physical damage of the brain structures. This theory suggests that concussion is created by diffuse axonal injury (DAI) which occurs from the shearing forces created from a sudden deceleration of the brain such as when a patient falls from a height or as is created in a whiplash scenario. According to this theory, clinical presentation of concussive injury seems to be due to swelling within the axons created by localized transport failures stemming from the shear forces within the brain upon impact. The swelling then may cause a lysis of the axons combined with wallerian degeneration. (Alexander M, 1995) Shear forces may also cause small vessels along the long axis of the brain to burst resulting in petechial hemorrhages and swelling within the brain in focal regions. Deficits in attention and executive functioning as seen in clinical signs and symptoms, such as being easily distracted, memory problems, and sleep disturbances, may be due to the fact that the deep white matter of the brain tends be the primary part of the brain that is injured, in particular, within the cortex of the brain and the brain stem. (Alexander M, 1995)

A more recently proposed concept is the theory that concussive injury is caused not by physical damage to the brain structures, but is caused by disruption of the metabolic processes of the brain, evidenced by the transient nature of the signs and symptoms of the injury. (Giza CC, Hovda DA 2001) These transient neural dysfunctions may be caused by ionic shifts, alterations of metabolism within the brain, impaired neural connectivity, and changes in neurotransmission. (Giza CC, Hovda DA 2001; Grindel SH 2003) Ionic shifts occur within the brain when potassium (K^+) rushes out of the cell and calcium (Ca^{++}) rushes in altering the polarity of the axons causing the sodium-potassium (Na^+-K^+) pumps to work overtime attempting to maintain homeostasis. As the Na^+-K^+ pumps work, they create an increased demand for adenosine triphosphate (ATP); however, during this period of hypermetabolism, as the cell is working overtime to meet the ATP demands, an accumulation of lactate occurs in the absence of oxygen due to decreased cerebral blood flow, which further disrupts neuronal functioning. It is proposed that the energy crisis created by the cells' increased demand for ATP leads to post-injury vulnerability suggesting a potential neuropathology behind second impact syndrome and post-concussion syndrome. Following the acute phase of increased glucose demand, the brain then settles into a period of depressed metabolism. The brain remains in a vulnerable position as continued Ca^{++} influxes within the cell leads to disruption of neural connectivity and possible cell death. (Giza CC, Hovda DA 2001; Hovda DA, Lee SM, Smith ML, Von Stuck S, Bergsneider M, Kelly D, Shalmon E, Martin N, Caron M, Mazziotta J, Phelps M, Becker DP 1995)

The neurometabolic cascade following a concussive injury begins immediately following the trauma and has acute and sub-acute effects as well, lasting up to four weeks

post-injury. Immediately following a concussive force to the brain, physical trauma, such as stretching of the axons, begins a cycle of K^+ efflux and depolarization, which is exacerbated by the release of excitatory neurotransmitters. Calcium influxes result from the release of excitatory neurotransmitters caused by the efflux of K^+, which may result in diffuse axonal injury. (Giza CC, Hovda DA 2001; Hovda DA, et al. 1995) Amid these ionic fluxes occurring in the brain, cerebral blood flow, which normally runs at optimum performance, is diminished to fifty percent of normal. (Henninger N, Dützmann S, Sicard KM, Kollmar R, Bardutzky J, Schwab S 2005) Decreased magnesium leads to neuronal dysfunction such as impaired membrane potentials and exacerbation of Ca^{++} influxes as well as a decrease in ATP metabolism. (Giza CC, Hovda DA 2001)

Once this cycle of hypermetabolism has stabilized, a "spreading depression" follows. The factor that distinguishes the spreading depression following a concussive injury and classic spreading depression is that diffuse areas can be affected simultaneously; further, early loss of consciousness, amnesia, or other disruptions of cognition may be signs of spreading depression. (Giza CC, Hovda DA 2001) The brain continues to function in this reduced oxidative metabolic state for about ten days; further, decreased global cerebral glucose metabolism may last up to four weeks post-injury. (Longhi L, et al. 2005) Researchers have found that post-concussive hypometabolism does not correlate well with the Glasgow Coma Scale (GCS), which would contradict the notion that individuals with a concussion must have a GCS rating of 13 to 15 as suggested by Alexander (1995) and suggests that significant abnormalities may exist despite clinical presentation in obvious signs and symptoms. (Bergsneider M, Hovda

DA, Lee SM, Kelly DF, McArthur DL, Vespa PM, Lee JH, Huang S-C, Martin NA, Phelps ME, Becker DP 2000)

In addition to the two theories of pathophysiology behind the injury, two kinds of forces have been proposed as a means for causing mild traumatic brain injury (MTBI): acceleration-deceleration forces and rotational forces. Rotational movements of the brain may lead to shearing forces causing a more diffuse injury with greater axonal damage. (Bailes JE, Hudson V 2001) Athletes more commonly encounter acceleration-deceleration forces in contact sports as athletes travel mostly in linear directions. (Bailes JE, Hudson V 2001) A biomechanical model using Newtonian laws has been proposed for determining the forces transmitted to the head and brain at the incidence of concussion. (Barth JT, Freeman JR, Broshek DK, Varney RN, 2001) This model proposes that the severity of injury can be determined by analyzing the forces and vectors preceding the injury. At the core of this analysis is evaluation of the deceleration forces in the injury as well as the multiple vectors affecting the brain, which have been proposed as causing the greatest histokinetic changes and thus more diffuse axonal injuries within the brain. (Barth JT, et al. 2001)

Prevalence and Risk of Sport-Related Concussion

Underreporting of concussion occurrence is one of many stumbling blocks in research about the injury. One study found that 47% of high school football players report when they experience concussion symptoms; however, another study found that 18.7% of college athletes fail to report injury. (McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K 2004; Kaut K, DePompei R, Kerr J, Congeni R 2003) Several factors play a role in athletes failing to report their injuries including not recognizing when they have

sustained a concussion, not wanting to be removed from practice or competition, and not thinking that the injury was serious. (McCrea M, et al. 2004; Kaut K, et al. 2003) In addition to not reporting symptoms, athletes self-report continuing to playing through symptoms such as dizziness (28.2%) and headache (33%). (Kaut K, et al. 2003) Because recognition of concussion often relies on an athlete's subjective report of symptoms, determining exact prevalence rates of concussion is difficult. Researchers (Guskiewicz KM, et al. 2000; Schulz MR, et al. 2004) have conducted prospective studies using team physicians or certified athletic trainers to record incidence rates, while others (McCrea M, et al. 2004; Kaut KP, et al. 2003) have conducted retrospective surveys of athletes asking them to recall having sustained a concussion or having concussion-like symptoms in order to determine injury rates and even assess unreported injury rates.

Researchers reported that 20% of all non-fatal traumatic brain injuries occur in sports, which is an estimated 300,000 sports-related concussions annually. (Sosin DM, et al. 1996; Thurman D, Branche C, Sniezek J 1998) This rate is probably higher, however, as a head-injury had to have associated loss of consciousness with the injury to be counted in the survey. Of these injuries, 27% do not receive medical attention and 22% are outpatient care only. The majority of these concussions are seen in the 15-24 year old population. (Sosin DM, et al. 1996) In a prospective survey conducted at both the high school and college levels a 5% incidence rate was reported; in contrast, 15% of high school football players self-reported sustaining a concussion during their current season. (Guskiewicz KM, et al. 2000; McCrea M, et al. 2004) Another study reports incidence rates ranging from 33.09 to 9.36 per 100,000 athlete-exposures depending on the sport. (Schulz MR, et al. 2004) Researchers have reported that the highest risk of incidence for

sport-related concussion is at the high school level and Division III College (5.6% and 5.5% respectively) and that only about half of all concussions are reported to either a certified athletic trainer, coach, or parent, ultimately putting the athlete at a greater risk. (Guskiewicz KM, et al. 2000; McCrea M, et al. 2004) Similarly, Powell and Barber-Foss (1999) reported a similar incidence rate of 5.5% in high school sports. It has been suggested that increases in the rate of sports-related concussion over the past several years is associated with an increased exposure to athletics as more individuals are participating in sports, playing sports year-round, and starting to play sports at an earlier age. (McKeever CK, Schatz P 2003)

The sports with the highest incidence of concussion have been found to be football and soccer for males and basketball and track for females. (Schulz MR, et al. 2004) Those sports with a greater likelihood for contact result in greater incidences of concussion as the most common mechanisms for sport-related concussion are contact with an opponent and contact with a teammate. (Guskiewicz KM, et al. 2000) A majority of concussions occur in games (about 60%) across sports, with the exception of cheerleading, which has a higher incidence of concussions occurring in practice; and the most common grade of concussion sustained is a Grade 1, defined as no loss of consciousness and memory loss lasting fewer than 30 minutes. (Guskiewicz KM, et al. 2000; Schulz MR, et al. 2004) The research of Powell and Barber-Foss (1999) also found that game situations have a greater risk of athletes sustaining a concussion; however, wrestling and volleyball reported high percentages of sports-related concussions occurring at practice. In conclusion, due to underreporting of symptoms by athletes, incidence rates of sport-related concussion, generally accepted to be around 5%,

may be an inaccurate representation of actual risk athletes are at and that a history of concussion is the single best predictor in determining if an athlete may sustain another concussion.

Repeat Concussions

Strikingly, once an athlete has sustained one concussion the likelihood for sustaining another concussion within the same season increases three-fold. (Guskiewicz KM, et al. 2000) During a study of university football and soccer players, soccer players with a recognized previous concussion were three times more likely to have another concussion. (Delaney JS, Lacroix VJ, Leclerc S, Johnston KM 2002) Football players with a recognized previous concussion outside of football were three times more likely to experience a concussion, while those players with a recognized previous concussion in football were two times more likely to have another concussion. (Delaney JS, et al. 2002) In two self-report studies, 20%-30% of athletes have reported a history of concussion. (Kaut K, et al. 2003; McCrea M, et al. 2004) Previous concussion has been found to be the greatest risk factor for recurrent concussion, followed by sport – whether it is a high risk sport or a low risk sport, and being ranked in the bottom 20% for body mass index. (Schulz MR, et al. 2004) Understanding the increased risk that athletes are at once they have had one or more sport-related concussions is essential for coaches in their care of athletes and the ability to prevent repeated concussions or cumulative effects of repeat concussions.

Increased Vulnerability in Women

Although there is a lack of research on sports-related concussion in women, initial research has indicated that women are at a greater risk of concussion. In a study that

examined concussion incidence rates in both male and female high school sports, researchers found that females had a higher incidence rate of concussion compared with their male counterparts playing the same or similar sports – basketball, soccer, and baseball/softball. (Powell JW, Barber-Foss KD 1999) Likewise, in a self-report study of university soccer players, females were 2.5 times more likely to suffer a concussion than their male counterparts. (Delaney JS, et al. 2002) In a similar study, however, researchers only found that females had a higher incidence of concussion in basketball and track as compared with their male counterparts. (Schulz MR, et al. 2004) The reasoning for increase in concussion with females remains unclear, although, brain chemistry or other neuroanatomical differences have been proposed as possible reasons. (McKeever CK, Schatz P 2003) More research needs to be conducted on sports-related concussion in females to better understand any differences that may exist between males and females.

Diagnosis and Recognition of Sport-Related Concussion

Signs & Symptoms of Sport-Related Concussion

A relatively standardized list of signs and symptoms occurring following a concussion has been established within the literature (Alexander M 1995; Aubry M, et al. 2002; Guskiewicz K, et al. 2003; Guskiewicz K, et al. 2000; Kaut K, et al. 2003; Schulz MR, et al. 2004; Wilberger JE 1993). These signs and symptoms do not result only as a direct consequence of injury occurring to the brain, but may be intermixed with signs and symptoms from injuries to peripheral areas, such as the vestibular system or trauma to the head and neck. (Alexander M 1995) The signs and symptoms of concussion may include alterations of mental faculties, such as disorientation, confusion, amnesia, feeling

dazed, sleep disturbances, fatigue, feeling slowed down, slow to respond to questions, being easily distracted, displaying inappropriate emotions, personality changes, inappropriate playing changes, and decreased playing ability; sensory deficits, such as dizziness, poor balance and coordination, seeing stars or lights, ringing in the ears, double vision, a vacant stare or being glassy eyed, and slurred speech; somatic complaints, such as headache, nausea, and vomiting; as well as other symptoms such as loss of consciousness, reports of "having my bell rung", and convulsions. (Aubry M, et al. 2002; McCrory P, et al. 2005) Recent research has examined the validity of narrowing the typical 20 item Graded Symptom Scale down to a mere 9 item model with symptoms fitting into three categories of somatic, neurobehavioral, and cognitive impairments. (Piland SG, Motl RW, Ferrara MS, Peterson CL 2003; Piland SG, Motl RW, Guskiewicz KM, McCrea M, Ferrara MS 2006) Similarly, when asked in a survey regarding consequences of head injury athletes most commonly responded with symptoms of memory problems, headache, nausea/vomiting, dizziness, and visual problems. (Kaut K, et al. 2003)

It is important to note that an athlete may not experience all of these signs and symptoms as concussions vary by individual and symptoms may have a delayed onset, presenting after the initial evaluation. (Alexander M, 1995) Symptoms following concussion are typically short-lived and resolve spontaneously. (Wilberger JE 1993) Symptoms that become persistent, typically headache or dizziness, are considered post-concussion syndrome. The presence of post-concussion syndrome may be indicative of lingering neurophysiologic abnormalities. (Wilberger JE 1993) Some of the more common symptoms reported by athletes include headache, dizziness, poor balance,

decreased concentration, confusion/disorientation, and fatigue. (Guskiewicz KM, et al. 2003; Guskiewicz KM, et al. 2000) In a self-report on concussions by college football and soccer players, headache, confusion or disorientation, and dizziness were the most commonly reported symptoms. (Delaney JS, et al. 2002)

Loss of consciousness and post-traumatic amnesia are considered hallmarks of the injury although neither occur as frequently as many of the other symptoms such as headache, dizziness, or poor concentration. Loss of consciousness is a dysfunction of the brain involving either of the brain's hemispheres or deep structures within the brain causing a paralytic coma-like state. (Kelly JP 2001) In an unconscious individual, responses range from primitive to completely absent. Periods of brief unconsciousness may occur with sports-related concussion, but it is more common that an athlete does not lose consciousness. (Cantu RC, 2001; Kelly JP 2001) During a study evaluating the cumulative effects of concussion in high school athletes, those with a history of multiple concussions have a significantly increased likelihood to have loss of consciousness, anterograde amnesia, and confusion during a sideline evaluation after a subsequent concussion. (Collins MW, Lovell MR, Iverson GL, Cantu RC, Maroon JC, Field M 2002) Athletes with no history of concussion experienced loss of consciousness 5% of the time whereas athletes with a history of multiple concussions had on-field loss of consciousness in 26% of concussions, putting them at a 6.7 times greater likelihood for experiencing loss of consciousness. Overall, athletes with a history of three or more prior concussions are nine times more likely to exhibit on-field markers of concussion severity: loss of consciousness, post-traumatic amnesia, and confusion. (Collins MW, et al. 2002)

Recent research has shown that amnesia is present in only about 8% of all concussive injuries sustained in sports. (Schulz MR, et al. 2004) Controversy has arisen lately as to whether post-traumatic amnesia is a better predictor of concussion severity as compared to loss of consciousness. (Cantu RC 2001) Post-traumatic amnesia is subdivided into retrograde amnesia – difficulty remembering events preceding head injury – and anterograde amnesia – difficulty forming new memories following head injury. Several prospective studies have shown a correlation between post-traumatic amnesia and post-concussion symptoms as well as abnormal neuropsychological test results. (Cantu RC 2001; Collins MW, Iverson GL, Lovell MR, McKeag DB, Norwig J, Maroon J 2003b) Athletes exhibiting post-traumatic amnesia during a sideline evaluation are more likely to present as overtly symptomatic at a follow-up evaluation 1-2 days post-injury. (Collins MW, et al. 2003b) In another study, athletes with post-concussion headache at seven days post-injury were found to be significantly more likely to present with on-field anterograde amnesia. (Collins MW, Field M, Lovell MR, Iverson G, Johnston KM, Maroon J, Fu FH, 2003a)

Parents and coaches may downplay a concussive injury if an athlete has not suffered a loss of consciousness or post-traumatic injury saying he has simply "had his bell rung". Clinicians may still rely on the presence of a brief loss of consciousness, post-traumatic amnesia, and a Glasgow Coma Scale of 13 to 15 in order to diagnose a patient with concussion. (Alexander M, 1995) Athletes who do not recognize symptoms of a concussion are less likely to tell medical personnel and are more likely to continue playing while symptomatic than those athletes who recognize when they have had a concussion. (Delaney JS, et al. 2002)

Determination of Injury

Many pieces go into the evaluation of sport-related concussion. While initial recognition of injury may be subjective and depend on the patient reporting signs and symptoms, the evaluation and determination of injury is complex, taking into account the mechanism of injury, the findings from the clinician's physical exam, symptoms the patient reports, the patient's cognitive ability post-injury, patient's postural stability, and the patient's personal history of concussion. As stated in the definition of concussion, it is caused by trauma to the head, which can be a result of either a direct blow to the head, or by acceleration or deceleration forces transmitted indirectly to the head, such as with whiplash. The most common mechanisms of injury seen in sport-related concussions are contact with another player (opponent or teammate), contact with the ground, and contact with equipment on the playing field. (Guskiewicz KM, et al. 2000)

As with any other injury, the clinician's physical exam for a possible sport-related concussion should be organized and follow a logical order. A primary survey is initially completed as well as checking for on-field indicators of severity including loss of consciousness, amnesia – either retrograde or anterograde – and confusion. (Oliaro S, Anderson S, Hooker D 2001) During the history portion of the exam, gathering detailed information in regards to any loss of consciousness at the time of injury, as well as a thorough history of any previous concussion, as well as symptoms the athlete may be experiencing is important. While talking to the athlete, the clinician should note any evidence of slurred speech and respiratory rate. Other signs to observe include pupillary reaction – equal and reactive to light – as well as checking for obvious deformity, signs of trauma, or battle signs. Vital signs should be checked, which may indicate serious

complications occurring with the concussion such as epidural or subdural hematoma. Finally, special tests should check the patient's level of cognition, coordination, and screen the cranial nerves. (Oliaro S, et al. 2001) Cognitive ability can be checked by having the patient recall a set of words that you give them immediately and after five minutes as well as having the patient perform simple mathematical skills such as subtracting by sevens. Coordination may be monitored in several ways: classic sobriety tests, such as touching the finger to the nose, or a basic Romberg test will provide a quick assessment of the patient's coordination. A quick screen of the cranial nerves can be conducted by having the patient read the scoreboard, follow the clinician's finger through a pattern of motions with the eyes, check pupil reaction, and check the athlete's ability to make facial expressions. Additionally, neck range of motion should be assessed, but only after the clinician has ruled out the possibility of a cervical injury. Strength can be assessed by an efficient upper and lower quarter screen, testing all major muscle groups in both the upper and lower extremities. Finally, as a measure to determine if the athlete is ready to return to play, exertional tests may be conducted; however, this should only be done after the athlete is no longer reporting symptoms at rest and the clinician is trying to determine if the patient's symptoms will return after resuming activity. (Guskiewicz KM, et al. 2004)

Serial examinations as well as following up with a physician experienced in dealing with sport-related concussion should be conducted to monitor the athlete's progress following injury. Initially, the clinician should continue to monitor vital signs and level of consciousness every five minutes until the patient's symptoms stabilize and begin to improve. (Guskiewicz KM, et al. 2004) This should be done in order to detect

worsening of symptoms to detect possibly life-threatening complications, such as epidural or subdural hematomas. Not every sport-related concussion needs to be referred to a physician immediately or even the same day as the injury; however, the athletic trainer must be able to recognize the signs that indicate a prompt referral and be able to distinguish them from those that can be delayed. (Guskiewicz KM, et al. 2004) Signs that require immediate transport of the patient to the emergency department include a deterioration of neurologic function, decreases in the level of consciousness, decreased or irregular respirations, decreased or irregular pulse, unequal, dilated, or unresponsive pupils, any signs or symptoms of associated injuries, spine or skull fracture, or bleeding, mental status changes, such as lethargy, difficulty maintaining arousal, confusion, or agitation, and seizure activity. Other signs that indicate the patient should be seen by a physician on the day of injury include loss of consciousness on the field, amnesia lasting longer than fifteen minutes, increased blood pressure, cranial nerve deficits, vomiting, motor, sensory, balance, or cranial nerve deficits after initial on-field assessment, postconcussive symptoms that worsen or if new symptoms develop after the initial on-field assessment, and if the patient is still symptomatic at the end of the game or practice. Delayed referral, meaning the patient can be seen by a physician after the day of injury, should occur when postconcussion symptoms worsen or fail to improve over time, the patient reports new postconcussion symptoms, or if postconcussion symptoms begin to interfere with the patient's activities of daily living. (Guskiewicz KM, et al. 2004)

Evaluation Tools

Evaluation tools have been developed to aid the clinician in the evaluation process and help in judging when the athlete may be ready for return to play. The three main

areas that these tests are targeted at include symptomatology, cognitive ability, and postural stability. The graded symptom checklist provides an objective measure of the subjective symptoms a patient may report and allows the clinician to monitor how many and which specific symptoms the patient is experiencing as well as how the symptoms are improving over time. (Guskiewicz KM, et al. 2004) Similar to the graded symptom checklist is the Head Injury Scale (HIS) to be used in the identification and evaluation of an athlete's postconcussive symptoms, which has been proven valid for the assessment of concussion symptoms. (Piland SG, et al. 2003) The standardized assessment of concussion (SAC) is a sideline test developed to assess an athlete's cognitive ability by assessing orientation, memory – both immediate and delayed, neurologic functioning, and concentration. (McCrea M, Kelly JP, Randolph C, Kluge J, Bartolic E, Finn G, Baxter B 1998) Various other standardized methods of concussion assessment (SMCA) exist and several were combined to develop the Sport Concussion Assessment Tool (SCAT) recently in Prague. (McCrory P, et al. 2005) Despite the recent growth in research supporting the use of SMCA, these tools are not growing in popularity for clinical management of concussion among athletic trainers. (Notebaert AJ, Guskiewicz KM 2005) Neuropsychological testing is another evaluation tool used to measure an athlete's cognitive ability and monitor the athlete's recovery. (Guskiewicz KM, et al. 2004) Various test batteries have been developed and are available commercially in an attempt to make neuropsychological testing efficient and affordable for any level of play, such as the Concussion Resolution Index and the ImPACT test battery. (Erlanger D, Saliba E, Barth J, Almquist J, Webright W, Freeman J 2001; Lovell MR, Collins MW, Iverson GL, Johnston KM, Bradley JP 2004; Iverson GL, Gaetz M, Lovell MR, Collins

MW 2004) Research has found, however, that neuropsychological test scores do not always correlate with the use of currently used grading scales such as Cantu, Colorado, or AAN guidelines, suggesting a need for further research into the use of both. (Hinton-Bayre AD, Geffen G 2002) The Balance Error Scoring System (BESS) is a sideline test developed to assess an athlete's static postural stability and could be thought of as an on-field extension of the postural assessment a clinician may perform in the laboratory on the NeuroCom or other similar equipment. (Guskiewicz KM, Ross SE, Marshall SW 2001; Riemann BL, Guskiewicz KM, Shields EW 1999) The NeuroCom Smart Balance Master is a piece of laboratory equipment that measures a subject's center of gravity to visualize the postural stability of the subject. (Guskiewicz KM, et al. 2004) Using a dual-task method of assessing both cognitive and balance functioning at the same time, however, has not been shown to be effective in a healthy population as this testing method actually improved results as compared to individual testing. (Broglio SP, Tomporowski PD, Ferrara MS 2005) Clinicians should note that in using any of these tools as an aid in assessment, baseline testing is a very important factor as each athlete is an individual and thus how they are affected by the injury will also be unique.

Other tools that may be helpful in the assessment of sport-related concussion are in the neuroimaging domain and include computed tomography (CT) scans, magnetic resonance imaging (MRI), and a newer functional MRI (fMRI). Traditionally, in mild cases of sport-related concussion neuroimaging techniques were not effective in aiding in the assessment of injury as the tests generally return negative. (Alexander M, 1995) They are valuable, however, in more serious cases as they may show intracranial bleeds, identifying potentially life-threatening complications. The new fMRI, however, has

proven to be more sensitive in detecting specific neural signatures that may occur due to sport-related concussion even in mild cases. (Jantzen KJ, Anderson B, Steinberg FL, Kelso JAS 2004) The fMRI, when paired with a working memory task, has been shown to have the potential for identifying pathology in symptomatic concussed subjects as can be noted by altered activation patterns within the brain. (Chen J-K, Johnston KM, Frey S, Petrides M, Worsley K, Ptito A 2004) The fMRI along with other new neuroimaging techniques such as positron emission tomography (PET) and single photon emission computed tomography (SPECT) remain in the experimental phases while a body of literature is compiled for their uses. (McCrory P, et al. 2005; Jantzen KJ, et al. 2004; Chen J-K, et al. 2004) Other experimental methods for the assessment of concussion include genetic testing for the Apolipoprotein-epsilon4 (ApoE4) allel or a particular calcium subunit gene, various electrophysiological recording techniques, and monitoring biochemical serum markers in the blood. (McCrory P, et al. 2005) None of these experimental methods has been recommended for the use of assessing concussion.

Treatment and Management of Sport-Related Concussion

Recovery from Sport-Related Concussion

In general, recovery following a sport-related concussion is spontaneous and the symptoms gradually resolve over the period of a week. (Aubry M, et al. 2001; McCrory P, et al. 2005; McCrea M, Barr WB, Guskiewicz K, Randolph C, Marshall SW, Cantu R, Onate JA, Kelly JP 2005) It was found that symptom duration lasts, on average, 82 hours with 88% of patients recovering to an asymptomatic state after one week. (Guskiewicz KM, et al. 2003) Collins et al. (2003a) found that athletes who were still suffering with post-concussion headache at seven days post-injury also experienced significantly more

post-concussion related symptoms than athletes without a headache did. Additionally, these athletes performed worse on neuropsychological tests at the seven day follow-up evaluation than athletes without a headache. (Collins MW, et al. 2003a) Following a mild concussion, memory deficits may continue for a week even when the athlete may report being asymptomatic after 36 hours; however, in those athletes with less severe concussions, symptoms lasting less than five minutes, memory improved at approximately day four. (Lovell MR, Collins MW, Iverson GL, Field M, Maroon JC, Cantu R, Podell K, Powell JW, Belza M, Fu FH 2003) In the NCAA concussion study, athletes were found to have symptoms that gradually resolve over the period of a week with cognitive impairments following the recovery of symptoms gradually over the week; however, balance deficits recover to baseline approximately 3 to 5 days post-injury. (McCrea M, et al. 2003)

Recent research has shown that the adolescent mind is not only more susceptible to injury, but also takes longer to recover from injury. (McKeever CK, Schatz P 2003; Theye F, Mueller KA 2004) As compared to college athletes, high school athletes have a longer recovery period after sports-related concussion. (Field M, Collins MW, Lovell MR, Maroon J 2003) High school athletes demonstrated memory deficits that persist to day seven while symptoms may resolve at approximately day three or five. (Field M, et al. 2003) Following a severe head injury, children and adolescents show long-term verbal memory deficits as well as defects in memory retrieval. (Levin HS, Eisenberg HM, Wigg NR, Kobayashi K 1982) High school athletes that sustained a mild concussion remained symptomatic, as measured by self-reported symptoms and memory tests, at 36 hours although their on-field symptoms resolved within fifteen minutes.

(Lovell MR, et al. 2004) These findings suggest that current guidelines allowing return to play on the same day following a mild concussion may be too liberal. (Lovell MR, et al. 2004) As yet, there is not evidence currently to suggest that children and adolescents are at an advantage in recovering from traumatic brain injury. (Levin HS, et al. 1982)

Grading Scales for Concussion

Several return-to-play guidelines have been written and published to aid the clinician in making the return to play decision. Over twenty-five different scales have been published and can be loosely grouped into several categories: surrogate head injury scales, neurosurgical scales, sport-specific scales, sporting injury scales, and an unclassifiable scale. (Johnston KM, et al. 2001) These scales provide the clinician with a classification of injury severity – generally, mild/moderate/severe or graded – as well as the criterion for making the classification and return to play guidelines based upon the classification of the injury. Some of the more commonly used grading scales in sports medicine include the Cantu Evidence-Based Grading Scale, Colorado Medical Society Guidelines, and the American Academy of Neurology Concussion Grading Scale. (Cantu RC 2001; Quality Standards Subcommittee 1997) Research has shown a disagreement between athlete performance on neuropsychological tests and return-to-play recommendations based on concussion severity guidelines. (Hinton-Bayre AD, Geffen G 2002) At this time, three approaches may be used in the classification of sport-related injury: classifying the injury at the time of the injury, deferring classification until all the symptoms have resolved, or not classifying the injury, but rather focusing on the patient's recovery. (Guskiewicz KM, et al. 2004) Recently, the Second International Conference on Concussion in Sport recommended a new retrospective way of classifying concussions

for management purposes as either being simple or complex. (McCrory P, et al. 2005) A simple concussion resolves gradually over the course of 7 to 10 days with no complications. A complex concussion is one where athletes have persistent symptoms or cognitive impairment, a period of loss of consciousness lasting longer than one minute, or athletes who have suffered multiple concussions in the past. (McCrory P, et al. 2005) Depending on how the athlete's concussion is graded, treatment considerations could change.

Despite the potentially helpful nature of these grading scales, they have some flaws. Many of these scales rely heavily on loss of consciousness (LOC) and/or amnesia as indicators of severity, thus influencing the classification of the injury and the subsequent return to play decision. (Guskiewicz KM, et al. 2004) The problem with these scales relying on LOC and amnesia is that they have been shown in research to occur infrequently (9% and 27% of all cases, respectively) and they have been shown either together or individually to not be good predictors of injury severity. (Guskiewicz KM, et al. 2004) When asked about grading scales that rely heavily on the presence of LOC or amnesia, physicians noted a concern that these guidelines may be too conservative. (Roos R 1996) This sentiment is very different today as seen in the very conservative recommendations by the International Conference on Concussion in Sport. Further, many of these scales allow for the return of a concussed athlete to play the same day of injury if the athlete's signs and symptoms resolve within fifteen minutes of assessment. Researchers have found that athletes whose symptoms have resolved in the initial fifteen minute window still had memory deficits and increased symptoms at thirty-six hours after injury as compared to age-matched controls. (Lovell MR, et al. 2004)

This evidence is suggestive that these return-to-play guidelines may be too liberal in allowing a patient to return to play on the day of injury. Further, another study found that concussed high school athletes performed worse in tests of memory performance at seven days post-injury compared with matched controls; whereas college-aged athletes were performing at similar levels of the matched controls at three days post-injury. (Field M, et al. 2003) These finding suggest that extra care should be taken in treating the adolescent patient as they may require longer time to recover. Others have suggested that the brain remains in a vulnerable state and may be prone to reinjury up to ten days post-injury and most repeat concussions occur within a seven to ten day window post-injury, further suggesting that return to play guidelines may allow for early return before the patient has had a chance to recover fully. (Giza CC, Hovda DA 2001; Guskiewicz KM, et al. 2003)

Return to Play Decisions

Common treatment following a sport-related concussion is rest. The patient's brain requires time to recover, and an early return to activity may put the patient at greater risk for potentially catastrophic outcomes. (Giza CC, Hovda DA 2001) No patient should return to play until he is completely asymptomatic – both at rest and during exertional maneuvers. (Aubry M, et al. 2002) Some guidelines allow an athlete to return to play on the same day as suffering a concussion if an athlete's symptoms resolve within a short time period, usually 15 to 30 minutes. (Quality Standards Subcommittee 1997) More recently, however, it has been suggested that once an athlete has suffered a concussion he or she should be removed from activity altogether that day and not allowed to return at all that day. (McCrory P, et al. 2005) Once the athlete is ready to return to play, however, it

should be a guided progression following a stepwise process to limit the risk for a second injury. (Aubry M, et al. 2002) This progression has been divided into six phases: (1) complete rest, (2) light aerobic activity – walking or stationary biking, (3) sport specific, non-contact training – running or skating, (4) sport specific, non-contact training drills, (5) full contact training (after medical clearance), and (6) return to competition. (Aubry M, et al. 2002; McCrory P, et al. 2005)

Prevention of Concussion

Due to the nature of a concussive injury, little has been proven by science to support measures that actually prevent injury; however, a few methods for reducing the risk of injury have been shown to be effective. Rules changes such as making spearing illegal in football and eliminating head checking in ice hockey serve to reduce the risk of concussion in high risk sports by eliminating behaviors that have been shown to be causes of the injury. (Aubry M, et al. 2002; Johnston KM et al., 2001) Rule enforcement is of equal importance and referees as well as coaches should enforce the compliance with these rules for the safety of all athletes. (Aubry M, et al. 2002; Johnston KM et al., 2001) In addition to rule changes, the use of properly fitting protective equipment in sports that require the use of helmets (baseball, football, ice hockey, lacrosse, softball, etc.) can aid in the reduction of injury rate. (Aubry M, et al. 2002) The National Athletic Trainers' Association has recommended that the certified athletic trainer enforce the proper use of helmets as required by certain sports. (Guskiewicz KM, et al. 2004) The ATC should work together with coaches to ensure that helmets properly fit each athlete and that all helmets meet National Operating Committee on Standards for Athletic Equipment (NOCSAE) or American Society for Testing and Materials (ASTM)

standards. (Guskiewicz KM, et al. 2004) Soccer and rugby headgear and mouthguards, however, have not been shown to reduce the risk of concussion at this time. (Aubry M, et al. 2002; Guskiewicz KM, et al. 2004) Additionally, it has been proposed that neck muscle conditioning may help to reduce the impact of forces transmitted to the head; however, this idea is mainly theoretical and little evidence exists to support this practice. (Johnston KM, et al. 2001)

Perhaps the easiest and most effective way to reduce and prevent the potentially catastrophic outcomes of a concussion is education. Everyone involved with the care of the athlete, parents, players, and coaches should be educated about the risk of concussion. (Johnston KM, et al. 2001) Recommendations have suggested that education efforts should include the definition of the injury, signs and symptoms, how to recognize an injury, consequences of not reporting a concussion, and proper technique and respect for the game. (Aubry M, et al. 2002; Kaut K, et al. 2003; McCrea M, et al. 2004) Players need to be educated about how to recognize a concussion when they sustain an injury as well as the risks associated with not reporting the injury so that they will be more likely to report when they have sustained a concussion, as a concussion may not be recognized by the medical staff until the player reports symptoms. While players may not report sustaining concussions because they do not want to be removed from competition or lose playing time, research has shown that two of the top three reasons players stated for not reporting a concussion have roots in a lack of education about the injury – they did not think it was serious enough to report and they did not know it was a concussion. (Kaut K, et al. 2003; McCrea M, et al. 2004) Additionally, research has shown that when athletes are provided merely with a definition of concussion and the signs and symptoms

of the injury they are able to identify a concussion much easier. (McCrea M, et al. 2004) Coaches need to be educated to teach proper technique and enforce the rules of competition, especially those that may reduce the risk of injury. Additionally, coaches should be educated to know how to recognize signs of a possible concussion and the risks associated with not reporting a concussion to encourage athletes to report their injuries rather than to continue playing through the injury. Parents, likewise, need to know how to recognize an injury and the potential risks of failing to report a concussion to support and encourage athletes not to hesitate about reporting a concussion. Further, parents should be educated in regards to proper at home care and understanding exactly what a concussive injury entails so as to dispel any myths that parents may have about the injury (ex. that you must lose consciousness to have a concussion). Education efforts can be addressed during a preseason meeting with parents, coaches, and players all present as an efficient means to disseminate information to everyone involved in the care of the athletes.

Current Knowledge of Concussion

Guidelines for Management of Sport-Related Concussion

Recently, two separate committees have issued guidelines for the care of athletes having sustained a concussion. The International Conference on Concussion in Sport published a summary statement in 2002 with the goal of providing guidelines to improve the safety and health of athletes having sustained a concussion in sports. (Aubry M, et al. 2002) The Concussion in Sport group set out to develop a universal model for understanding concussion to be used by doctors, therapists, health professionals, coaches, and other involved with the care of athletes. (Aubry M, et al. 2002) During the

conference, the committee developed an updated definition of concussion and a revised protocol covering clinical history, evaluation, neuropsychological testing, imaging procedures, research methods, management and rehabilitation, prevention, education, future direction in the field, and medicolegal considerations. (Aubry M, et al. 2002) At a second meeting of the International Conference on Concussion in Sport, a new guideline for the management of simple versus complex concussions was proposed stating that formal neuropsychological testing need not be done on athletes with a simple concussion, but that serial examinations of cognitive function should be conducted as well as following a graded program to return to activity. (McCrory P, et al. 2005)

The National Athletic Trainers' Association (NATA) published a position statement in 2004 stating that combining research and clinical practice effectively paves the way for reducing the risk associated with concussion and management of the injury. (Guskiewicz KM, et al. 2004) The guidelines that the NATA issued address defining and recognizing the injury, evaluating and making return-to-play decisions, concussion assessment tools, when to refer an athlete, when to disqualify an athlete, special considerations for young athletes, home care for the athlete, and equipment issues. (Guskiewicz KM, et al. 2004) These guidelines serve to improve practitioners' standards of care by increasing knowledge through research to progress the care of athletes clinically.

Survey Research

Survey research often provides important data about knowledge of individuals and patterns of behavior that may provide insight to creating intervention methods and developing ways to improve standards of care. In a recent survey of athletic trainers,

Ferrara and colleagues (2001) assessed the practice patterns of athletic trainers in regards to frequency of concussions evaluated and use of evaluation tools. While the results of this survey found that ATCs use a mixture of evaluation tools, such as clinical examination, symptom checklist, and the Colorado Guidelines, standardized methods are beginning to be used more than in years past. This data shows that research efforts and continuing education focusing on concussion have had a significant impact on the clinical practices of certified athletic trainers. In a recent update surveying the practice patterns of athletic trainers in managing concussions, a clinical examination and symptom checklist were the most commonly used tools for evaluating a concussion. (Notebaert AJ, Guskiewicz KM 2005) Additionally, a clinical exam, doctor recommendations, specific return-to-play guidelines, and self-reported symptoms by the athlete were the most commonly used tools for making a return-to-play decision. In all, the survey found that athletic trainers do a better job of assessing and managing concussions than they did five years ago; however, only 3% of athletic trainers comply with the NATA recommended guidelines of using the BESS, graded symptom checklist, and neuropsychological testing. (Notebaert AJ, Guskiewicz KM 2005)

A survey of medical practitioners (pediatric, family practice, and emergency physicians and pediatric and family practice nurse practitioners) assessing their knowledge of the Colorado Medical Society Guidelines (CMSG) for return-to-play following a concussion revealed that these practitioners' knowledge of the CMSG was low. The survey was designed as an assessment and the practitioners' scores were graded. The survey results revealed that less than 10% of respondents were able to answer correctly for a grade 1 concussion according to the CMSG while 56% responded

correctly for a grade 2 and less than 30% correctly recognized a grade 3 concussion. (Bazarian J, Veenema T, Brayer A, Lee E 2001) When asked about advice regarding return-to-play decisions following a concussion, only 20% of the practitioners surveyed cited some sort of guidelines that they follow and of that 20%, only 5.6% reported using the CMSG as part of their decision process. (Bazarian JJ, et al. 2001) This study shows that while progress towards using a standardized method is being made in the field of athletic training, there is still a long way to go in educating other members of the medical society that may be responsible for the care of athletes.

Another study surveying family practice physicians found that generally, family practice physicians have a poor knowledge of sports-related head injury and are using inappropriate tools for assessing injury. (Amadeus R, Mason G, Monaco R, Ivins D, Brooks J 2001) Additionally, the survey found that team physicians have a greater knowledge of when to return athletes to play; however, overall a greater understanding of concussion among family practice physicians is needed. (Amadeus R, et al. 2001) Current knowledge of research about concussions in sports provides a wealth of information, however, that information may be conflicting or confusing as agreement about definitions muddled and there is no single evidence-based guideline for the medical community to follow. Research shows that efforts need to be made to bridge the information gap between the athletic training profession and other medical professions in order to reach some form of agreement on the care for an athlete having sustained a concussion. In the meantime, athletic trainers should work together with their own team physicians to develop a plan of action in the event that a concussion does occur.

Survey techniques of coaches most often involves some sort of questionnaire that was either mailed or given to coaches to take and return to the research team (Sossin K, et al. 1997; Turk JC, et al. 1999; Langford Bedgood B, Tuck MB 1983; Cooney M, et al. 2000; Ransone J, Dunn-Bennett LR 1999), yet some researchers have conducted interview sessions with coaches to allow for greater elaboration of answers which is limited with questionnaire studies. (Wiersma LD, Sherman CP 2005; Juzwiak CR, Ancona-Lopez F 2004) Findings generally found a lack of knowledge on a variety of subjects ranging from nutritional concerns to management of severe neck injuries and first aid knowledge. Each of the studies concluded that coaches need to be better educated about health-related issues that may face their athletes. A variety of educational methods were suggested by coaches in response to their lack of knowledge including formal workshops (Langford Bedgood B, Tuck MB 1983; Turk JC, et al. 1999; Sossin K, et al. 1997; Cooney M, et al. 2000; Wiersma LD, Sherman CP 2005) and greater availability of educational material such as books, professional journals, and informational packets. (Sossin K, et al. 1997; Wiersma LD, Sherman CP 2005)

Researchers have conducted several studies to determine the knowledge that athletes have about concussions in sports as a means for improving prevention plans by educational intervention. (Delaney JS, et al. 2002; Kaut K, et al. 2003; McCrea M, et al. 2004; Pettersen JA 2002) Some of these studies have examined athletes' knowledge of head injuries in the specific areas of determining self-reported histories of concussion, knowledge of concussion symptomatology, athletes' behaviors regarding reporting of head injuries, and knowledge of potential consequences of sustaining a concussion. One study of in-coming college athletes found that nearly 20% of the athletes experiencing

dizziness during play did not report their symptoms; and 30% of athletes surveyed reported continuing to play with a headache after receiving a blow to the head. (Kaut K, et al. 2003) In another study of university football and soccer athletes, 20% of soccer players and 23% of football players recognized having experienced a concussion during the season; however, 63% of soccer players and 70% of football players reported experiencing symptoms of a concussion. (Delaney JS, et al. 2002) In a study of high school football players, researchers found that athletes had a higher self-reported prevalence of concussion than has been found in prospective studies. (McCrea M, et al. 2004) When asked about their knowledge of potential effects following a blow to the head, less than half the athletes surveyed reported having any knowledge in this topic area. (Kaut K, et al. 2003) Similarly, when asked, Canadian rugby players were asked about their opinions of headgear use in the sport most stated that they believed headgear can prevent concussion, but most players do not wear headgear nor do they feel that headgear in rugby should be made mandatory. (Pettersen JA 2002) These studies are important as they give insight to athletes' thoughts, opinions, and behavioral patterns regarding concussions in sports. From the conclusions of these studies it becomes apparent that efforts need to be made in educating athletes about head injuries occurring in sports, especially in regards to recognizing the signs and symptoms of concussion as well as the potential effects of not reporting a head injury and continuing to play. Additionally, education should also include the benefits of using properly fitting protective equipment.

Summary

Coaching certification has been and still remains a significant issue among high school and youth level sports. (Schweitzer C 1989; Brylinsky J 2002) While several national agencies have developed coaching education programs and standards, there is still much progress that needs to be made in developing a national certification standard for all high school and youth sports coaches. (NASPE 2006; Coach Education (NFHS); National Coaching Certification Program 1997) Educating coaches about prevention and management of injuries is a starting point; however, education should also stress the inherent risks of returning an injured athlete to participation without thorough evaluation. (Ransone J, Dunn-Bennett LR 1999) With this in mind, first aid and CPR certification should be a minimum requirement, but further education about specific health-related issues coaches may be exposed to would benefit both coaches and athletes. (Ransone J, Dunn-Bennett LR 1999; Parrott R, et al. 1999; Wiersma LD, Sherman CP 2005)

Concussion in sports is a fairly common occurrence, especially in high-risk sports such as football, ice hockey, and lacrosse with approximately 300,000 mild head injuries happening in sports annually. (Sosin DM, et al. 1996) Although no formal definition of concussion has been agreed upon by the medical community at large, several characteristics of concussion have been agreed upon and an extensive list of symptoms that may be experience following a head injury have been comprised by leaders in the field. (Aubry M, et al. 2001; McCrory P, et al. 2005)

In examining an athlete with a suspected head injury, a detailed history and a thorough clinical examination are essential. Additionally, further testing of the cranial nerves, cognitive functioning, balance performance, and self-reported symptoms of the

athlete all factor into the evaluation and management of concussed athletes. (Guskiewicz KM, et al. 2004; Oliaro S, et al. 2001) Over the past several years, standardized assessment tools have been developed to assist athletic trainers in accurately and efficiently managing concussions.

When treating a concussion, the key is to make sure the athlete has rest and is asymptomatic at both rest and with activity before allowing return to competition. (Aubry M, et al. 2001; McCrory P, et al. 2005) Recovery from a concussion generally follows a steady progression over the course of a week as the symptoms gradually resolve. Once an athlete is ready to return to activity, as stepwise progression into athletics is recommended, ensuring that the athlete is asymptomatic at all levels of return before resuming competition. (Aubry M, et al. 2001; McCrory P, et al. 2005)

While no specific tactics have been proved effective for the prevention of concussion, several methods of reducing the risk for concussion have been implemented. Properly fitting helmets in sports such as football and ice hockey, rule changes where a specific mechanism of injury is indicated and subsequent rule enforcement, and conditioning of neck muscles have all been suggested as a means for reducing concussion risks. (Aubry M, et al. 2001; Johnston KM, et al. 2001; McCrory P, et al. 2005) Additionally, educating those involved with the daily care of athletes is essential for improving the quality of care they receive by increasing the awareness of signs and symptoms and the severity of a concussion among coaches, parents, and athletes.

CHAPTER III

METHODOLOGY

This study's design included a demographic questionnaire to gather personal information from the coaches, the coaches' current certifications, and their coaching experiences. A multiple-choice assessment of the coaches' knowledge was mailed out to local high schools and distributed to coaches to evaluate their knowledge in the areas of recognition of concussion signs and symptoms, basic management of concussion, and prevention of concussions. The dependent variable was the coaches' knowledge of concussion as determined by the coaches' respective scores on the assessment. The independent variables that were examined were gathered from the demographic questionnaire.

Subject Characteristics

Subjects included 126 high school athletic coaches (81 males, 42 females) from the Hampton Roads area of Virginia, at both public (68) and private (58) high schools. Three coaches did not indicate sex. The coaches (age 38.78±11.519, 12.67±10.141 years experience) participating in this study coached one or more of the following sports: baseball (9), basketball (18), cheerleading (5), crew (1), cross country (7), field hockey (8), football (16), golf (4), gymnastics (2), lacrosse (3), soccer (10), softball (5), swimming (10), tennis (4), track and field (7), volleyball (13), or wrestling (3). The researcher collected 126 out of 221 assessments distributed, with a return rate of 57%. Full completion and return of the survey instrument was considered the subject's consent to participate in the study. The college Human Investigation Committee approved this study prior to collection of data.

Instrumentation

Since the research team was not aware of any pre-existing instrument designed to assess the knowledge high school coaches have of sport-related concussion, a two-part survey instrument, consisting of a demographic questionnaire and a multiple-choice assessment was created by the researchers that included numerous questions developed from the review of literature was used for data collection. The multiple-choice assessment was a twenty-four question assessment; each section contained eight questions, to assess high school athletic coaches' base knowledge about the recognition of signs and symptoms, injury management, and prevention of concussion. Data were scored based upon a possible score of twenty-four, one correct answer for each question, with a higher score indicating a coach's greater knowledge of sport-related concussion as determined by the Coaches' Knowledge of Concussion survey (CoKC).

A demographic questionnaire was used to gather specific information about the coaches, their respective sports, and their experience in dealing with concussions. The questionnaire consisted of twenty-five questions that include educational background, major field of study, age, gender, number of years coached, and sports coaching. Additional questions determined if the coach has had a previous concussion during their sports career, has had an athlete sustain a concussion without a certified athletic trainer present, discussed concussions with a certified athletic trainer, has received a brochure about concussion management, and has ever attended a workshop or informal session on concussion.

Testing Procedure

Validity and reliability were determined for the constructed instrument used in this study. A panel of eight experts in the fields of sport-related concussion and/or survey research, as identified from the NATA Position Statement on the management of sport-related concussion or other published literature pertaining to concussion and survey research, reviewed the instrument for content and face validity noting any flaws, misunderstandings, or problems before the final copy was mailed to schools.

The CoKC was pilot tested for reliability among eight athletic coaches in the Hampton Roads area of Virginia. The coaches were asked to complete the CoKC on two separate occasions. Coaches were given a copy of instructions for taking the survey and the survey instrument. After receiving the initial survey back from the coaches, with a minimum of a one-week interval, a second survey was given to the coaches to fill out a second time. Only the coaches that filled out the survey initially filled out the survey a second time, and only those coaches that completed the survey both times were included in the pilot study. Surveys were tracked with a code provided by the coaches consisting of the initials of their first and last names followed by their birth date (ex: JS021867). This code was used only for matching surveys for reliability testing purposes and not for reporting of individual data. ICC calculations and an item analysis were conducted in determining the reliability of the survey instrument.

A list of schools and contacts within the Hampton Roads area of the Commonwealth of Virginia, defined as the cities of Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, Suffolk, Virginia Beach, and Williamsburg, was generated from the Hampton Roads website and individual city websites. Approval from city

school boards was obtained to gain permission to conduct research in public schools within the sample population. The study was approved by the Chesapeake, Portsmouth, Virginia Beach, and Williamsburg/James City County school boards. A database of school contact information, including contact name, address, phone number, and email was generated from the Virginia High School League (VHSL) and Virginia Association of Independent Schools (VAIS) directories. Following approval, individual school athletic directors or athletic trainers were contacted about their schools' participation in the study. Once the school contact agreed to participate, a packet was sent to the athletic director, with a cover letter (Appendix A) explaining the purpose of the study as well as a script to be read to the coaches (Appendix B) along with copies of the CoKC to be given to coaches, which included the demographic questionnaire (Appendix C) and the knowledge assessment (Appendix D). Packets were sent to schools for data collection, which were then be distributed by the athletic director or athletic trainer to the athletic coaches.

The script that the athletic directors provided with the CoKC for the coaches' reference, and read to the coaches, explained to the athletic coaches that the completion of the assessment was voluntary and all participants were to remain anonymous. Full completion of the CoKC survey instrument (both the demographic questionnaire and the knowledge assessment) was considered as consent to participate in the study. After completion of the survey, coaches were instructed to return the completed survey back to the school contact who then returned the completed surveys to the research team. Additionally, the school contact recorded the total number of coaches at the school, the number of coaches the survey was given to, and the number of surveys returned on the

School Information Sheet (Appendix E). Follow up with school contact was conducted via an email at day 5 and at day 7 to confirm receipt of the packet and as a reminder to please have the coaches fill out the surveys. All data collected was kept confidential and results were reported only based on group findings. Only the research team viewed the results of the surveys and all collected data was kept in a locked cabinet.

Data Analysis

All statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS 12.0, SPSS, Inc., Chicago, IL). Descriptive statistics were analyzed using an *a priori* alpha level set at $\leq .05$ statistical significance. Grouped multiple analysis of variance (MANOVA) tests with homogeneity statistics were run to determine the effect of demographic data on section scores. These analyses were conducted together to reduce the introduction of type I error into the results. Additionally, grouped analysis of variance (ANOVA) tests with homogeneity statistics were completed to determine the effect of demographic data on total Coaches' Knowledge of Concussion (CoKC) scores. The total scores were not included in the MANOVA tests to avoid problems with collinearity in the data, due to the component scores of each section being integrated into the total score. Independent t-tests were used in place of MANOVA tests when the Levene's test for homogeneity of variance indicated that the analysis conducted violated the assumptions of the MANOVA. No adjustments were made to significance levels for t-tests due to the fact that each demographic section was a separate question to be answered independently of other analyses. A 2 x 2 x 3 MANOVA was conducted to compare effects of gender and school type on knowledge scores. Chi-squared analyses were used to identify associations between demographic information, and one subsequent

MANOVA was completed for gender with its correlates: sport type, and concussion discussion (2 x 2 x 2 x 3) to identify possible interactions and Tukey's post-hoc analysis was completed as necessary to identify main effects for coaching experience. A 2 x 2 x 3 MANOVA was also completed to determine the effect of higher education degree and health-related major on assessment scores. A 2 x 3 MANOVA was conducted to assess the effects of first aid and CPR certification on coaches' knowledge. Two 2 x 3 MANOVA's were conducted to assess the effect that review of informational brochure material and time spent reviewing the informational material had on assessment scores. A 4 x 2 x 2 x 3 MANOVA was used to determine effects of coaching experience (years coaching, type of sport coached, and coaching position) on coaches' knowledge scores with Tukey's post-hoc testing for years coaching. Three 2 x 3 MANOVA's were completed to assess the effects of discussion with an athletic trainer, concussion history, and workshop attendance separately. Item analysis was also conducted for closer analysis of group answers (Appendix G).

CHAPTER IV

RESULTS AND DISCUSSION

Results

Reliability

Test-retest values for each question in Table 1. A one-way random, Cronbach's alpha intraclass correlation model was used to determine reliability numbers. Additionally, an item analysis was run to specifically address specific questions that had low ICC values to more closely examine subject responses (Appendix F).

Survey Results

The mean score for the recognition section was 7.40±0.81 (92.5%) with a range between 4.00 and 8.00. The mean score for the management section was 6.33± 1.02 (79%) with a range between 4.00 and 8.00. The mean score for the prevention section was 6.53±1.34 (81%) with a range between 0.00 and 8.00. The mean overall CoKC score was 20.27±2.10 (84%) with a range between 12.00 and 24.00. Table 2 shows the mean scores for each of the three sections and the total assessment score. There was a significant main effect for gender on recognition knowledge ($t_{1,121} = -3.198$, $p < 0.01$) with male coaches scoring (7.593±0.628) significantly higher than female coaches (7.024± 0.975) (Table 3, Figure 1). We conducted a chi-square analysis on gender with other demographic variables to find associations to explain the possible gender differences found in our data. Chi-square analysis revealed significant associations with gender and coaching a high-risk sport ($p < 0.01$) and with gender and ATC discussion ($p = 0.019$); however, when a subsequent MANOVA was conducted with gender and its correlates no significant interactions were found.

Educational Background

There were no significant differences found between coaches that possess a higher education degree and those coaches that did not. There were no significant differences between coaches that had a health-related major and those that did not have a health-related degree. First aid and/or CPR certification had no significant impact on a coach's sport-related concussion knowledge as assessed by the CoKC. Neither review, nor the amount of time spent reviewing informational brochure material yielded significant differences in coaches' knowledge scores on the survey.

Coaching Experience

There were no significant differences ($p = .281$) in knowledge of concussion found for years of coaching experience, as assessed by the survey instrument. The type of sport coached, either high-risk or low-risk, was found to have no significant impact ($p = .480$) on the knowledge a coach possesses on sport-related concussion. There were no significant differences ($p = .203$) found to exist based upon a coaches position on the staff, whether it be as head or other (assistant, volunteer, etc).

Discussion with Athletic Trainer

All schools participating in this study had a certified athletic trainer on staff at the school for practice and game coverage. Although 49% of subjects had discussed concussions with their certified athletic trainer, no significant differences existed between those coaches who had discussed concussions with their certified athletic trainer and those who had not.

Personal History

There was a main effect for personal history of concussion on the recognition section score ($F_{1, 124} = 4.210$, $p = 0.042$) with those coaches who have a personal history of concussion scoring (7.615±0.673) significantly higher than those coaches who do not have a history of concussion (7.299±0.851) (Table 10, Figure 2). The effect size (0.44) for the change in recognition scores suggests that these findings are not only statistically significant, but also have moderate clinical significance.

Workshop Attendance

There was a main effect for workshop attendance on the management section ($F_{1,123} = 5.604$, $p = 0.019$). The effect size for management scores (0.57) indicates a moderate clinical significance for improving the knowledge of those coaches who attended a workshop on concussion (6.809± 0.873) when compared with those coaches who did not attend a workshop on concussion (6.240±1.029) (Table 11, Figure 3).

Table 1. ICC Reliability Values for CoKC Survey Instrument

Question	ICC value
Recognition 1	-
Recognition 2	-
Recognition 3	1.00
Recognition 4	-
Recognition 5	-
Recognition 6	-
Recognition 7	-
Recognition 8	-
Management 1	-.077
Management 2	-
Management 3	-
Management 4	-
Management 5	.741
Management 6	-
Management 7	-
Management 8	.632
Prevention 1	-
Prevention 2	1.00
Prevention 3	-.077
Prevention 4	.300
Prevention 5	-
Prevention 6	.741
Prevention 7	-
Prevention 8	.517

Table 2. Coaches' Knowledge of Concussion (CoKC) Mean Scores for All Subjects

n = 126	Mean	Standard Deviation
Recognition Section	7.397	0.811
Management Section	6.333	1.020
Prevention Section	6.532	1.343
Total CoKC Score	20.270	2.099

Table 3. Gender and School Type Effects on Mean Survey Scores

		Gender		School Type	
		Female n = 42	Male n = 81	Private n = 55	Public n = 68
Recognition Section	Mean	7.024	7.593	7.509	7.309
	SD	0.975	0.628	0.742	0.851
	F	-3.918^		1.323^	
	p	0.000*		0.188	
	Levene's *F*, *p*[a]	5.070, 0.002*			
	Effect Size	0.75		0.25	
Management Section	Mean	6.333	6.265	6.291	6.338
	SD	0.796	1.188	1.048	1.016
	F	0.515		0.020	
	p	0.474		0.887	
	Levene's *F*, *p*[a]	2.505, 0.062			
	Effect Size	0.15		0.05	
Prevention Section	Mean	6.667	6.469	6.800	6.323
	SD	1.243	1.397	1.145	1.460
	F	0.416		3.676	
	p	0.520		0.058	
	Levene's *F*, *p*[a]	0.599, 0.617			
	Effect Size	0.15		0.36	
Total CoKC Score	Mean	19.905	20.420	20.600	19.956
	SD	2.022	2.144	1.760	2.327
	F	2.011		3.099	
	p	0.159		0.081	
	Levene's *F*, *p*[a]	0.797, 0.498			
	Effect Size	0.25		0.31	

a. Levene's values reported in this table are for the MANOVA with significance indicating a violation of the ANOVA assumptions

^ indicates *t* value being reported rather than *F* value due to violation of ANOVA assumptions based on significant Levene's test

* indicates significance of $p \leq .05$

Table 4. Educational Background Effects on Mean Survey Scores

		Higher Education Degree		Health-related Major	
		No n = 66	Yes n = 59	No n = 94	Yes n = 31
Recognition Section	Mean	7.454	7.322	7.394	7.387
	SD	0.706	0.918	0.793	0.882
	F	2.936		0.016	
	p	0.089		0.900	
	Levene's *F*, *p*[a]	2.348, 0.076			
	Effect Size	0.16		0.01	
Management Section	Mean	6.394	6.271	6.287	6.484
	SD	0.909	1.142	1.022	1.029
	F	0.075		0.904	
	p	0.785		0.344	
	Levene's *F*, *p*[a]	2.348, 0.076			
	Effect Size	0.12		0.19	
Prevention Section	Mean	6.379	6.695	6.404	6.903
	SD	1.444	1.221	1.424	1.012
	F	0.000		3.287	
	p	0.990		0.072	
	Levene's *F*, *p*[a]	0.911, 0.438			
	Effect Size	0.24		0.38	
Total CoKC Score	Mean	20.212	20.322	20.074	20.839
	SD	2.152	2.071	2.131	1.951
	F	0.421		3.308	
	p	0.518		0.071	
	Levene's *F*, *p*[a]	1.031, 0.381			
	Effect Size	0.05		0.37	

a. Levene's values reported in this table are for the MANOVA with significance indicating a violation of the ANOVA assumptions

Table 5. First Aid and CPR Certification Effects on Mean Survey Scores

		First Aid/CPR Certification	
		No n = 58	Yes n = 67
Recognition Section	Mean	7.517	7.298
	SD	0.707	0.888
	F	2.272	
	p	0.134	
	Levene's *F*, *p*[a]	0.813, 0.369	
	Effect Size	0.27	
Management Section	Mean	6.379	6.298
	SD	0.952	1.087
	F	0.193	
	p	0.662	
	Levene's *F*, *p*[a]	1.092, 0.298	
	Effect Size	0.07	
Prevention Section	Mean	6.483	6.567
	SD	1.454	1.258
	F	0.121	
	p	0.728	
	Levene's *F*, *p*[a]	0.202, 0.654	
	Effect Size	0.06	
Total CoKC Score	Mean	20.362	20.194
	SD	2.222	2.017
	F	0.196	
	p	0.658	
	Levene's *F*, *p*[a]	0.204, 0.652	
	Effect Size	0.08	

a. Levene's values reported in this table are for the MANOVA with significance indicating a violation of the ANOVA assumptions

Table 6. Review of Informational Brochure Material Effects on Mean Survey Scores

		Review of Informational Brochure	
		No n = 97	Yes n = 29
Recognition Section	Mean	7.412	7.345
	SD	0.813	0.814
	F	0.154	
	p	0.695	
	Levene's *F*, *p*[a]	0.014, 0.906	
	Effect Size	0.08	
Management Section	Mean	6.299	6.448
	SD	0.991	1.121
	F	0.477	
	p	0.491	
	Levene's *F*, *p*[a]	0.868, 0.353	
	Effect Size	0.15	
Prevention Section	Mean	6.546	6.483
	SD	1.384	1.214
	F	0.050	
	p	0.824	
	Levene's *F*, *p*[a]	0.100, 0.752	
	Effect Size	0.05	
Total CoKC Score	Mean	20.278	20.241
	SD	2.159	1.921
	F	0.007	
	p	0.934	
	Levene's *F*, *p*[a]	0.602, 0.439	
	Effect Size	0.02	

a. Levene's values reported in this table are for the MANOVA with significance indicating a violation of the ANOVA assumptions

Table 7. Time Spent Reviewing Informational Brochure Material Effects on Mean Survey Scores

		Time Reviewing Informational Brochure	
		Less than 5 min. n = 16	More than 5 min. n = 14
Recognition Section	Mean	7.062	7.357
	SD	0.929	1.082
	F	0.645	
	p	0.429	
	Levene's *F*, *p*[a]	0.016, 0.899	
	Effect Size	0.30	
Management Section	Mean	6.125	6.500
	SD	1.147	1.092
	F	0.834	
	p	0.369	
	Levene's *F*, *p*[a]	0.010, 0.920	
	Effect Size	0.35	
Prevention Section	Mean	6.125	6.714
	SD	1.360	1.139
	F	1.628	
	p	0.213	
	Levene's *F*, *p*[a]	2.764, 0.108	
	Effect Size	0.48	
Total CoKC Score	Mean	19.312	20.500
	SD	2.022	2.066
	F	2.521	
	p	0.124	
	Levene's *F*, *p*[a]	0.057, 0.813	
	Effect Size	0.60	

a. Levene's values reported in this table are for the MANOVA with significance indicating a violation of the ANOVA assumptions

Table 8. Coaching Experience Effects on Mean Survey Scores

		Coaching experience				Sport type		Coaching position	
		0-5 Yr. n = 36	5-10 Yr. n = 30	10-17 Yr. n = 29	17+ Yr. n = 30	Low-risk n = 76	High-risk n = 49	Head n = 103	Other n = 22
Recognition Section	Mean	7.333	7.433	7.379	7.467	7.368	7.449	7.447	7.182
	SD	0.956	0.626	0.775	0.860	0.877	0.709	0.813	0.795
	F	1.104				0.489		0.050	
	p	0.351				0.486		0.823	
	Levene's *F*, *p*[a]	1.162, 0.312							
	Effect Size	0.12, 0.05, 0.15				0.10		0.33	
Management Section	Mean	6.083	6.233	6.759	6.300	6.306	6.342	6.340	6.273
	SD	0.996	1.104	0.912	0.988	1.065	1.001	1.005	1.120
	F	1.213				0.501		0.344	
	p	0.309				0.480		0.559	
	Levene's *F*, *p*[a]	0.842, 0.629							
	Effect Size	0.15, 0.66, 0.22				0.04		0.07	
Prevention Section	Mean	6.417	6.267	6.828	6.633	6.449	6.579	6.650	5.954
	SD	1.296	1.818	1.071	1.066	1.542	1.214	1.304	1.430
	F	1.094				0.263		1.806	
	p	0.263				0.609		0.182	
	Levene's *F*, *p*[a]	1.604, 0.084							
	Effect Size	0.10, 0.35, 0.18				0.10		0.53	
Total CoKC Score	Mean	19.833	19.900	20.965	20.467	20.245	20.276	20.447	19.409
	SD	2.104	2.383	1.842	1.943	2.269	2.011	2.047	2.218
	F	1.293				0.121		1.638	
	p	0.281				0.729		0.203	
	Levene's *F*, *p*[a]	0.855, 0.616							
	Effect Size	0.03, 0.58, 0.32				0.01		0.50	

a. Levene's values reported in this table are for the MANOVA with significance indicating a violation of the ANOVA assumptions

Table 9. ATC Discussion Effects on Mean Survey Scores

		ATC Discussion	
		No n = 64	Yes n = 62
Recognition Section	Mean	7.344	7.452
	SD	0.0.858	0.761
	F	0.555	
	p	0.458	
	Levene's *F*, *p*[a]	0.559, 0.456	
	Effect Size	0.13	
Management Section	Mean	6.437	6.226
	SD	1.006	1.031
	F	1.361	
	p	0.246	
	Levene's *F*, *p*[a]	0.108, 0.743	
	Effect Size	0.21	
Prevention Section	Mean	6.656	6.403
	SD	1.224	1.454
	F	1.119	
	p	0.292	
	Levene's *F*, *p*[a]	0.114, 0.737	
	Effect Size	0.19	
Total CoKC Score	Mean	20.469	20.064
	SD	2.047	2.149
	F	1.169	
	p	0.282	
	Levene's *F*, *p*[a]	0.402, 0.527	
	Effect Size	0.19	

a. Levene's values reported in this table are for the MANOVA with significance indicating a violation of the ANOVA assumptions

Table 10. Concussion History Effects on Mean Survey Scores

		Concussion History	
		No n = 87	Yes n = 39
Recognition Section	Mean	7.299	7.615
	SD	0.851	0.673
	F	4.210	
	p	0.042*	
	Levene's *F*, *p*[a]	3.235, 0.075	
	Effect Size	0.44	
Management Section	Mean	6.345	6.308
	SD	0.986	1.104
	F	0.035	
	p	0.851	
	Levene's *F*, *p*[a]	1.943, 0.166	
	Effect Size	0.04	
Prevention Section	Mean	6.506	6.590
	SD	1.265	1.157
	F	0.105	
	p	0.747	
	Levene's *F*, *p*[a]	0.000, 0.991	
	Effect Size	0.06	
Total CoKC Score	Mean	20.161	20.513
	SD	2.129	2.037
	F	0.755	
	p	0.386	
	Levene's *F*, *p*[a]	0.377, 0.540	
	Effect Size	0.17	

a. Levene's values reported in this table are for the MANOVA with significance indicating a violation of the ANOVA assumptions

* indicates significance at $p \leq .05$

Table 11. Workshop Attendance Effects on Mean Survey Scores

		Workshop Attendance	
		No n = 104	Yes n = 21
Recognition Section	Mean	7.365	7.571
	SD	0.776	0.978
	F	1.123	
	p	0.291	
	Levene's *F*, *p*[a]	.003, .958	
	Effect Size	0.25	
Management Section	Mean	6.240	6.809
	SD	1.029	0.873
	F	5.604	
	p	0.019*	
	Levene's *F*, *p*[a]	2.362, 0.127	
	Effect Size	0.57	
Prevention Section	Mean	6.510	6.619
	SD	1.379	1.203
	F	0.114	
	p	0.736	
	Levene's *F*, *p*[a]	0.402, 0.527	
	Effect Size	0.08	
Total CoKC Score	Mean	20.135	20.952
	SD	2.090	2.109
	F	2.666	
	p	0.105	
	Levene's *F*, *p*[a]	0.007, 0.935	
	Effect Size	0.39	

a. Levene's values reported in this table are for the MANOVA with significance indicating a violation of the ANOVA assumptions

* indicates significance of $p \leq .05$

Figure 1.

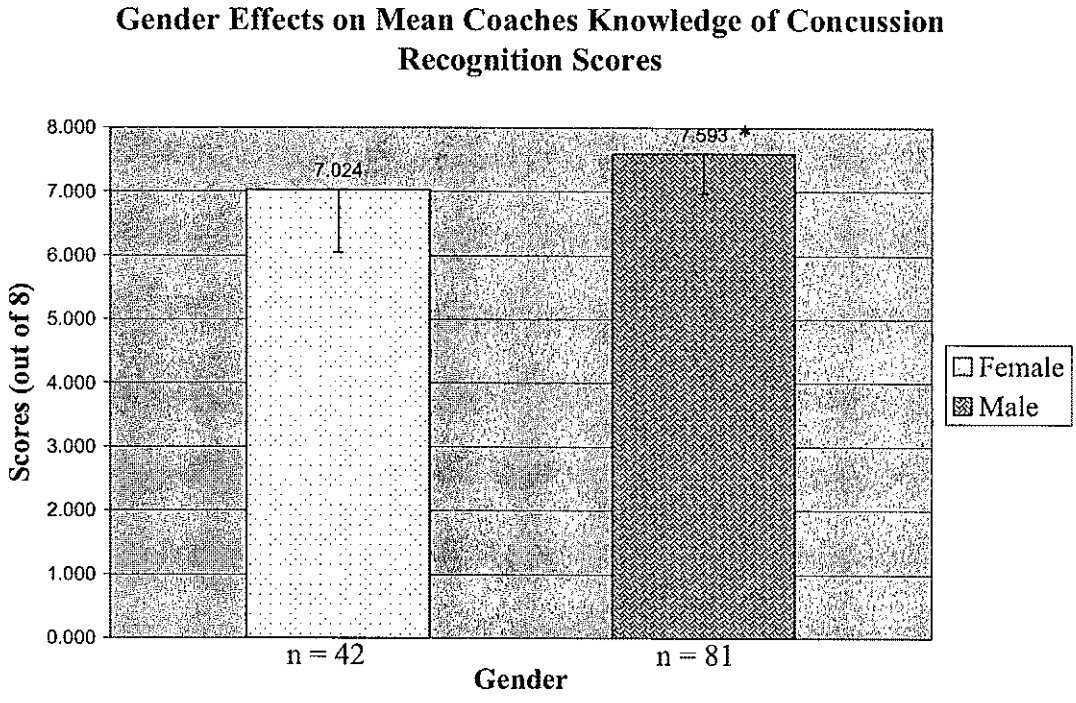

Gender Effects on Mean Coaches Knowledge of Concussion Recognition Scores
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
Scores (out of 8)
7.024
7.593
n = 42
n = 81
Gender
Female
Male

Figure 2.

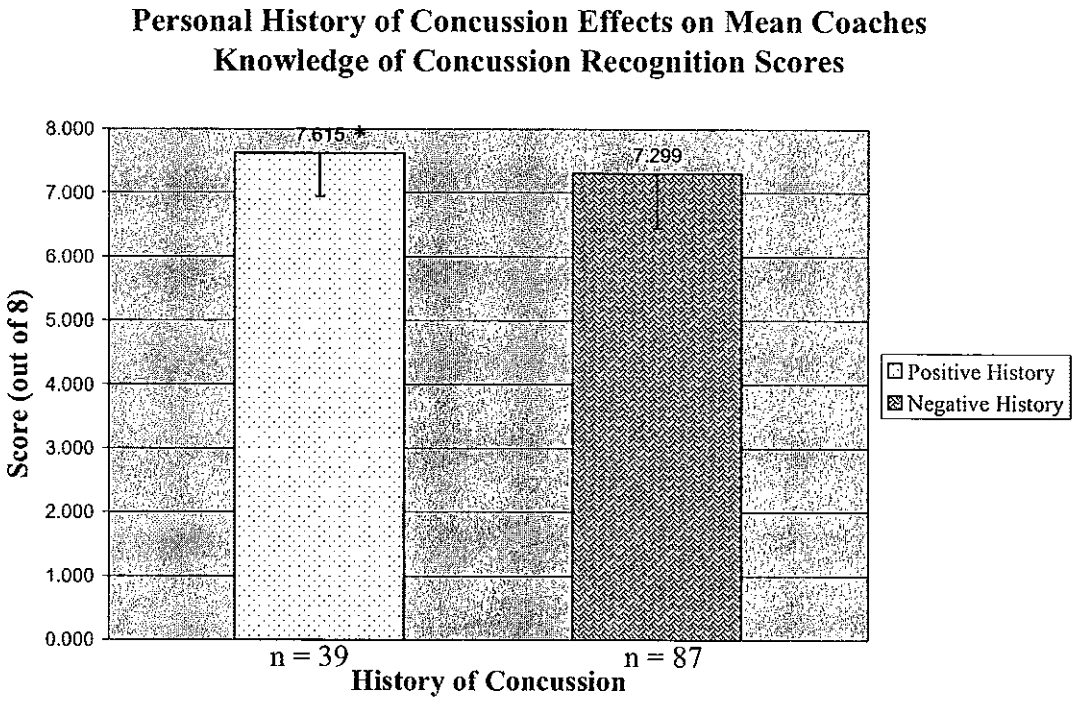
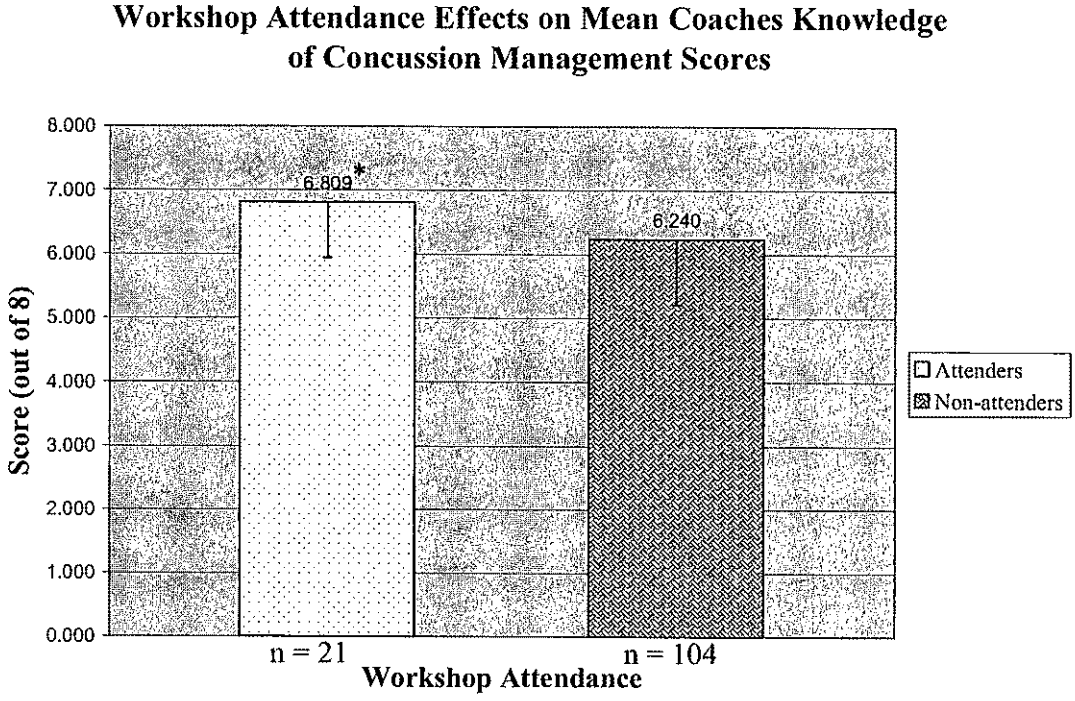

Personal History of Concussion Effects on Mean Coaches Knowledge of Concussion Recognition Scores
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
Score (out of 8)
7.615*
7.299
n = 39
n = 87
History of Concussion
Positive History
Negative History

Figure 3.


Workshop Attendance Effects on Mean Coaches Knowledge of Concussion Management Scores
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
Score (out of 8)
6.809
*
6.240
Attenders
Non-attenders
n = 21
n = 104
Workshop Attendance

Discussion

Reliability

While there were a few low ICC values for certain questions in the survey instrument, management question 1, prevention question 3, and prevention question 4, there a few reasons that this could be explained. The first possible explanation for these low values is that there was not enough power in the pilot study to counter-balance the effects of some small variance in the responses of the coaches. The second possible explanation for the observed low ICC values is that those particular questions were awkwardly worded or phrased in such a manner that the coaches did not fully understand what the question was asking.

Survey Results

Coaches' knowledge scores of sport-related concussion as assessed by the survey instrument used in this study ranged from 79% on the management section to 92.5% on the recognition section, indicating a moderate to high level of knowledge. The coaches' knowledge of concussion we found was fairly high, perhaps indicating that the assessment tool was too easy and more difficult questions should be asked, or that preliminary methods to educate coaches about sport-related concussion have been successful. The mean total score of 20.27 on this assessment (84%) seemed unusually high when compared with previous studies assessing the knowledge of head injuries. (Amadeus R, et al. 2001; Bazarian JJ, et al. 2001; Kaut K, et al. 2003; McCrea M, et al. 2004; Sye G, et al. 2006) In an investigation of family practice physicians, Amadeus et al. (2001) found that over half of the 352 physicians in the study scored less than 70% on the general knowledge portion of the head injury survey instrument used in the study; and

that more than 60% of the physicians were using improper assessment techniques and management protocols. Similarly, in a study assessing the knowledge that physicians caring for children have of the Colorado Medical Society Guidelines, a gross lack of understanding for the latest version of the guidelines was observed: only 7.6% correctly identifying a Grade 1 concussion, 56% correctly identifying a Grade 2 concussion, and 28% correctly identifying a Grade 3 concussion. (Bazarian JJ, et al. 2001) In two studies evaluating athletes' knowledge of concussion signs and symptoms and reporting behaviors, researchers found that athletes demonstrated an alarming trend to continue playing through concussion-like symptoms (28.2% with dizziness, 30.4% with headache) following a blow to the head during competition. (Kaut K, et al. 2003; McCrea M, et al. 2004) Athletes cited lack of understanding their condition (36.1%) and failure to appreciate the seriousness of the condition they were experiencing (66.4%) as two main reasons for not reporting their symptoms. (McCrea M, et al. 2004) In a recent study of high school rugby players' knowledge about concussion and return to play guidelines (Sye G, Sullivan SJ, McCrory P, 2006) only half of the athletes in the study were aware of concussion guidelines; however, 60% were able to identify correctly the mandated period of time a player must abstain from competition following a concussion as part of the leagues' rules. Only 66 out of 296 athletes suspecting having had a concussion returned to play after gaining medical clearance. The fact that more than 50% of respondents stated that they got their information about concussions from teachers/coaches only serves the highlight the importance for coaches to be educated about sport-related concussion. (Sye G, et al. 2006)

The observed lower scores and wider ranges for the management and prevention sections could be attributed to low ICC values for particular questions within these sections, specifically management question 1 (-.077), prevention question 3 (-.077), and prevention question 4 (.300). Another explanation for lower scores on the management and prevention sections is that educational efforts to raise awareness about sport-related concussion have focused primarily on recognition of signs and symptoms. (Kaut K, et al. 2003; McCrea M, et al. 2004)

Gender differences were found to be related to coaching a high-risk sport and having discussed concussions with a certified athletic trainer. Therefore, because male coaches are more likely to coach a high-risk sport, they are more likely to have an athlete experience a sport-related concussion prompting them to talk to their athletic trainer about concussions, thereby explaining the gender differences observed in our results. While our results found significant gender differences for recognition of concussion signs and symptoms, Kaut et al. (2003) found no gender differences in assessing head injury and symptom knowledge of college athletes.

Educational Background

Our finding that specific markers of a coach's educational background, such as possessing a higher education degree, having a health-related major, and certification in first aid and/or CPR, were not found to have significant influence on a coach's knowledge of sport-related concussion is commensurate with other published literature investigating coaches' knowledge of other health-related issues facing athletic coaches. (Langford Bedgood B, Tuck MB 1983; Ransone J, Dunn-Bennett LR 1999; Cooney M, et al. 2000; Wiersma LD, Sherman CP 2005) In our study, 46.8% of coaches had a higher

education degree and 24.6% held a health-related major with a mean score of 84%. Comparatively, in a study of high school coaches in Texas, 49% of participants held a Master's degree and 69% had a health-related major, yet coaches scored a mean of 55.12, which was below the determined average value of 70 for the purpose of the study. (Langford Bedgood B, Tuck MB 1983) Additionally, 25% of the coaches in the study by Langford Bedgood and Tuck (1983) reported having no formal education in nutrition, though 86% of them dispense nutritional information to athletes on a monthly basis. The lack of formal training in health-related topics was also found among volunteer youth sport coaches in a study conducted by Wiersma and Sherman (2005). Ransone and Dunn-Bennett (1999) specifically assessed high school coaches' retention of first aid knowledge. Of the 104 coaches in the study, 92% were certified in first aid; however, only 36% passed the first aid re-test given by the researchers by the required 80%. These findings suggest that while coaches may learn the material required to pass the certification test as required by law where they live to maintain coaching credentials, the information is not made a permanent part of the coaches injury care knowledge. In a study of Irish rugby coaches, Cooney et al. (2000) found that among the coaches in their study, 50% of them currently held first aid certification, and while these coaches were found to improve the recognition of serious neck injury symptoms – 1.6 for uncertified coaches compared to 1.9 for certified coaches – the improvement was minimal. Additionally, only 19% of the coaches in the study stated that they would immobilize an athlete with a suspected serious neck injury, indicating that first aid knowledge is not adequate for educating coaches on the proper procedures for care of neck-injured athletes. These studies along with our research suggest the need to further investigate the

potential benefits of formal, recurrent training beyond basic first aid in the care and prevention of athletic injuries to keep information fresh and at the forefront of coaches' minds in the event that an injury does occur. It should be noted that for the purposes of this study, the researchers did not inquire the depth or specific types of first aid and CPR certifications that the coaches in the study had, simply whether or not they were certified. This could make a difference as some sports first aid courses do contain a component on head injury, while lay responder first aid certification does not.

While our study did not find a significant effect following a coach's receipt and review of an informational brochure on sport-related concussion on the coach's knowledge of sport-related concussion, it could be due to the fact that informational brochure material was not widely distributed among coaches in our population sample (only 24% of the coaches in this study had received any material). Additionally, the research team did not assess the depth of knowledge covered in the material or how long ago the coaches had received the material, which could both influence the results of our study. Other educational interventions have been developed for athletes' knowledge of sport-related concussion and those studies have found significant improvements in awareness about symptoms and causes of concussion. (Goodman D, Bradley NL, Paras B, Williamson IJ, Bizzochi J 2006; Cook DJ, Cusimano MD, Tator CH, Chipman ML 2003) In a study investing the effects of the Smart Hockey video created by the ThinkFirst Foundation of Canada, Cook et al. (2003) found that youth hockey players in the intervention group increased the number of causes and mechanisms of concussion they could identify (1.13 to 2.47 and .67 to 1.22) following viewing the video as well as an observed decrease in the number of body checking penalties as compared to the

control group. Furthermore, players retained the knowledge that they gained from watching the video at a three month post-test. Similarly, in a study testing the efficacy of the Symptom Shock video game, researchers found that youth hockey players that played the experimental version of the video game improved their knowledge of concussion symptoms while concomitantly decreasing the amount of time it took them to recognize the symptoms of concussion when compared to those playing the control version of the video game. (Goodman D, et al. 2006)

Coaching Experience

In our study, we found that an individual's previous coaching experience as measured by years coaching broken into quartiles, sport-type (either high-risk or low-risk), and coaching position was not found to have a significant impact on knowledge of sport-related concussion. The literature suggests that coaches' knowledge primarily comes from field experience, and that due to the many duties that coaches are expected to fulfill, a conflict of interest may arise between the coach's desire for the team to win and the coach's duty to provide first aid care to injured athletes. (Ransone J, Dunn-Bennett LR 1999; Wiersma LD, Sherman CP 2005; Sage GH 1989) Sage (1989) noted that the primary means of professional socialization for the coaching profession for novice coaches was coaching youth sports and student teaching with a coaching aspect. Additionally, the majority of knowledge about the coaching profession came from direct observation of previous coaches of teams that new coaches had played on before. The lack of professional socialization for coaches was also a key point in a study conducted by Wiersma and Sherman (2005) looking at the perspectives that volunteer youth sport coaches had on coaching education and certification. The coaches in this study noted that

they felt like they were on their own when it came to planning practices and coming up with drills and expressed a need for more formal modes of training as well as offering a mentorship program for novice coaches. Coaches also expressed the desire for training that was age or level specific to better understand the differences in developmental levels of the players they were responsible for coaching. (Wiersma LD, Sherman CP 2005) It appears that coaches are recognizing the lack of formal education in a variety of matters pertaining to the duties they are expected to fulfill; and in addition, would take advantage of more and better modes of training and certification if made available to them. Ransone and Dunn-Bennett (1999) found that a conflict of interest might arise in coaches as they are split between the dual role of effectively coaching the team and acting as a first aider. This study found that the coaches who passed the First-Aid Assessment generally returned injured athletes to the game whereas those coaches who did not pass the First-Aid Assessment tended to keep injured athletes out of the game, as assessed by the Game Situation Data Sheet. (Ransone J, Dunn-Bennett LR 1999) These findings highlight two important areas of coaching education: the need to educate coaches on the risks of returning injured athletes to competition and addressing coaches' lack of confidence in injury management skills. It could also be said from these studies that a little bit of knowledge could prove dangerous in untrained hands. (Turk JC et al. 1999)

Discussion with Athletic Trainer

Our assessment of high school coaches' knowledge of sport-related concussion found no significant differences between coaches who had discussed concussions with their athletic trainer and those coaches who had not discussed concussions with their athletic trainer. In a similar study assessing the knowledge that high school coaches have

about exercise-induced asthma, researchers also found that discussing EIA with an athletic trainer had no significant impact on coaches' knowledge of the condition being studied. (Wilson S, Van Lunen BL, Ridinger L, Dowling EA 2005) Furthermore, in a study that compared the perceptions that high school basketball coaches have regarding the role of the high school athletic trainer with the perceptions that high school athletic trainers have of their job, researchers found that there were significant discrepancies between what coaches perceived the role of the athletic trainer to be and the duties athletic trainers felt their job included. (Mensch J, Crews C, Mitchell M 2005) The study concluded that high school coaches do not completely understand the role of the athletic trainer and the wealth of knowledge that they possess, and thus athletic trainers remain an untapped resource for coaches in the secondary school setting. Perhaps if coaches fully understood the contributions athletic trainers could make to their athletic programs, athletic trainers' skills would become better utilized and coaches' knowledge of certain high-risk conditions would improve.

Personal History

Our research found that those coaches who had a personal history of concussion scored significantly higher on the recognition section of the assessment than coaches who did not have a personal history of concussion. Perhaps the reasoning for these findings is that once a coach has had a concussion and experienced the symptoms of a concussion, they are then better able to identify a concussion when they see the signs athletes may experience. Mackenzie and McMillan (2005) found that of participants in the study that had a history of mild traumatic brain injury (MTBI) and self-reported a greater number and higher severity of symptoms, tended to check more symptoms on the post-concussion

syndrome checklist (PCSC) than those who did not self-report as many or as severe symptoms on the PCSC. These results provide evidence for the postulated theory that personal history of concussion increases an individual's knowledge of symptoms, as coaches with a previous history of concussion may be more cautious when suspecting an athlete with a concussion.

Workshop Attendance

Several research studies investigating the knowledge levels of various groups of people (lay people, coaches, athletes, physicians) have concluded that education is the key to improving knowledge retention, either through informational packets such as the CDC's Heads-Up material or actively participating in hands-on workshops. (Bazarian JJ, et al. 2001; Parrott R, et al. 1999; Sossin K, et al. 1997; Langford Bedgood B, Tuck MB 1983; Wiersma LD, Sherman CP 2005) Our study found that for the 16.7% of coaches in the study that had attended some type of workshop on concussion, they had significantly improved knowledge scores on both the recognition ($p = 0.017$) and management ($p = 0.016$) sections of the survey instrument. A pilot study in Georgia found that an educational workshop designed to increase soccer coaches' awareness of sun exposure risk was successful in increasing coaches' knowledge of proper sunscreen application procedures. In addition, researchers found that educated coaches and parents alike were more likely to share their knowledge from the training and coaches in the education group felt that players were more receptive to information about sun exposure risk. (Parrott R, et al. 1999) Bazarian et al. (2001) noted that the dissemination of information through active means, such as a workshop, tended to have better outcomes than passive methods, such as mailing out educational material, for improving knowledge and

awareness of a particular topic. Volunteer coaches in the study done by Wiersma and Sherman (2005) commented that a hands-on workshop spread out over the course of a few days or throughout the season would be more beneficial than a one-time lecture prior to the start of the season. Similarly, when coaches were assessed about their nutritional beliefs, attitudes, and sources of information in two different studies, the need for better modes of education was apparent and many suggested the use of educational training or informational packets to educate coaches, parents, and athletes. (Bedgood and Tuck 1983; Sossin K, et al. 1997) Despite low numbers of coaches who had actually attended a workshop on concussion (16.7%) in this study, a vast majority of coaches (76.2%) expressed the desire to attend a workshop on concussion were one made available for them.

The results of this study shed light on the fact that while coaches may have an acceptable understanding of how to recognize a concussion, greater education efforts need to be placed on informing coaches of basic management skills and methods of preventing sport-related concussion. While the published literature indicates that individuals from various populations (physicians, lay people, individuals with previous concussion history, athletes) all have poor knowledge of concussion, whether it be recognition, management, or prevention, some study results, including the results of this study, indicate that basic educational intervention methods are effective in increasing knowledge of sport-related concussion. (Amadeus R, et al. 2001; Bazarian JJ, et al. 2001; Mackenzie JA, McMillan TM 2005; Kaut K, et al. 2003; McCrea M, et al. 2004; Goodman D, et al. 2006; Cook DJ, et al. 2003) Those coaches who have made the effort to educate themselves, through either informational brochure-type material or by

attending a workshop on concussion have benefited from these interventions with increased knowledge on sport-related concussion, and educational efforts should continue to be made to better educate a larger number of coaches on this matter. Coaches need to have a basic understanding of sport-related concussion since it is something that every coach could potentially have to deal with. While all of the coaches in our study had an athletic trainer present at their school during practices and games, 16% of the coaches reported having an athlete suffer a concussion when no athletic trainer was present and the knowledge of how to recognize and manage this condition acutely is of utmost importance.

Limitations

Certain limitations existed within this study that may have affected the results The research team used a contact person at each school, either the athletic director or the athletic trainer, to distribute the survey instruments rather than visiting each school to personally administer the survey. In the absence of the research team, coaches participating in the study may not have given their full attention to the survey, rushing through instead of taking the time to understand fully what each question was asking. The research team conducted regular follow-up contact emails with each of the school contacts on day 5 and day 7 once the coaches' packet had been sent to the school to verify receipt of the packet and as a reminder to have the coaches fill out the surveys. Another limitation of the study was that certain questions had low ICC values, which may interfere with the value of the responses coaches gave to those questions. These low values, however, could possibly be explained by the low number of coaches (8) in the pilot study, indicating that there was not enough power in the pilot study to address the

variability in the questions. Another possibility for low ICC values could be that these specific questions were poorly worded and coaches did not fully understand what the questions were asking. Coaches may not have truly understood what the question was asking or the question was worded in a manor that made answering the question difficult. Some coaches did not answer every question or selected multiple responses to questions, resulting in some demographic data missing; for those questions in the survey that coaches skipped or had marked multiple responses, the question was marked as being incorrect. Another limitation of the study could be that the questions asked in the survey were too easy resulting in the higher scores when compared with published literature; however, the survey instrument was reviewed by a panel of experts in the fields of survey research and sport-related concussion for content and face validity to ensure the quality of material covered by the questions asked in the survey instrument. Due to the limitations of this study and the relatively small sample included in the research, it is important to remember that our results should be interpreted cautiously.

CHAPTER V

CONCLUSIONS

The purpose of this study was to assess high school athletic coaches' knowledge of concussion signs and symptoms in regards to recognition, management, and prevention of the injury. Given the information gathered in this study, there is a need for educating coaches in all areas of sport-related concussion with particular emphasis placed on prevention and basic early management of sport-related concussion. This is valuable information to certified athletic trainers, high school coaches, and administrators, as sport-related concussion is a common occurrence in high-risk sports and can occur during participation in any sport. Certified athletic trainers are an excellent source of knowledge regarding sport-related concussion and coaches would benefit from taking advantage of the often-untapped resource. Coaches may benefit from an informational session on sport-related concussion as many of the coaches in this study indicated an interest in attending a workshop conducted to educate coaches about the issue. While there is nothing we can do to prevent all concussions from occurring in sports participation, there are certain things that coaches can do to minimize their athletes' risks and being educated about sport-related concussion is one of them. By being educated about the basic early management of sport-related concussion, coaches could possibly prevent the sequelae of mismanaging the initial stages of a concussion, thus preventing long-term catastrophic damage, such as post-concussion syndrome or second-impact syndrome, in athletes with mild traumatic brain injuries. Coaches should be able to recognize and perform basic management skills for a sport-related concussion in the event that an athlete suffers a

concussion in the absence of an athletic trainer, which can happen even if the school coaches are working at has an athletic trainer on staff.

This study helps to provide more information about knowledge individuals possess about sport-related concussion as research is sparse in this area. This study also serves to raise the awareness among coaches about the need for sport-related concussion education and to bring attention to school administrators about the need for coaches to be educated about sport-related concussion on all levels. Athletic trainers can serve as an important contact point in educating coaches through their personal knowledge of concussion and/or leading educational intervention efforts for the coaching staff. Further research should investigate the retention of knowledge gained from an informational session or workshop given on sport-related concussion. Additionally, future studies should be conducted to evaluate the effectiveness comparing active means of disseminating information with passive means of disseminating information (i.e. comparing workshop interventions to interventions using mailed informational packets) to coaches as well as comparing the effectiveness of various different educational intervention programs. Other future studies could be conducted to assess the knowledge that other sample populations have on sport-related concussion, such as parents, youth sport coaches, physical education teacher, and school administrators.

REFERENCES

Alexander, M. Mild traumatic brain injury: Pathophysiology, natural history, and clinical management. *Neurology.* 1995;45(7):1253-1260.

Allemand M. VHSL first-ever state high school association to receive NCACE accreditation for coaching education program. *American Sport Education Program.* 11 Jan 2006. Available at: <http://www.asep.com/news/ShowArticle.cfm?ID=75>. Accessed: 2 Mar 2007.

Amadeus R, Mason G, Monaco R, Ivins D, Brooks J. Sports-related Head Injury: Family practice physician survey. (Abstract) *Clin J Sport Med.* 2001;11(4):292.

American Sport Education Program. *Illinois High School Association.* Available at: <http://www.ihsa.org/nficep/index.htm>. Accessed: 1 Mar 2007.

APG Youth Sports 10 Most Asked Questions. *Aberdeen Proving Ground Morale, Welfare & Recreation.* Available at: <http://www.apgnwr.com/family/ys_faq.html>. Accessed: 2 Mar 2007.

ASEP Marketing. Babe Ruth League and Ripken Baseball online coaching certification courses now available. *American Sport Education Program.* 18 Jan 2007. Available at: <http://www.asep.com/news/ShowArticle.cfm?ID=100>. Accessed: 4 Mar 2007.

Athletic Coaching Certificate 7-12. *Arizona Dept. of Education – Certification Unit.* Available at: <http://www.ade.az.gov/certification>. Accessed: 1 Mar 2007.

Aubrey JB, Dobbs AR, Rule BG. Laypersons' knowledge about the sequelae of minor head injury and whiplash. *J Neurol, Neurosurg, and Psychiatry.* 1989;52(7):842-846.

Aubry M, Cantu R, Dvorak J, Graf-Baumann T, Johnston K, Kelly J, Lovell M, McCrory P, Meeuwisse W, Schamasch P. Summary and agreement statement of the first International Conference on Concussion in Sport, Vienna 2001. *Br J Sports Med.* 2002;36:6-10.

Babe Ruth League Coaching Education Center FAQ. *Babe Ruth League.* Available at: <http://www.ripkencoaching.org/faq/cfm>. Accessed: 1 Mar 2007.

Bailes JE, Hudson V. Classification of sport-related head trauma: A spectrum of mild to severe injury. *J Athl Train.* 2001;36(3):236-243.

Barrington Youth Football. *American Sport Education Program.* Available at: <http://www.asep.com/asep_content/org/BYF.cfm?associate=4134>. Accessed: 2 Mar 2007.

Barth JT, Freeman JR, Broshek DK, Varney RN. Acceleration-deceleration sport-related concussion: The gravity of it all. *J Athl Train.* 2001;36(3):253-6.

Bazarian JJ, Veenema T, Brayer AF, Lee E. Knowledge of concussion guidelines among practitioners caring for children. *Clin Pediatr.* 2001;40:207-212.

Bergsneider M, Hovda DA, Lee SM, Kelly DF, McArthur DL, Vespa PM, Lee JH, Huang S-C, Martin NA, Phelps ME, Becker DP. Dissociation of cerebral glucose metabolism and level of consciousness during the period of metabolic depression following human traumatic brain injury. *J Neurotrauma.* 2000;17(5):389-401.

Broglio SP, Tomporowski PD, Ferrara MS. Balance performance with a cognitive task: A dual-task testing paradigm. *Med Sci Sports Exerc.* 2005;37(4):689-695.

Brylinsky J. *National Standards for Athletic Coaches.* Washington DC: ERIC Clearinghouse on Teaching and Teacher Education; 2002. ERIC Document Reproduction Service ED477725.

Bureau of Labor Statistics, US Dept. of Labor. Athletes, coaches, umpires, and related workers. *Occupational Outlook Handbook.* 4 Aug 2006. Available at: <http://www.bls.gov/oco/ocos251.htm>. Accessed: 1 Mar 2007.

Cantu RC. Posttraumatic retrograde and anterograde amnesia: Pathophysiology and implications in grading and safe return to play. *J Athl Train.* 2001;36(3):244-8.

Certification and Licensing for Soccer Coaches. *Coach's Manual.* 1998. Available at: <http://www.ncs.mun.ca/~dgraham/manual/Pages/Resources/cert.html>. Accessed: 1 Mar 2007.

Chen J-K, Johnston KM, Frey S, Petrides M, Worsley K, Ptito A. Functional abnormalities in symptomatic concussed athletes: An fMRI study. *NeuroImage.* 2004;22:68-82.

Clark MA. Who's coaching the coaches? In: Gerdy, JR, ed. *Sports in school: The future of an institution.* New York: Teachers College, Columbia University; 2000:55-65.

Coach Education. *National Federation of State High School Associations.* Available at: <http://www.nfhs.org/web/2006/08/nfhs_coach_education_program.aspx>. Accessed: 1 Mar 2007.

Coaching Education Recommended Guidelines. *USA Hockey.* 2007. Available at: <http://edit.usahockey.com/usa_hockey/coaches/main/usa_hockey/coaching_education391/>. Accessed: 1 Mar 2007.

Coaching Requirements. *Lumberton Township, New Jersey*. Available at: <http://www.lumbertontwp.com/recreation/coaching.html>. Accessed: 2 Mar 2007.

Collins MW, Field M, Lovell MR, Iverson G, Johnston KM, Maroon J, Fu FH. Relationship between postconcussion headache and neuropsychological test performance in high school athletes. *Am J Sports Med.* 2003a;31(2):168-173.

Collins MW, Iverson GL, Lovell MR, McKeag DB, Norwig J, Maroon J. On-field predictors of neuropsychological and symptom deficit following sports-related concussion. *Clin J Sport Med.* 2003b;13:222-229.

Collins MW, Lovell MR, Iverson GL, Cantu RC, Maroon JC, Field M. Cumulative effects of concussion in high school athletes. *Neurosurgery*. 2002;51(5):1175-1181.

Collins MW, Lovell MR, Mckeag DB. Current issues in managing sports-related concussion. *JAMA*. 1999;282(24):2283-2285.

Congress of Neurological Surgeons. Committee on head injury nomenclature: Glossary of head injury. *Clin Neurosurg*. 1966;12:386-394.

Cook DJ, Cusimano MD, Tator CH, Chipman ML. Evaluation of the ThinkFirst Canada, *Smart Hockey*, brain and spinal cord injury prevention video. *Injury Prevention*. 2003;9:361-6.

Cooney M, Coleman F, Flynn A. A study of the knowledge that school rugby coaches have in the management and prevention of serious neck injury. *Ir Med J.* 2000;93(6):171-4.

Delaney JS, Lacroix VJ, Leclerc S, Johnston KM. Concussions among university football and soccer players. *Clin J Sport Med.* 2002;12:331-8.

Education Requirement ; New Coaches. *USA Swimming*. 2004. Available at: <http://www.usaswimming.org/USASWeb/DesktopDefault.aspx?TabId=61&Alias=Rainbow&Lang=en>. Accessed: 1 Mar 2007.

Erlanger D, Saliba E, Barth J, Almquist J, Webright W, Freeman J. Monitoring resolution of postconcussion symptoms in athletes: Preliminary results of a web-based neuropsychological test protocol. *J Athl Train*. 2001;36(3):280-7.

Ferrara MS, McCrea M, Peterson CL, Guskiewicz KM. A survey of practice patterns in concussion assessment and management. *J Athl Train*. 2001;36(2):145-9.

Field M, Collins MW, Lovell MR, Maroon J. Does age play a role in the recovery from sports-related concussion? A comparison of high school and collegiate athletes. *J Pediatr*. 2003;142:546-553.

Giza CC, Hovda DA. The neurometabolic cascade of concussion. *J Athl Train.* 2001;36(3):228-235.

Goodman D, Bradley NL, Paras B, Williamson IJ, Bizzochi J. Video gaming promotes concussion knowledge acquisition in youth hockey players. *J Adolescence.* 2006;29:351-360.

Grindel SH. Epidemiology and pathophysiology of minor traumatic brain injury. Curr *Sports Med Rep.* 2003;2:18-23.

Guskiewicz KM, Bruce SL, Cantu RC, Ferrara MS, Kelly JP, McCrea M, Putukian M, Valovich McLeod TC. National Athletic Trainers' Association position statement: Management of sport-related concussion. *J Athl Train.* 2004;39(3):280-297.

Guskiewicz KM, McCrea M, Marshall SW, Cantu RC, Randolph C, Barr W, Onate JA, Kelly JP. Cumulative effects associated with recurrent concussion in collegiate football players: The NCAA concussion study. *JAMA.* 2003;290(19):2549-2555.

Guskiewicz KM, Ross SE, Marshall SW. Postural stability and neuropsychological deficits after concussion in collegiate athletes. *J Athl Train.* 2001;36(3):263-273.

Guskiewicz KM, Weaver NL, Padua DA, Garrett WE. Epidemiology of concussion in collegiate and high school football players. Am J Sports Med. 2000; 26(5): 643-650.

Guskiewicz KM, Riemann BL, Perrin DH, Nashner LM. Alternative approaches to the assessment of mild head injury in athletes. *Med Sci Sports Exerc.* 1997;29(7) Supplement:213-221.

Henninger N, Dützmann S, Sicard KM, Kollmar R, Bardutzky J, Schwab S. Impaired spatial learning in a novel rat model of mild cerebral concussion injury. *Exp Neurol.* 2005;195:447-457.

Hinton-Bayre AD, Geffen G. Severity of sports-related concussion and neuropsychological test performance. *Neurology.* 2002;59:1068-1070.

Hoch D. Coaching education and certification. *Coach and Athletic Director.* 2004;74(2):14.

Hovda DA, Lee SM, Smith ML, Von Stuck S, Bergsneider M, Kelly D, Shalmon E, Martin N, Caron M, Mazziotta J, Phelps M, Becker DP. The neurochemical and metabolic cascade following brain injury: moving from animal models to man. *J Neurotrauma.* 1995;12(5):903-6.

Iverson GL, Gaetz M, Lovell MR, Collins MW. Relation between subjective fogginess and neuropsychological testing following concussion. *J Int Neuropsychol Soc.* 2004;10:904-906.

Jantzen KJ, Anderson B, Steinberg FL, Kelso JAS. A prospective functional MR imaging study of mild traumatic brain injury in college football players. *Am J Neuroradiol.* 2004;25:738-745.

Johnston KM, McCrory P, Mohtadi NG, Meeuwisse W. Evidence-based review of sport-related concussion: clinical science. *Clin J Sport Med.* 2001;11:150-9.

Juzwiak CR, Ancona-Lopez F. Evaluation of nutrition knowledge and dietary recommendations by coaches of adolescent Brazilian athletes. *Int J Sport Nutr Exerc Metab.* 2004;4:222-235.

Kaut KP, DePompei R, Kerr J, Congeni J. Reports of head injury and symptom knowledge among college athletes: Implications for assessment and educational intervention. *Clin J Sport Med.* 2003;13:213-221.

Kelly JP. Loss of consciousness: Pathophysiology and implications in grading and safe return to play. *J Athl Train.* 2001;36(3):249-252.

Kelly JP, Rosenberg JH. Diagnosis and management of concussion in sports. *Neurology.* 1997;48(3):575-580.

Langford Bedgood B, Tuck MB. Nutrition knowledge of high school athletic coaches in Texas. *J of the American Dietetic Association.* 1983;83(6):672-5.

Levin HS, Eisenberg HM, Wigg NR, Kobayashi K. Memory and intellectual ability after head injury in children and adolescents. *Neurosurgery.* 1982;11(5):668-673.

Longhi L, Saatman KE, Fujimoto S, Raghupathi R, Meaney DF, Davis J, McMillan A, Conte V, Laurer HL, Stein S, Stocchetti N, McIntosh TK. Temporal window of vulnerability to repetitive experimental concussive brain injury. *Neurosurgery.* 2005;56(2):364-374.

Lovell MR, Collins MW, Iverson GL, Johnston KM, Bradley JP. Grade 1 or "Ding" concussions in high school athletes. *Am J Sports Med.* 2004;32(1):47-54.

Lovell MR, Collins MW, Iverson GL, Field M, Maroon JC, Cantu R, Podell K, Powell JW, Belza M, Fu FH. Recovery from mild concussion in high school athletes. *J Neurosurg.* 2003;98(2):296-301.

Mackenzie JA, McMillan TM. Knowledge of post-concussional syndrome in naïve lay-people, general practitioners and people with minor traumatic brain injury. *Br J Clin Psych.* 2005;44:417-424.

McCrea M, Barr WB, Guskiewicz K, Randolph C, Marshall SW, Cantu R, Onate JA, Kelly JP. Standard regression-based methods for measuring recovery after sport-related concussion. *J Int Neuropsychol Soc.* 2005;11:58-69.

McCrea M, Hammeke T, Olsen G, Leo P, Guskiewicz K. Unreported concussion in high school football players: Implications for prevention. *Clin J Sports Med.* 2004;14:13-7.

McCrea M, Guskiewicz KM, Marshall SW, Barr W, Randolph C, Cantu RC, Onate JA, Yang J, Kelly JP. Acute effects and recovery time following concussion in collegiate football players: The NCAA concussion study. *JAMA.* 2003;19:2556-2563.

McCrea M, Kelly JP, Randolph C, Kluge J, Bartolic E, Finn G, Baxter B. Standardized assessment of concussion (SAC): On-site mental status evaluation of the athlete. *J Head Trauma Rehabil.* 1998;13(2):27-35.

McCrory P, Johnston K, Meeuwisse W, Aubry M, Cantu R, Dvorak J, Graf-Baumann T, Kelly J, Lovell M, Schamasch P. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. *Br J Sports Med.* 2005;39:196-204.

McKeever CK, Schatz P. Current issues in the identification, assessment, and management of concussions in sports-related injuries. *Appl Neuropsych.* 2003;10(1):4-11.

Mensch J, Crews C, Mitchell M. Competing perspectives during organizational socialization on the role of certified athletic trainers in high school settings. *J Athl Train.* 2005;40(4):333-340.

National Coaching Certification Program. *United States Sports Academy.* 1997. Available at: <http://www.ussa.edu/programs/ce/national_coaching_certification_program/index.asp>. Accessed: 1 Mar 2007.

National Standards Published by the National Association for Sport and Physical Education. *NASPE.* 2006. Available at: <http://www.aahperd.org/naspe/template.cfm?template=ns_index.html>. Accessed: 1 Mar 2007.

National Youth Sports Coaches Association. *Hays Recreation Commission.* 2007. Available at: <http://www.haysrec.org/index.asp?DocumentID=1123>. Accessed: 2 Mar 2007.

National Youth Sports Coaches Association. *National Alliance for Youth Sports.* 2003. Available at: <http://www.nays.org/IntMain.cfm?Cat=3&Page=2>. Accessed: 1 Mar 2007.

New York State Coaching License Requirements. *NY State Education Dept.* Available at: <http://www.sectionxi.org/donna/coachingreq.htm>. Accessed: 28 Feb 2007.

Notebaert A, Guskiewicz KM. Current trends in athletic training practice for concussion assessment and management. *J Athl Train.* 2005;40(4):320-5.

Oliaro S, Anderson S, Hooker D. Management of cerebral concussion in sports: The athletic trainer's perspective. *J Athl Train.* 2001;36(3):257-262.

Onyeaso CO, Adegbesan OA. Knowledge and attitudes of coaches of secondary school athletes in Ibadan, Nigeria regarding oro-facial injuries and mouthguard use by the athletes. *Dental Traumatology.* 2003;19:204-8.

Parrott R, Duggann A, Cremo J, Eckles A, Jones K, Steiner C. Communicating about youth's sun exposure risk to soccer coaches and parents: A pilot study in Georgia. *Health Education & Behavior.* 1999;26(3):385-395.

Pettersen JA. Does rugby headgear prevent concussion? Attitudes of Canadian players and coaches. *Br J Sports Med.* 2002;36:19-22.

Piland SG, Motl RW, Guskiewicz KM, McCrea M, Ferrara MS. Structural validity of a self-report concussion-related symptom scale. *Med Sci Sports Exerc.* 2006;38(1):27-32.

Piland SG, Motl RW, Ferrara MS, Peterson CL. Evidence for the factorial and construct validity of a self-report concussion symptoms scale. *J Athl Train.* 2003;38(2):104-112.

Powell JW, Barber-Foss KD. Traumatic brain injury in high school athletes. *JAMA.* 1999;282(10):958-963.

Quality Standards Subcommittee. Practice parameter: The management of concussion in sports (summary statement). *Neurology.* 1997;48(3):581-585.

Ransone J, Dunn-Bennett LR. Assessment of first-aid knowledge and decision making of high school athletic coaches. *J Athl Train.* 1999;34(3):267-271.

Return to Play Guidelines after Head Injuries. *USA Hockey.* 2007. Available at: <http:// www.usahockey.com/safety/main_site/main/concussion//>. Accessed: 1 Mar 2007.

Riemann BL, Guskiewicz KM, Shields EW. Relationship between clinical and forceplate measures of postural stability. *J Sport Rehab.* 1999;8:71-82.

Roos R. Guidelines for managing concussion in sports: A persistent headache. *Phys Sportsmed.* 1996;24(10):31-46.

Rutgers S.A.F.E.T.Y. Clinic. *Youth Sports Research Council, Rutgers U.* Available at: <http://www.youthsports.rutgers.edu/cgi-bin/sb/nav.cgi/aip=f0179Leqs0J05hL3E EqU0x3,Tpx-e,uwSfRq.?nav=101404>. Accessed: 2 Mar 2007.

Sage GH. Becoming a high school coach: from playing sports to coaching. *Research Quarterly for Exercise and Sport.* 1989;60(1):81-92.

Schulz MR, Marshall SW, Mueller FO, Yang J, Weaver NL, Kalsbeek WD, Bowling JM. Incidence and risk factors for concussion in high school athletes, North Carolina, 1996-1999. *Am J Epidemiol.* 2004;160:937-944.

Schweitzer C. *Coaching Certification.* Washington DC: ERIC Clearinghouse on Teacher Education; 1989. ERIC Document Reproduction Service ED310112.

Sisley B, Wiese DM. Current status: Requirements for interscholastic coaches. Results of NAGWS/NASPE coaching certification survey. *J Phys Ed Rec Dance.* 1987;58(7):73-85.

Sosin DM, Sniezek JE, Thurman DJ. Incidence of mild and moderate brain injury in the United States, 1991. *Brain Injury.* 1996;10(1):47-54.

Sossin K, Gizis F, Marquart LF, Sobal J. Nutrition beliefs, attitudes, and resource use of high school wrestling coaches. *Int J of Sport Nutr.* 1997;7:219-228.

State-by-State Requirements for Athletic Coaches. *National Association of State Boards of Education.* 30 Jan 2007. Available at: <http://www.nasbe.org/HealthySchools/ States/Topics.asp?Category=B&Topic=10>. Accessed: 1 Mar 2007.

Sye G, Sullivan SJ, McCrory P. High school rugby players' understanding of concussion and return to play guidelines. *Br J Sports Med.* 2006;40(12):1003-5.

Theye F, Mueller KA. "Heads Up": Concussions in high school sports. *Clin Med Research.* 2004;2(3):165-171.

Thurman D, Branche C, Sniezek J. The epidemiology of sports-related traumatic brain injuries in the United States; Recent developments. *J Head Trauma Rehab.* 1998;13(2):1-8.

Turk JC, Prentice WE, Chappell S, Shields EW. Collegiate coaches' knowledge of eating disorders. *J Athl Train.* 1999;34(1):19-24.

USA Volleyball Coaching Accreditation Program. *USA Volleyball.* Available at: <http://www.usavolleyball.org/Education/about.asp>. Accessed: 1 Mar 2007.

United States. CDC. Dept. of Health and Human Services. *Heads up: Concussion in high school sports: A guide for coaches.* Washington: GPO, 2005.

Virginia High School League Coaching Education Requirements. *American Sport Education Program.* Available at: <http://www.asep.com/asepdata/asepmedia/ACF3B5.pdf>. Accessed: 28 Feb 2007.

Wiersma LD, Sherman CP. Volunteer youth sport coaches' perspectives of coaching education/certification and parental codes of conduct. *Research Quarterly in Exercise and Sport.* 2005;76(3):324-338.

Wilberger JE. Minor head injuries in American football: Prevention of long term sequelae. *Sports Med.* 1993;15(5):338-343.

Wilson S, Van Lunen BL, Ridinger L, Dowling EA. An assessment of high school athletic coaches' knowledge of exercise-induced asthma. *Applied Research in Coaching and Athletics Annual.* 2005;20:40-64.

Dear High School Athletic Director,

My name is Erin O'Donoghue and I am currently a graduate student in the Post Professional Accredited Graduate Athletic Training Education program at Old Dominion University. As part of my Masters degree, I am conducting research for a Masters thesis. The purpose of this research project is to determine the current level of knowledge among high school athletic coaches about the recognition, management, and prevention of concussion in sports.

Included in this packet, you will find the school information sheet, a script for you to read to the coaches, and the survey instrument, which includes a copy of the script, a demographic questionnaire, and a multiple-choice assessment for the coaches to fill out. Please have your athletic coaches fill out the survey instrument during your coaches meeting, which should only take about 10-15 minutes to complete, and have them return them to you at the end of the meeting or upon finishing the survey. No individual coaches, schools, or surveys will be identified in publications or presentations and all results will remain confidential. Only the research team will view data and all collected data will be kept in locked cabinet. Please do not allow coaches to refer to outside sources while completing this survey. This study has been approved by the Old Dominion University internal review board.

Your school's participation in this will allow for the development of an educational intervention to improve coaches' knowledge about the care of sport-related concussion when acting in the absence of a certified athletic trainer. The results of this study will also benefit certified athletic trainers by providing them with an overview of the knowledge coaches have about sport-related concussion because there are not always certified athletic trainers present in all high school settings.

Your help with this study is greatly appreciated. If you have any questions or concerns about this study feel free to contact Erin M. O'Donoghue at 757-889-1275 or by email at erin.odonoghue@gmail.com. Thank you very much for your time and participation.

Sincerely,

Erin M. O'Donoghue, ATC
Graduate Athletic Training Student
Old Dominion University

James A. Onate, PhD, ATC
Director, Sports Medicine Research Laboratory
Old Dominion University

Bonnie L. Van Lunen, PhD, ATC
Director, Graduate Athletic Training
Old Dominion University

Connie Peterson, PhD, ATC
Assistant Professor, Athletic Training
James Madison University

Script to be read to High School Coaches

Athletic Directors: Please read this to the coaches exactly as it is printed below. Thank you very much for your time and help with this study.

This study is being conducted by Erin O'Donoghue, a graduate athletic training student at Old Dominion University as part of her Masters degree. The purpose of this study is to assess the current knowledge base of high school athletic coaches about sport-related concussion.

- Thank you very much for your time and participation in this study. Participation in this study is completely voluntary.
- This study will take 10-15 minutes of your time to complete.
- **Answer each question, selecting only one response**. Please write/circle all answers on the survey instrument provided to you. Please do not refer to any outside resources while completing this survey.
- Begin by filling out the demographic questionnaire and then fill out the knowledge assessment. Your completion of the survey will be considered your consent to participate in this study.
- All subjects will remain confidential and all results will be reported based on group findings.
- Your participation in this study will allow for the development of an educational intervention to improve coaches' knowledge about the care of sport-related concussion in the absence of a Certified Athletic Trainer.
- If you have any questions or comments, please feel free to contact the research team at 757-889-1275 or erin.odonoghue@gmail.com
- When you have completed the assessment, please place your survey in the envelope provided to your athletic director. **DO NOT SIGN OR WRITE YOUR NAME ON THE SURVEY.**

IMPORTANT: Athletic Directors

1. Record the total # of coaches at your school on the (School Information Sheet)
2. Record # of coaches that received the survey on the (School Information Sheet)
3. Record the # of surveys received back from the coaches on the (School Information Sheet)
4. Please include this information (see attached sheet) with the completed surveys to be mailed back to the research team)

SPORT RELATED CONCUSSION KNOWLEDGE ASSESSMENT
DEMOGRAPHIC QUESTIONNAIRE

1. What is the highest degree you have earned?
   _____ High School Diploma
   _____ Associates Degree
   _____ Bachelor's Degree
   _____ Master's Degree
   _____ Doctorate Degree
   _____ Other: _____

2. If you have a college degree, what was your major field of study?
   _____

3. What is your current occupation? _____

4. Age: _____

5. Gender: (circle one) MALE or FEMALE

6. Race: (check one)
   _____ African American
   _____ Arab
   _____ Asian
   _____ Caucasian
   _____ Hispanic
   _____ Native American/Alaskan Native
   _____ Pacific Islander

7. What would you say is the predominant socioeconomic status of the majority of the students at your school? (check one)
   _____ Upper Class
   _____ Upper-Middle Class
   _____ Middle Class
   _____ Lower-Middle Class
   _____ Lower Class

8. What would you say is the geographic setting of your schools' population?
   _____ Urban
   _____ Suburban
   _____ Rural

9. How many years have you been coaching at any level? _____

10. How many years have you been coaching at the high school level? _____

11. Please list other coaching experience that you may have: (in years)
    Middle School _____
    College/Univ. _____
    Professional _____
    Other: _____ Please list: _____

12. What sports do you currently coach (either in season or out of season)? (Please list all)

    _____

13. What is your coaching position?
    _____ Head Coach, Sport: _____
    _____ Assistant Coach, Sport: _____
    _____ Volunteer, Sport: _____
    _____ Other: _____, Sport: _____

14. Have **you** ever had a concussion? (circle one) YES or NO
    If yes, was this concussion from playing sports? (circle one) YES or NO
    If yes, what sport? _____
    Can you briefly describe the circumstances surrounding your concussion incident?

    _____
    _____
    _____

    If yes, did you report this concussion to any of the following (circle all that apply):
    - Coach
    - Parent
    - Physician
    - Athletic Trainer
    - Other:

    _____

    Who determined that you had sustained a concussion? _____
    What treatment did you receive, if any? _____
    How do you feel about the way it was treated? _____
    How many days of competition (practice/game) did you miss (please provide your best estimate)? _____

15. Have you ever experienced any of the following symptoms (blurry vision, dizziness, headache, disorientation, memory problems, nausea, poor balance, trouble concentrating, ringing in the ears, seeing stars) after hitting your head?
    (circle one) YES or NO

16. Do you have a certified athletic trainer (ATC) at your school that regularly attends practices and games? (circle one) YES or NO

17. If you have an ATC at your school, have you ever discussed concussions with your ATC? (circle one) YES or NO

18. Have you received a brochure (Heads Up: Concussion in High School Sports) about concussion in high school sports? (circle one) YES or NO

19. If you have received the brochure, did you take time to look over it? (circle one)
YES or NO

20. If you looked over the brochure, how much time did you spend reviewing it?
_____ 30 seconds to 1 minute
_____ 1 – 5 minutes
_____ 5- 10 minutes
_____ 10 – 15 minutes
_____ More than 15 minutes

21. Are you aware of any set guidelines in place at your school in the event that one of your athletes sustains a concussion? (circle one) YES or NO

22. Have you ever had an athlete sustain a concussion at a game or practice when an ATC was not present? (circle one) YES or NO

23. Have you ever attended a workshop/lecture on concussion?
(circle one) YES or NO

24. Would you ever attend a workshop/lecture on concussion?
(circle one) YES or NO

25. What certifications do you currently hold?
_____ First Aid
_____ CPR
_____ Other: _____

COACHES' KNOWLEDGE OF SPORT-RELATED CONCUSSION (CoKC)

The purpose of this assessment is to determine current high school coaches' knowledge of sport-related concussion.

Your completion of this assessment is considered your consent to participate in the study. Your participation in this assessment will remain anonymous. Please answer all questions truthfully and to the best of your knowledge and ability.

Please circle the single best response for each question.

Recognition Section:

1. What is the minimum time an athlete has to be knocked out to have a sport-related concussion?
    a. Athletes do not have to be knocked out
    b. 30 seconds or less
    c. 1 to 2 minutes
    d. Greater than 5 minutes
2. Which sign would an athlete with a concussion present with (excluding other injuries)?
    a. Bleeding from the nose or mouth
    b. Excessive sweating
    c. Inability to move head in one or more directions
    d. Slow to answer questions
3. Which of the following situations is most likely to result in a sport-related concussion?
    a. Body checking in men's lacrosse
    b. Heading a ball in soccer
    c. Setting a pick in basketball
    d. Spearing (leading with the head) in football
4. How important is the proper recognition of a sport-related concussion?
    a. It's not very important – they just need time to walk it off
    b. It's a minor injury – they should put ice on their head after practice
    c. It's a normal injury – they should go see the athletic trainer after the practice/game
    d. It's a serious injury – they need immediate attention
5. What sports can an athlete get a concussion playing?
    a. Sports where a ball is being thrown or hit
    b. Sports where collisions are common
    c. Sports where protective equipment is required
    d. All sports
6. You might suspect an athlete has a concussion if they complain of which of the following symptoms?
    a. Excitement or happiness
    b. Feeling "in the zone"

   c. Headache or dizziness
   d. Hunger or thirst
7. What sign may indicate that an athlete's concussion is getting worse?
   a. Acting extremely hyper
   b. Developing a rash around the head and neck
   c. Fading in and out of consciousness
   d. Having clammy skin
8. Which of the following is true of an athlete in the hours or days following an initial sport-related concussion?
   a. They can begin to sweat excessively
   b. They can develop extreme hunger or thirst
   c. They can experience new or difference symptoms of a concussion
   d. They can get a rash around the head and neck

Management Section:

1. When an athlete has sustained a concussion, what should your immediate action be?
   a. Activate the school's emergency action plan
   b. Call the athletic director
   c. Give the athlete medicine and let him rest
   d. Let the athlete walk it off
2. Coaches and other appropriate staff should be trained in a concussion action plan that includes which of the following components?
   a. Phone numbers of the janitors and other coaches
   b. Signed progress reports and permission to treat forms
   c. Step-by-step directions for grading a concussion
   d. Ways to recognize a concussion and emergency contact numbers
3. Before returning to play following a concussion and being cleared by qualified medical personnel, an athlete should meet which of the following criteria?
   a. Able to pass a classroom test
   b. Free of symptoms during rest/activity
   c. Given time to walk it off
   d. Prescribed medication
4. Should every level of athlete be allowed to return to competition at the same rate of return?
   a. Yes, All athletes recover at the same rate
   b. No, Collegiate athletes take longer to return than other athletes
   c. No, High school athletes take longer to return than other athletes
   d. No, Professional athletes take longer to return than other athletes
5. What is the least amount of time an athlete should stay out of sports after having a sport-related concussion?
   a. Twelve hours
   b. One day
   c. Seven days
   d. Fourteen days

6. When should an athlete's parents be contacted after a sport-related concussion?
    a. If you think the athlete needs to see a doctor
    b. Let the athlete tell their parents when they get home
    c. Once the athlete has been cleared to return by medical personnel
    d. When you suspect an athlete has a concussion
7. What activities should an athlete NOT participate in if they are still symptomatic (having sport-related concussion symptoms)?
    a. Any level of sport activity
    b. Games
    c. Practice
    d. Warm-up
8. What is the most effective type of treatment for an athlete with a concussion?
    a. Exercise without contact to the head
    b. Medicine from a doctor
    c. Time to rest
    d. X-rays and imaging done by doctors

Prevention Section:

1. Who should be the targeted group of individuals that need to participate in a school's education program concerning concussion awareness?
    a. Athletes, parents, and coaches
    b. Hospital staff and emergency services personnel
    c. Referees, league directors, and sports administrators
    d. Sports equipment makers and retailers
2. Which of the following should an education program designed to increase awareness about sport-related concussion include?
    a. Medical definition and terminology
    b. Pre-season testing and physical
    c. Symptoms and care instructions
    d. Team policies and procedures
3. What components should pre-season testing for concussion include?
    a. Baseline testing (balance and mental tests) and medical history
    b. MRI and X-rays
    c. Nothing – it's already included in the physical exam
    d. Pulse and blood pressure
4. What technique is most effective in helping prevent concussions while an athlete is out playing on the field?
    a. Avoiding plays were head contact may occur
    b. Playing on artificial turf
    c. Reminding athletes to play fair
    d. Wearing properly fitting helmets
5. When should a plan for concussion management (screening, education, etc) be in effect?
    a. During pre-season
    b. Once the season starts

c. In the off-season
d. Year-round

6. What is one major concern about returning an athlete to play before completely recovering from an initial concussion?
    a. Blind spots in vision
    b. Inability to hear coaching instructions
    c. Lack of concentration in game/practice
    d. Second impact syndrome
7. Which of the following puts an athlete more at risk to experience another concussion?
    a. Having a poor sense of balance
    b. Having had a previous sport-related concussion
    c. Having poor neck muscle strength
    d. Participating in preseason conditioning
8. What action is most effective in reducing the risk of repeated sport-related concussions and the associated cumulative effects?
    a. Being educated about concussion
    b. Developing strong neck muscles in athletes
    c. Having injured athletes attend workshops about concussion
    d. Proper stretching before and after exercise

School Information Sheet

Athletic Directors please fill in the following information:

Total number of coaches at your school: _____

Number of coaches that received the survey: _____

Number of coaches who returned the survey: _____

Please include this information in the return packet with completed surveys. This information is used only for response rate determination.

	A	B	C	D	Missing
Recognition Q1-1	100% (8)				
Recognition Q1-2	87.5% (7)	12.5% (1)			
Recognition Q2-1				100% (8)	
Recognition Q2-2				100% (8)	
Recognition Q3-1	12.5% (1)	12.5% (1)	12.5% (1)	62.5% (5)	
Recognition Q3-2		37.5% (3)		62.5% (5)	
Recognition Q4-1				100% (8)	
Recognition Q4-2				100% (8)	
Recognition Q5-1				100% (8)	
Recognition Q5-2				100% (8)	
Recognition Q6-1			87.5% (7)	12.5% (1)	
Recognition Q6-2			100% (8)		
Recognition Q7-1			87.5% (7)	12.5% (1)	
Recognition Q7-2			100% (8)		
Recognition Q8-1			100% (8)		
Recognition Q8-2			100% (7)		1
Management Q1-1	87.5% (7)	12.5% (1)			
Management Q1-2	87.5% (7)	12.5% (1)			
Management Q2-1				100% (8)	
Management Q2-2			12.5% (1)	87.5% (7)	
Management Q3-1		100% (8)			
Management Q3-2		100% (8)			
Management Q4-1	80% (4)	20% (1)			3
Management Q4-2	66.7% (4)	16.7% (1)		16.7% (1)	2
Management Q5-1	12.5% (1)	62.5% (5)	25% (2)		
Management Q5-2	12.5% (1)	50% (4)	37.5% (3)		
Management Q6-1				100% (8)	
Management Q6-2				100% (8)	

	A	B	C	D	Missing
Management Q7-1				100% (8)	
Management Q7-2				100% (8)	
Management Q8-1			75% (6)	25% (2)	
Management Q8-2			87.5% (7)	12.5% (1)	
Prevention Q1-1	100% (8)				
Prevention Q1-2	100% (8)				
Prevention Q2-1		12.5% (1)	87.5% (7)		
Prevention Q2-2		12.5% (1)	87.5% (7)		
Prevention Q3-1	87.5% (7)		12.5% (1)		
Prevention Q3-2	87.5% (7)	12.5% (1)			
Prevention Q4-1	37.5% (3)		12.5% (1)	50% (4)	
Prevention Q4-2	25% (2)		12.5% (1)	62.5% (5)	
Prevention Q5-1				100% (8)	
Prevention Q5-2	12.5% (1)			87.5% (7)	
Prevention Q6-1			25% (2)	75% (6)	
Prevention Q6-2			37.5% (3)	62.5% (5)	
Prevention Q7-1		100% (8)			
Prevention Q7-2		100% (8)			
Prevention Q8-1	62.5% (5)		37.5% (3)		
Prevention Q8-2	62.5% (5)		25% (2)	12.5% (1)	

	A	B	C	D	Other	Missing
Recognition Q1	92.9% (117)	7.1% (9)				
Recognition Q2			.8% (1)	99.2% (125)		
Recognition Q3	4% (5)	15.1% (19)	1.6% (2)	76.2% (96)	3.2% (4)	
Recognition Q4	.8% (1)		.8% (1)	98.4% (122)		2
Recognition Q5		1.6% (2)		97.6% (122)	.8% (1)	1
Recognition Q6		1.6% (2)	96.8% (122)	.8% (1)	.8% (1)	
Recognition Q7		.8% (1)	92.1% (116)	7.1% (9)		
Recognition Q8	4% (5)	3.2% (4)	90.3% (112)		2.4% (3)	2
Management Q1	75.6% (93)	19.5% (24)	3.3% (4)	.8% (1)	.8% (1)	3
Management Q2			4.8% (6)	92.9% (117)	2.4% (3)	
Management Q3	.8% (1)	99.2% (124)				1
Management Q4	43.1% (50)	1.7% (2)	47.4% (55)	6.9% (8)	.9% (1)	10
Management Q5	2.4% (3)	40% (50)	53.6% (67)	3.2% (4)	.8% (1)	1
Management Q6	1.6% (2)		1.6% (2)	96.8% (122)		
Management Q7	99.2% (125)	.8% (1)				
Management Q8	1.6% (2)		75.4% (95)	20.6% (26)	2.4% (3)	
Prevention Q1	96.8% (122)	1.6% (2)	1.6% (2)			
Prevention Q2	1.6% (2)	6.5% (8)	78.9% (97)	5.7% (7)	7.2% (9)	3
Prevention Q3	73.4% (91)	3.2% (4)	16.9% (21)	3.2% (4)	3.2% (4)	2

	A	B	C	D	Other	Missing
Prevention Q4	21.8% (27)		6.5% (8)	70.2% (87)	1.6% (2)	2
Prevention Q5	8.7% (11)	1.6% (2)	4.8% (6)	83.3% (105)	1.6% (2)	
Prevention Q6	7.1% (9)		9.5% (12)	82.5% (104)	.8% (1)	
Prevention Q7	4% (5)	88.9% (112)	4.8% (6)		2.4% (3)	
Prevention Q8	83.3% (105)	4.8% (6)	7.1% (9)	3.2% (4)	1.6% (2)	

VITA

Erin M. O'Donoghue

Department of Study

Old Dominion University
Department of ESPER
Spong Hall
Norfolk, VA 23529

Education

May 2007	Master of Science in Education Old Dominion University Norfolk, VA 23529
May 2005	Bachelor of Arts Minor: English The University of North Carolina – Chapel Hill Chapel Hill, NC 275

Professional Experience

08/06 – 05/07

Assistant Athletic Trainer at Norfolk Academy in Norfolk, VA.
Responsible for prevention, recognition, and rehabilitation of athletic injuries and provided events and practice coverage for all athletic teams.

05/06-06/06, 08/06-12/06

Graduate Teaching Assistant for EXSC 322 and EXSC 340, Old Dominion University. Responsibilities included assisting in the preparation of the syllabus, lectures, and oral and written examinations for undergraduate students.

08/05 – 05/06

Assistant Athletic Trainer at Green Run High School in Virginia Beach, VA.
Responsible for prevention, recognition, and rehabilitation of athletic injuries and provided events and practice coverage for all athletic teams.

Funding History

Awarded 07/06

Osternig Master's Grant - $1,000
Title: "An Assessment of High School Coaches' Knowledge of Sport-Related Concussion"