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Concussion Management, Education and Diagnosis in Eastern Maine High School Football

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CONCUSSION MANAGEMENT, EDUCATION AND DIAGNOSIS IN EASTERN MAINE HIGH SCHOOL FOOTBALL

by

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Abstract

Recent evidence has shown that concussions are more serious than previously anticipated, particularly in young adults. Football is one of the sports in which concussions are most commonly seen. It is important for high schools to educate, diagnose and manage concussions correctly to prevent the occurrence of potentially catastrophic events like second impact syndrome. Through interviews and observations of practices and games, three Eastern Maine high schools were assessed to evaluate their concussion policies. Administrators, coaches and medical personnel were interviewed regarding their concussion awareness. Through a qualitative coding process, themes were found and assessed. Themes found included: honesty; misconceptions; testing and assessment; knowledge of players; personal connection; education; communication; changes in point of view over time; and Maine Principals' Association oversight. Based on the themes, recommendations and a conceptual framework for concussion management were developed to unify concussion management policies throughout Eastern Maine high schools.

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Chapter 1: Introduction and Rationale

"Concussion" is a term that has been used in medicine and sports for many years. Different definitions have been created, and as the understanding of the brain has increased, the definition has evolved. Current resources define concussion as a mild traumatic brain injury (mTBI), following a blow to the head or body (McCrory et al., 2009). New research is also suggesting that the effects of concussions are more severe when the brain is still developing, particularly in adolescence (Daneshvar, Riley et al., 2011).

Recently there have been more stories in the news about concussions. As physicians and medical team members develop better tools to diagnose concussions they are realizing that more concussions occur than had previously been thought. Because major play-makers in sports like football and hockey are being diagnosed with concussions, governing bodies of professional sports are developing new rules about contacts to help prevent concussions. Professional players who have suffered a concussion often make the news and there is much speculation about the short and long term consequences of their injuries; but what about those players who are not professionals, and are not in the national eye? What about the high school athletes playing sports who experience concussions?

One example is Tim Greene, a high school boy from Falmouth, Maine who experienced a concussion during a junior varsity football game in August of 2009. Greene stated that he thought it was a "mild concussion" (Hoffman, 2010, p. 13);

however after the concussion he was not recovering like he had expected. His mother reports that he was "slurring his words" and after the school athletic trainer did an ImPACT test (a computerized concussion analysis tool) "his scores were horrible" (Hoffman, 2010, p. 13). Greene was seen by a doctor, who noted that the 16 year old was having memory lapses and experiencing difficulties walking. Although in most cases concussions improve over the course of one to two weeks, Greene's symptoms only got worse. His memory deteriorated, he had headaches and he could not concentrate on his schoolwork, leading him to start attending only two classes per day. These problems, combined with not being able to participate in sports, led to depression (Hoffman, 2010).

In November of 2009, Greene started going to physical therapy. The first test done was a Fall Risk Assessment with the results showing that Greene had the balance of a 105 year old man (Hoffman, 2010). Working hard through physical therapy, Greene improved physically and mentally, returning to school full-time five months after his concussion. While Greene recovered, he was restricted from playing football. His doctor, John Vogt M.D. said, "Concussions are much more significant in the younger athletic population…the adolescent brain has a long way to go. The vulnerability to concussions is much more serious. The brain doesn't fully develop until the mid-20s" (Hoffman, 2010, p. 15).

While Tim Greene suffered severe after-effects from his concussion, there are athletes and families that have to deal with much worse. Austin Trenum was 17 when he was diagnosed with a concussion during a Friday night football game. His parents took him to the emergency room, where they were told he needed to rest and that they should monitor him for signs of internal bleeding. The next day Austin texted, watched game

film, went fishing and went to a concert. He also forgot a turn while driving home, and was having problems remembering simple things while he was fishing. The next day he woke up early to play video games, which was completely out of character. That afternoon he went upstairs to do homework and he never came down (White, 2011). Austin Trenum killed himself, but he had never shown any symptoms of depression. Later his parents connected all the dots, the strange post-concussion behavior, the "football headaches" (White, 2011) he had never mentioned before that season, and the history of one diagnosed and two probable concussions. While knowledge of concussions is making its way into the professional leagues, it is taking longer to trickle down into high school athletics. Trenum's brain was examined by the Center for the Study of Traumatic Encephalopathy in Boston. It was determined that he had a multi-focal axonal injury, which was primarily located around the centers for impulse control and judgment. (White, 2011)

Cases like Tim Greene and Austin Trenum are not unique. McGrath estimates that coaches should expect a rate of concussion of 5-10% for contact sports. All too often, high school athletes suffer a concussion and do not understand it well enough so they ignore it or do not treat it properly. It is very important that high schools help educate the parents and athletes about concussions, their symptoms and the best methods of their management. High school athletes are vulnerable for concussions and their lasting effects, and steps should be taken to help educate, diagnose and manage concussions better. It is the goal of this study to examine how three high schools in Eastern Maine educate, manage and diagnose concussions in their football athletes.

Chapter 2- Literature Review

Introduction

Concussion is a term describing a mild traumatic brain injury. Medical professionals have been aware of concussions for approximately seventy years (Webbe, 2006). The changes in definition that have occurred represent an increase in knowledge of the brain and how it responds to injury. Casson et al. (2010) defined concussion as a "traumatically induced alteration in brain function" (p.472). They specified that this "alteration in brain function" was characterized by "alteration of awareness or consciousness, including but not limited to being dinged, dazed, stunned, woozy, foggy, amnesic or, less commonly, rendered unconsciousness" (Casson, 2010, p. 472). A list of common symptoms also was given to help identify concussions.

Many sources consider concussion as a form of mild traumatic brain injury (mild TBI or mTBI) (Macleod, 2010; Stern et al., 2011; Bergman and Bay, 2010; Denke, 2008). In the past concussions were graded; however, Jagoda et al. (2009) suggest that grading mTBI may not be appropriate as there is no way to determine how long symptoms will last or how severely the patient may be disabled following their brain injury. The American Congress of Rehabilitation Medicine gives the following definition of a mild traumatic brain injury:

> As manifested by at least one of the following:
>
> 1. Any period of loss of consciousness;
> 2. Any loss of memory for events immediately before or after the accident;
> 3. Any alteration in mental state at the time of the accident (eg. feeling dazed, disoriented or confused) and;

> 4. Focal neurological deficits that may or may not be transient (1993, p. 86).

Similarly, the National Center for Injury Prevention and Control (2003) has developed its own definition for mild TBI:

> An occurrence of injury to the head, resulting from blunt trauma or acceleration or deceleration forces with one or more of the following conditions attributable to the head injury during the surveillance period:
>
> - Any period of observed or self-reported transient confusion, disorientation or impaired consciousness
> - Any period of observed or self-reported dysfunction of memory (amnesia) around the time of injury
> - Observed signs of other neurologic or neuropsychological dysfunction
> - Any period of observed or self-reported loss of consciousness lasting 30 minutes or less (p. 16)

These sources provide a series of criteria to diagnose a mild traumatic brain injury. The National Athletic Trainers' Association provided a working definition of concussion as:

> A mild, diffuse injury… the injury involves an acceleration-deceleration mechanism in which a blow to the head or the head striking an object results in 1 or more of the following conditions: headache, nausea, vomiting, dizziness, balance problems, feeling "slowed down," fatigue, trouble sleeping, drowsiness, sensitivity to light or noise, LOC [loss of consciousness], blurred vision, difficulty remembering or difficulty concentrating (Guskiewicz et al., 2004, p. 283).

Webbe (2006) discussed the history of concussions, and how the definition of concussion has varied through the years. He also described the various difficulties in defining concussions, as there are many aspects and phenomena that should be included. Dorothy Gronwall (1991) gave this as a possible definition for concussion, "an injury in which head trauma is not followed by abnormal neurological signs, though it can be and often is followed by complaints of headache, poor memory, impaired concentration, vertigo, irritability, sensitivity to light and noise, and easy fatigue" (254). These definitions represent possible causes and describe many of the symptoms and problems

associated with concussions. They also identify the potential for prolonged symptoms, also known as post-concussion syndrome.

Daneshvar, Nowinski et al. (2011) define concussions as "a TBI [traumatic brain injury] induced by an impulsive force transmitted to the head resulting from a direct or indirect impact to the head, face, neck, or elsewhere" (p. 3). The authors also acknowledged that many concussions are not reported as "these impairments in neurologic function often present with a rapid onset and resolve spontaneously" (p. 3).

The Zurich Consensus Statement, published by McCrory et al. in 2009 is currently accepted by a large percentage of medical professionals as the most up-to-date guidelines for concussions. The authors agreed that a concussion is defined as, "a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces" (p. 435). The authors also acknowledged that this injury may have been due to a direct blow to the head or an "impulsive" (p. 435) force where the force is transmitted to the head from another area of the body. It is also stated that neurological function is affected soon after injury, though the symptoms are short-lived and resolve spontaneously. These symptoms are due mostly to a functional disturbance, rather than a true structural injury to the brain, and as such, no abnormalities are seen on standard neuroimaging studies. The Zurich Consensus Statement also discussed treating concussions on an individual basis, rather than using a grading scale (McCrory et al., 2009).

Etiology

One major research topic has been to study what occurs in the brain during a concussion episode. Webbe (2006) discussed that the cause of concussion may result from a direct impact to the head or an impulse injury, which is due to an abrupt change of direction.

The National Athletic Trainers' Association position statement on concussions discussed that a concussion is a diffuse traumatic brain injury that is characterized by disruption of neurological function (Guskiewicz et al., 2004). In all but the most severe cases lesions on the brain are not visible. The authors recognized that most diffuse TBI are caused by acceleration-deceleration motions in the linear or rotational planes. This action is usually caused by a blow to the head or by the head striking an object. The authors discussed that the stresses placed on the brain that result in injury are one of three types: compressive, tensile or shearing. A compressive force is the result of a crushing force when the tissue cannot withstand any further force. A tensile force is caused by a pulling or stretching of neural tissue. Shearing forces consist of forces that move across the parallel structure of tissue (Guskiewicz et al., 2004). The authors also acknowledged that while brief compressive forces can be well tolerated, shearing or tensile forces are not well tolerated in the brain.

Signs and Symptoms

There is a general consensus on many symptoms of concussion, though some sources provide more in-depth lists. In a study with National Football League players Casson et al. (2010) divide the symptoms they use to classify concussions into six categories: general symptoms, cranial nerve symptoms, memory problems, cognitive

problems, somatic problems and unconsciousness. General symptoms consist of problems like headache, seizure, nausea, syncope and back and neck pain. Cranial nerve symptoms appear in a cranial nerve test, like tinnitus, dizziness, papillary response and photophobia. Memory problems relate to anterograde or retrograde amnesia, problems processing information or attention problems. Cognitive problems are defined as immediate recall, or disorientation. Somatic complaints consist of depression, fatigue, anxiety, sleep disturbances or irritability (Casson et al., 2010). While many of these symptoms were self-reported by the National Football League players in the Casson's study, others had to be determined by investigators and by testing.

Webbe (2006) discussed whether or not loss of consciousness (LOC) should be a defining characteristic of concussion. He discussed that in the past, investigators listed LOC as a symptom that always occurred, perhaps due to its dramatic characteristic. He also acknowledged that recent studies have identified that "individuals may show similar clinical symptoms following mild, closed head trauma when some have exhibited LOC and some have not (Webbe, 2006, p. 46). Johnson (2011) presented an analysis of concussions in youth hockey, in this article he offered a short list of symptoms, including "fatigue, lack of concentration, memory loss and headache" (p. 921). He also acknowledged that concussions in youth can have "devastating effects on both athletic and academic performance" (p. 921).

Lau et al. (2011) provided a list of on-field signs and symptoms to examine as potential indicators of protracted recovery from concussion in high school football players. This list includes dizziness, headache, posttraumatic amnesia, sensitivity to light and/or noise, visual problems, retrograde amnesia, confusion, fatigue, balance problems,

personality changes, vomiting, numbness and loss of consciousness (Lau et al., 2011). The researchers found that the only symptom that showed a link with protracted recovery from concussion was on-field dizziness.

Management

There are currently many management strategies for diagnosing and treating concussions. Daneshvar, Nowinski et al. (2011) reported that "many coaches, athletic trainers, and other sports medicine professionals do not properly use current guidelines for concussion assessment and management" (p. 3).

Computerized neurocognitive testing has recently come to light as a tool in concussion management. It has been recognized as "a more objective measure for determining the subtle cognitive changes associated with concussion" (Covassin et al., 2009, p. 639). Neurocognitive baselining, which establishes a pre-concussion "normal" test result, has also helped to increase detection of post-concussion impairment. If a baseline is not available, computerized neurocognitive testing provides normative data based on age, gender and level of education which can be used, however baseline tests allow medical professionals to track each concussed athlete's individual progress (Covassin et al., 2009). While many schools administered a neurocognitive baseline test, less than half of the athletic trainers responding reported verifying their baseline results, which can hinder diagnosis and management of concussions. Baseline verification includes examining reaction time, processing speed and verbal and visual memory scores which determines whether the athlete was not paying attention or sabotaged his/her results to determine a low baseline result (Covassin et al., 2000).

Bergman and Bay (2010) discussed the need for a gradual return to physical activity after symptoms resolve. They also suggested that patients not drive while symptomatic and that patients rest more. In addition, they recommend that patients limit activities that require intense thinking or concentration, which may increase the persistence of symptoms.

Moser and Schatz (2002) discussed that there is not a consensus on how to manage a concussion, which they state may be due to the lack of evidence behind concussion severity scales and return to play guidelines. The authors reported that there are many concussion severity scales for clinicians to use, however none have been validated. The various scales make it difficult to compare findings across locations, as the clinicians may not use the same scale (Moser and Schatz, 2002).

Neal McGrath identified the need to define how a concussed student-athlete should return to school and return to play. In his article, he set up a model for concussion management that includes both the practice fields and the classroom. McGrath first identified the need for education among coaches, students, parents and school personnel, including guidance counselors, teachers, school nurses and others. The author stated that this will help prepare them to support the student-athletes (2010). McGrath next stated that using a preseason baseline testing protocol, preferably using a neurocognitive assessment program, should be integrated into the concussion management protocol, as these computer-based programs "control[s] for the effects of medications, learning disabilities, attention deficit/hyperactivity disorder (ADHD) and other preexisting conditions" (McGrath, 2010, p. 494). Once an athlete has a suspected concussion, McGrath (2010) identified the need for a sideline assessment and follow-up

neurocognitive evaluation within the first few days following a concussion. McGrath stated that these tests help the students and their parents comprehend the injury and the accompanying deficits.

McGrath also identified the need for a set return to play protocol, which delineates the roles of professionals involved and also covers academic support procedures. One such accommodation suggested is excused absence from class for the student-athlete with severe symptoms. McGrath identified that recovery time generally decreases with rest, including rest from the "cognitive demands of academic work" (2010, p. 494). This means reduced time in the classroom. Along these lines are rest periods during the school day as another possible accommodation. Allowing the student to rest briefly throughout the day in the nurse's office can help maximize the time spent in class. McGrath also suggested extending assignment deadlines as concussed student-athletes may have problems processing information. In the same vein is staggering or postponing tests, as this helps remove stress and mental effort which may lead to exacerbation of symptoms. For the symptomatic athlete who feels they can take a test, McGrath suggested extending the test time given to accommodate for the decreased rate of information processing. Another suggested accommodation relates to light and sound sensitivity, and includes excusal from assemblies, dimming the lights in the classroom, wearing hats or sunglasses to dim the light or permission to move away from noisy areas of the classroom or cafeteria. McGrath suggested removal from sports team practices and gym class activities, to promote rest as the time spent could be used to rest or work on classwork. Students should also monitor the weight of their backpack and consider using an elevator, as exertion from using the stairs may exacerbate symptoms. Other

accommodations include using a reader for tests and assignments, using a note-taker or working with a tutor to prioritize and monitor the student's academic progress. Allowing the students to take an exam in a quiet room may also help eliminate distractions. McGrath also emphasized that a student-athlete recovering from a concussion should receive a consistent message from all professionals involved and their parents (McGrath, 2010).

McCrory et al. (2009) developed the concept of a step-by-step return to play protocol which builds on itself, slowly working the player back into activity. The authors also stated that youth athletes should never return to play the day a concussion has occurred as they "are more likely to have delayed onset of symptoms" (p. 438). They also discussed that cognitive rest is important for youth and adolescents recovering from concussions. This concept of cognitive rest includes limiting exertion with regular activities, limiting cognitive stressors like texting, reading and playing video games, and, if necessary, limiting school attendance to avoid symptom provocation (McCrory et al., 2009).

Risks

There are many risks associated with concussions, both short and long term. Webbe (2006) stated that a history of prior concussions significantly increases the risk of a future concussion. New evidence also suggests that repeated sub-concussive blows may have a cumulative effect on the brain and may lead to structural or functional impairment (Webbe, 2006).

Denke (2008) stated that "after athletes sustain one concussion, they are 3 to 7 times more likely to sustain a second concussion compared with other players who have not been concussed" (p. 364). She also discussed the lack of information regarding the number and degree of concussions required for permanent damage, although she does acknowledge that "repeated concussions, even when mild, can increase the risk of post-concussive symptoms such as headaches, memory loss and difficulty concentrating" (Denke, 2008, p. 364).

Johnson (2011) presented the risk of chronic traumatic encephalopathy (CTE) as a potential long term risk due to repeat concussions. This disease is characterized by memory loss, behavioral and personality changes, depression and most notably early dementia and motor neuron disease (Johnson, 2011). Johnson reported that in one half of confirmed cases of CTE "symptoms developed within four years of the athletes stopping play" (2011, p. 921), and he acknowledged that sub-concussive blows are also attributed as a cause of CTE. In the brain, CTE is shown through the deposition of Tau proteins (Johnson, 2011).

Gavett et al. (2010) also discussed the risks associated with mild traumatic brain injury and repeated concussive and sub-concussive blows. The primary risk defined is CTE. The authors discussed the diagnosis of CTE, and how it has only been documented in "individuals with a history of repetitive closed head injury, most often in the context of contact sports" (Gavett et al., 2010, p. 2). This condition becomes symptomatic in mid-life and is characterized by "disordered cognition, most pronounced in the areas of memory and executive functioning; disturbances in mood and comportment (for example, apathy, irritability); and Parkinsonian signs" (Gavett et al., 2010, p. 1). The authors also

detailed that central nervous system trauma also is designated as a risk factor for Parkinson's Disease and amyotrophic lateral sclerosis (ALS). The authors suggested that traumatic brain injury "could conceivably trigger multiple molecular pathways that result in the overproduction and aggregation of a number of key proteins that form pathological aggregates in neurodegenerative diseases" (Gavett et al., 2010, p. 2).

One of these proteins is known as a tau protein, and is discussed by Stern et al. (2011). The tau protein is also characteristic of Alzheimer's disease; however CTE differs from Alzheimer's in the location of where the tau proteins are laid down. The authors discussed the need for further research as "it also is unknown whether CTE is more likely to occur after extended exposure to repetitive brain trauma or whether a single traumatic injury can initiate this neurodegenerative cascade in susceptible individuals" (Stern et al., 2011, p. S461). Another future research topic is whether age plays a factor in later CTE development, as:

> The increased plasticity of a younger brain may allow a younger individual to better compensate and recover after brain injury. However, current literature indicates that a younger brain may be more susceptible to diffuse brain injury, which leads to more pronounced and prolonged cognitive deficits" (Stern et al., 2011, p. S464).

Other sources have indicated prior incidence of mTBI as a predictor of attentional and psychiatric issues in children. Daneshvar, Riley et al. (2011) discussed that though some sources believe brain injuries at a young age predict better recovery as the young brain is quite plastic, new evidence suggests that "the developing brain appears, in fact, to be more vulnerable to diffuse brain injury" (p. 687). The authors also discussed that children who experienced an mTBI before age 14 had a significantly higher incidence of

psychiatric issues in the subsequent 3 years. The children with mTBIs also exhibited attentional problems within the first year following injury (Daneshvar, Riley et al., 2011).

Moser et al. (2005) stated that the effects of concussions may be exacerbated when the brain is in its key developmental stage. Their study also revealed that athletes with a history of two or more concussions were virtually indistinguishable from recently (within 1 week) concussed athletes in tests of concentration, processing speed, mental flexibility, and attention (Moser et al., 2005).

Post-Concussion Syndrome

Bowen (2003) discussed post-concussion syndrome patients reporting the following symptoms: "headaches (especially with exertion), labyrinthine disturbances, fatigue, irritability, and impaired memory and concentration" (p. 287). These symptoms persist long past the usual length of symptom duration for concussions. Bowen reported that "persistence of these symptoms is believed to reflect neurotransmitter function and typically correlates with the duration of posttraumatic amnesia" (Bowen, 2003, p. 287).

Bergman and Bay (2010) discuss how many mTBI discharge sheets fail to mention that the athlete many develop post-concussive symptoms, even though according to a study by Bazarian and Atabaki, 58% of patients with mTBI were still symptomatic after one month (2001). Common physical symptoms of post-concussion syndrome are headache, dizziness, fatigue, sleep disturbance and visual difficulties. Emotional symptoms are often seen with post- concussion syndrome, including depression, anxiety and occasionally post-traumatic stress disorder. Cognitive symptoms exhibited by post-concussion syndrome patients are often attention difficulties, as well as memory issues,

and difficulty problem solving. The authors also discussed that people who exhibit cognitive symptoms "may have decreased ability to self-manage their symptoms because of lack of concentration, poor ability to plan and memory difficulties" (Bergman and Bay, 2010, p. 223).

Macleod (2010) stated that in many cases moderate or severe concussions do not develop into post-concussion syndrome, but mild concussions most often do. He also identified that for most individuals, post-concussion symptoms dissipate after three months, and that the symptoms will resolve spontaneously within days or weeks. For a small number, Macleod (2010) hypothesized around 5%, symptoms can persist for up to one year post-injury.

Second Impact Syndrome

Second Impact Syndrome is a severe risk associated with multiple concussions. Webbe (2006) described it as "injury induced vulnerability to further concussion" (p. 62). This involves the sudden collapse and death of individuals, many of whom had recently suffered another concussion.

Bowen (2003) reported that in "the minutes to several days following a concussion, brain cells that are not irreversibly destroyed remain intact but are in a vulnerable state produced by metabolic dysfunction" (p. 288). This vulnerable state means the brain is exquisitely sensitive to changes in cerebral blood flow, intracranial pressure or cellular hypoxia. In animal models, reductions in blood flow following soon after a concussion resulted in extensive neuronal cell death. The theory behind this is that the metabolic demand of the vulnerable tissue increases with injury, and thus, when there

is insufficient fuel supply to these tissues, the tissue dies. Bowen described Second Impact Syndrome as "rapid cerebral edema and herniation after a second head injury" (2003, p. 288). Second Impact Syndrome occurs when an athlete returns to play before the symptoms of an original concussion clear, and receives a second blow. Bowen described the series of events that occur with Second Impact Syndrome:

> The athlete usually remains on his or her feet for 15 seconds to 1 minute and often walks off the playing field unassisted. Within seconds to minutes following the second impact, the athlete collapses to the ground, semicomatose, with rapid pupil dilation, lack of eye movement, and respiratory failure (2003, p. 288).

While the pathophysiology of Second Impact Syndrome is not clear, it is believed to be due to disordered autoregulation of blood supply to the brain. This leads to intracranial vascular engorgement, causing a rapid increase in intracranial pressure (Bowen, 2003). She estimated that "the typical time from second impact to brain stem failure is rapid—an estimated 3 to 5 minutes. This catastrophic condition has a mortality rate close to 50% and a morbidity rate approaching 100%" (p. 289).

Denke also discussed Second Impact Syndrome, stating that "some experts have suggested that if an athlete sustains a second concussion (second impact syndrome) during this vulnerable time, this concussion can result in loss of cerebral autoregulation, leading to vascular engorgement and subsequent cerebral edema" (2008, p. 364). Denke also discussed the controversial nature of the existence of Second Impact Syndrome, arguing that "the literature suggests that this syndrome is a rare but deadly phenomenon that appears to be highest in children and adolescents" (2008, p.364).

McCrea et al. (2004) reported that most instances of Second Impact Syndrome have been linked with the player "not reporting an initial concussion or a reported injury

being improperly assessed or managed" (p. 15). The authors also defined Second Impact Syndrome as "when an athlete sustains a second concussion while still symptomatic from an earlier head injury" (p. 15). This is characterized by rapid neurological deterioration, often with no chance for medical assistance which leads to death or severe complications and disability (McCrea et al., 2004).

Youth Concussion

Many researchers have noticed a difference in concussion severity based on the age of the patient. Daneshvar, Nowinski et al. reported that "high school athletes appear to recover more poorly as compared with collegiate athletes, despite the latter typically incurring more acutely severe injuries as a result of being bigger, faster and stronger" (2011, p. 6). The evidence provided by the study showed that high school football athletes who had suffered a concussion exhibited poor recovery in the area of prolonged memory dysfunction (Daneshvar, Nowinski et al., 2011). The main theory to explain this is that the high school football player's brain may not be fully developed, which leads to a decreased tolerance for brain injury. This decreased tolerance includes more fragile blood vessels and a thinner skull. Daneshvar, Nowinski et al. (2011) also suggested other explanations for poor recovery including less medical access for high school athletes than college athletes, poor body control and technique, and less neck strength leading to more head movement with contacts. It is a general consensus however, that athletes with a history of concussion are more likely to suffer subsequent concussions than athletes with no history of concussion.

Denke (2008) reported that the increased susceptibility of high school athletes to mTBI may be due to many factors, including central nervous system immaturity, failure

to recognize the occurrence of a concussion, and the subjective nature of self-reporting concussion symptoms. She also reported that "children may undergo more prolonged and diffuse cerebral swelling after mTBI, which increases their risk of ischemia and intracranial hypertension" (p. 363). Denke also acknowledged reasons athletes may not report their injuries. This list includes, "fear of letting down their parents/coach; believing the injury was not serious enough to warrant reporting it; not wanting to be withheld from competitions; and even not being aware that the symptoms they were having were due to a concussion" (2008, p. 363).

McCrory et al. (2009) addressed how best to manage concussions among youth, discussing the need for age appropriate symptom checklists for the very young (below 10 years). The authors also discussed that cognitive testing should be developmentally sensitive as the brain continues developing until the late teen years which would compromise the baseline tests after a time.

Concussion in Football

While there is a high incidence of concussion in all contact sports, the sport that has been studied the most is football. A 2010 report by Casson et al. addressed concussion data from the National Football League (NFL). Using an NFL designed injury tracking system concussions were tracked for two consecutive six-year periods. Over the twelve years studied, 1545 concussions were recorded and monitored. Summarizing the results, concussion management became more conservative as time passed, with an 8% decrease in immediate return to play following concussion between the two periods. There was also a 6% increase in removal from play between the two periods. The results also showed an increase in documentation of actions taken by the medical staff members,

as the first period reported 15 concussions with unknown actions and 0 in the second period (Casson et al., 2010).

Daneshvar, Nowinski et al. (2011) conducted a study that compared concussion in many different sports, including football, basketball, soccer, wrestling and baseball. The authors concluded that concussions occurred more frequently in football than in any other sport studied. The study examined both high school and collegiate sports. Many more concussions were reported in collegiate sports, which the authors thought was due to collegiate athletes' increased access to medical professionals. The study also noted that "the increase may be because of medical infrastructure rather than differences in the number of actual concussions sustained" (Daneshvar, Nowinski et al., 2011, p. 6).

In their study regarding unreported concussions in high school football players, McCrea et al. (2004) discussed that especially among football players, "lack of knowledge about the potential consequences from head injury, failure to recognize concussion signs and symptoms, and the likelihood that athletes continue sports participation while experiencing head injury symptoms" (p. 14) is particularly high. These findings led the investigators to make the following suggestions regarding concussion education:

> Preparticipation meetings could be offered to educate athletes, parents, coaches, and others affiliated with athletic programs on the signs and symptoms of concussion and to dispel many of the myths about head injury… Multimedia … approaches also could be used to disseminate information on concussion management (McCrea et al., 2004, p. 16)

The authors also state that an athlete's honesty in reporting symptoms and their awareness of concussions are key elements in diagnosis and management of sports concussions.

Incidence

Lau et al. (2011) stated that "researchers estimate that each year approximately 3.2 million concussions occur in the United States, with 136,000 in high school-aged individuals" (p. 1). Neal McGrath (2010) stated that coaches should expect a rate of concussion in contact sports of 5-10%. McGrath also acknowledged that many student athletes may not report symptoms, and that coaches whose teams report no concussions may be missing signs and symptoms of concussion in their athletes. (McGrath, 2010). Moser et al. (2005) reported that data from 1983 shows that in high school football athletes 250,000 concussions were reported with 20% of athletes receiving a yearly concussion. In contrast, more recent research, as reported by McCrea et al. (2004), states that concussion incident rates are 3-6%. The National Center for Injury Prevention and Control estimates that approximately 1.5 million people experience traumatic brain injury each year, with up to 75% experiencing mild traumatic brain injuries (2003).

In a study conducted by Daneshvar, Nowinski et al., (2011) concussion incidence in football was examined at the high school and collegiate levels. The authors found that in high schools, athletic trainers diagnosed concussions at a rate of 0.21 per 1000 athlete exposures in practices and 1.55 per 1000 athlete exposures in competitions. In comparison to this, collegiate athletic trainers diagnosed 0.39 per 1000 athlete exposures in practice and 3.02 per 1000 in competition. This study generated statistically significant results in diagnosed concussion rates, which the study acknowledged may be due to the increased access collegiate athletes have to medical professionals (Daneshvar, Nowinski et al., 2011).

McCrea et al. performed a study investigating unreported concussions in high school football players. Prior evidence had suggested that the rate of incidence was 3-6% (McCrea et al., 2004). The researchers found that the rate of unreported concussions was so high that their study suggested a rate of concussion closer to 15% in high school football players (McCrea et al., 2004).

Education

McLeod et al. (2007) conducted a study regarding concussion knowledge in youth coaches. The authors reported that there is no national certification program for coaches, and in studies investigating first aid knowledge, the majority of coaches surveyed could not pass a basic first aid assessment. It was acknowledged that failure to identify a concussion could lead to long term side-effects or even death. Their study, which included a symptom identification list and true-false statements regarding concussion knowledge, found that there were indeed many misunderstandings among coaches regarding youth concussions. Forty-two percent of coaches surveyed thought loss of consciousness was necessary for a concussion to occur and 32% thought that a Grade I concussion did not require removal from play. Additionally, 26% of coaches surveyed would let an athlete who was still symptomatic return to play (McLeod et al., 2007). The study concluded that further education regarding sport-related concussion is necessary, as it could help to increase concussion reporting and thus decrease the number of athletes who play while symptomatic, which helps reduce the risk of recurrent injury. The study also suggested that increasing a coach's knowledge regarding concussions influences the reporting of concussions to medical personnel (McLeod et al., 2007). The study also mentioned that the Centers for Disease Control and Prevention have created the *Heads*

Up: Concussion in High School Sports toolkit, which provides a video, posters, fact sheets, wallet sign/symptom lists and other resources (2011). The results of this study led the authors to suggest that:

> The inability of youth coaches to recognize the signs and symptoms of sport-related concussion should prompt youth sports organizations to provide injury recognition courses, mandate that volunteer coaches complete these courses and consider hiring medical professionals with expertise in this area to ensure a safe sporting environment. (McLeod et al., 2007, p. 142)

Moser and Schatz (2002) discuss that knowledge regarding the effects and management of concussion is not only lacking in the general public, but in the general medical community as well. McGrath also discussed a lack of concussion knowledge, although he discussed it in relation to school personnel outside the athletic department, stating that they:

> May not be aware of the recovering student's needs or of the important role that guidance counselors, school nurses, social workers, psychologists, and teachers—working together with parents and the student-athlete's personal physician—can play in this process to help minimize the academic consequences of the injury. (McGrath, 2010, p. 492)

McCrea et al. (2004) reported that "athletes themselves may not be sufficiently aware of the signs, symptoms and potential effects of concussions" (p. 14). They also found that more than one third of players who did not report their injury failed to recognize that they might have a concussion. Once the athletes were supplied with a definition and sign/symptom list, "these players more readily recognized and admitted to sustaining a concussion over the course of the football season" (McCrea et al., 2004, p. 15).

Moser et al. (2005) discussed the need to educate in their study regarding prolonged effects of concussion in the high school athlete. The article states:

> What was particularly striking in the present study was the surprise and lack of knowledge that parents and athletes exhibited during the interviews. Many athletes described concussive events without ever having realized that concussions had been sustained. Parents frequently seemed embarrassed and alarmed listening to their children describe, for the first time, a mild hit that resulted in confusion, disorientation, "seeing stars" and headache. (Moser et al., 2005)

The authors also identified that many coaches, parents and healthcare providers are unaware of the hazards associated with concussions.

Maine

The state of Maine is home to the Maine Concussion Management Initiative (MCMI). This initiative is dedicated to "making computerized cognitive testing available to all high schools in Maine" (Maine Concussion Management Initiative)**.** MCMI is a group of professionals whose aim is to minimize the effects of concussion in Maine. The program is funded through grants and helps Maine schools purchase the ImPACT computerized testing program. ImPACT is a neurocognitive assessment tool for healthcare professionals to use to determine a baseline level for all athletes and to monitor progress of athletes with concussions. Schools that participate in MCMI sign an expectations form which establishes guidelines for management of concussions (See Appendix E)

The Maine Concussion Management Initiative Expectations Form (Maine Concussion Management Initiative) states that schools who sign on with the program "agree that MCMI can hold an educational session, as deemed necessary, with my coaches, parents and athletes" (MCMI**).** The topics covered in this meeting would be concussion recognition, the biology of concussions, why neurocognitive testing is

important, short and long term effects from concussions, and proper return to play guidelines (MCMI).

Chapter 3: Methodology

Institutional Review Board and Subject Recruitment

This research project was started by receiving permission from the University of Maine Human Subjects Review Board. An application and the proper documents were sent, reviewed and edits were provided and made. Permission for the research was given on September 1, 2011.

In Maine, high schools are divided into classes based on their size. Maine high school football has schools in class A (the largest), class B, and class C (the smallest). There is a class D as well, however there are not enough schools for a separate class D in football, these schools compete up in class C.

A list of high schools with football teams had been created, and following receipt of permission, letters of inquiry were sent to three schools in each athletic class (A, B, and C). After one week, follow-up phone calls were made. A second round of letters was sent to the classes that had not responded to find a school. The primary researcher was looking to find a total of three schools, one from each athletic class.

Interviews

Interviews were conducted with an administrator from the school, the athletic director, the head football coach and any members of the medical team at the school including athletic trainers, nurses or doctors. Interviews were arranged via phone, email or face to face. A list of questions approved by the IRB were asked and answers were recorded on the primary researcher's cell phone, an iPhone 4, which allowed the

researcher to interact more naturally and not solely rely on hand-written notes. Hand-written notes were also taken during each interview. No follow-up questions were asked and clarifications given were minimized and did not lead towards an answer to prevent research bias towards expected answers.

Practice Observations

Five full-contact practices were observed at each school. At practice the researcher will listen for coaching cues, and observe coaching strategies to prevent head injuries. The researcher also observed for signs of concussion during practice and, monitored staff actions to potential concussions. The researcher did not ask questions about concussions, or educate coaches or players about concussions. Notes about practice activities were recorded.

Game Observation

Two games were observed at each school. During the first game, the researcher observed from the stands, monitoring what the medical providers were doing, and if there was a sign of a concussion or an athlete with a head injury, close attention was paid as to what happened next. The second game was spent on the field with the team, watching for the same keys. One game was spent in the stands and one on the field to prevent responses being changed because the staff was aware of someone watching them and how they handled concussions. The coaching staff and medical team were unaware that the primary researcher was in the stands.

Transcription and Data Storage

At the completion of field research, each school received a randomly drawn code number. Audio interviews were transferred from the recording device to the researcher's computer, where they were stored, organized and transcribed. The researcher's computer is password protected and all folders containing research materials are password protected as well. Following the completion of all interviews, the audio recordings were transferred onto compact discs and labeled with the school's given number. Typed transcriptions of the interviews were made to aid in data analysis. Any identifying factors in the transcripts were removed to maintain subject confidentiality.

Written notes from practice and game observations and interviews were scanned into the computer where identifying factors were removed. Original notes were stored in a locked room. Scanned copies of notes were kept on the researcher's computer. Any hard copies were destroyed when they were no longer needed for research.

Data Analysis

Following completion of transcription, the interviews and notes were reviewed and coded for themes. Multiple reviews were performed to ensure consistency in theme development and the development of a comprehensive understanding of concussion education, diagnosis and management in the three Eastern Maine high school football programs. Triangulation was performed by examining interviews, findings from direct observation and findings from notes taken. Triangulation helps to ensure that the interviewees are not just saying what they think the researcher "wants to hear."

Themes were analyzed and the primary investigator developed recommendations using the data found and the information from the literature. These recommendations were based solely on research performed by the investigator and not by any prior knowledge or information.

Chapter 4: Results

Participants

Participant schools were from Eastern Maine and were selected via response to a letter of inquiry sent out by the primary investigator. Schools chosen were the first respondents from their respective athletic class. One school from classes A, B, and C were studied. Participants interviewed consisted of the football coaches, the assistant principals, the athletic directors and any members of the medical teams for each school. At schools one and three the only members of the medical team were the athletic trainers. At school two the medical team consisted of the athletic trainer [ATC], the school nurse and a local doctor. Interviews were conducted using a set list of questions and were recorded on the primary investigator's iPhone4. Interviews were later transcribed by the primary investigator. The interviews were analyzed and the following nine themes were found.

Honesty

Honesty is a theme that came up in many interviews. Honesty is very important in concussions, as a concussion is an internal injury. A young athlete may not exhibit any visible symptoms, unlike those seen with an ankle sprain; however, this does not mean that they are not injured. Athletes must be honest in regard to their symptoms so the members of the medical team can accurately track their recovery.

This theme was mentioned at all three schools. The athletic trainer from school three stated:

> What I tell them is that it can lead to death and that they need to be very honest with me about their symptoms… not to try to scare them but to try and put it into

> what can actually happen so that they will be very honest with me because I know they just want to play.

This was also echoed by the coach at school two, who stated, "You're talking about a kid telling you what happened [when they have a history of concussion] and kids don't always remember and kids aren't always 100% honest too." Honesty was also mentioned by the athletic trainer for school two, who said:

> They have to report them. It's not like something, like spraining an ankle or getting a Charlie-horse, when you're going to tough it out. I need to know that you got hit in the head and we're going to follow up.

The athletic trainer from school one emphasized being a good teammate as another component in honesty saying, "We actually kind of talk about being a good teammate and sharing with the staff when one of their teammates doesn't look well or is having trouble with remembering things on the field." The athletic trainer continued discussing honesty in regards with the athlete returning to play:

> It's a process to return to play and they have to be honest with me, because it's not like an ankle sprain where you can see the injury, it's an injury in the body, only they know when their brain is working correctly… every couple of days re-evaluation of the symptoms that have remained positive- but really trying to get them to be honest.

This theme was found in all three schools, although the people who mentioned it were either coaches or athletic trainers. These are typically the people who know the student-athletes best and see them the most, which means they more likely to be aware of honesty playing a role in concussion management.

Communication

Communication and errors in communication make up another key theme. It is very important for the athlete to communicate with the medical team, and for the medical

team to communicate with teachers, coaches and parents. Increased transparency in concussion management is very important to keep all involved members informed as to the individual developments in each athlete's case.

Communication was a theme mentioned by many people as a key aspect of a concussion management plan. Both the athletic director and an assistant principal at school one mentioned a parent and player athlete meeting that was held at the beginning of each athletic season. The athletic director stated:

> We, [ATC], during preseason have parent/player meetings; [ATC] goes through all the symptoms with them and their parents. And makes sure that they understand that she will not let them go onto that field until she's 100% sure that they are okay.

(Names have been changed to maintain participant confidentiality. Hereafter names will be denoted in brackets with the job title.) At school two this theme was mentioned by the athletic director, the athletic trainer, the coach, the nurse and the doctor. School two uses the school nurse as a main player in concussion management. The way the school handles communications between the athletic trainer and the nurse is through accident reports filled out by the athletic trainer. The nurse then follows up with the players during the school day.

School two also uses a doctor as a part of their concussion management program. The athletic director described how the doctor was integrated with their concussion management program:

> We work in conjunction with the local doctor's office so that doctor will read the results and if need be that doctor would have the student and parents come in and they would have their follow up through the doctor… typically the doctor tells us which direction he wants the student to take.

The nurse also discussed how the doctor will discuss the student-athlete's needs with his parents and if needed, will provide referrals to other healthcare providers.

At school three there were some communication discrepancies. The athletic trainer discussed the return to play protocol and stated that this decision was made by her, depending on SCAT-2 results returning to normal and symptoms resolving. The athletic director stated that the return to play decision should be made by a physician:

> That should be done in the doctor's office to find out what they're capable of doing. I'd rather not have our kids or our coaches find that out on the fly. If a student has been cleared to come back to activity with us, I hope that they've gone through some testing to determine that so we don't find out the hard way here. I can't speak for doctors but I'd imagine that that's got to be somewhat standard in order to release a patient back to activity.

The athletic trainer from school three also discussed a coaches' meeting to discuss concussion education and management strategies. She also mentioned individual meetings with coaches to discuss an individual athlete's return to play progress.

Education

One theme that was extremely clear was the need for education; it was one of the most frequently mentioned themes. Many of the participants interviewed mentioned educating teachers, athletes, coaches or parents regarding concussions and concussion management. As modern science continues to learn more about the brain and how concussions affect young football players it is important to share this knowledge with all the stakeholders. Education can help prevent serious complications due to multiple concussions, by informing people about conditions like post-concussion syndrome and second impact syndrome. It is only through educating people that understanding of the

severity of concussions will develop among the general populace. Educating the players was mentioned by the coach at school one, who said:

> Well, we teach our tackling is numbers on numbers, you take your chest and you put your numbers on his numbers, and we teach sink your hips, bow your neck, keep your head up. At worst your facemask should, we call it bite the football where you put your facemask on the football itself. We never teach lower the head at all.

All of the coaches emphasized teaching and practicing proper tackling technique to the players. It is also important to ensure that the coaches receive education relating to concussions. The athletic director from school one mentioned a new rule from the Maine Principals' Association, "All of our coaches are required by MPA rules to watch a mandatory concussion video, which is about a 20 minute video, through the National Federation of High School Sports." It was also clear that while administrators may have been aware of concussions and the education students received regarding concussions, many of them did not fully understand the dangers of a concussion. The athletic director from school one described an incident with the superintendent, who wanted to cut the sports medicine budget and how it wasn't until a parent came in praising the athletic trainer's management of her son's concussion that the superintendent understood.

Educating the teachers was also discussed by several people. The nurse at school two discussed her role in this:

> The other nice part about the ImPACT program is that I can now educate teachers more about what to look for in the classroom, what to expect from the athlete in the classroom. Before, that really wasn't part of my repartee; it was really just about returning to play, whether they could play or not. Now it's not just can they return to play but I also give recommendations to teachers about what they can and can't do right now with their concussion. So I think it's been an education for the teachers as well, I ask that they not have the student take a major test while they're impacted by the concussion, that they get copies of notes, things like that depending on what their specific results are from the tests.

For some, concussion management itself is a learning and educational process. The athletic director from school three describes how concussion education has changed and the new strategies for educating teachers:

> We try to further education of it not only from an athletic standpoint but how it impacts the student in the classroom. So, you know the importance of getting that information out from our trainer to the individual's teachers to try to make accommodations for them in the classroom is something that we just really started doing a couple years ago.

One of the most important aspects of education is educating the parents and students about concussions, whether this occurs as a pre-season meeting, as at school one; or after a concussion has occurred, as at school 2.

Testing and Assessment

It is important to understand how each school tests and assesses their student-athletes for concussions. This includes baseline tests, on-field and sideline evaluations, post-concussion screening and the return to play protocol. Each school fully discussed their testing and assessment plan. A common theme was the ImPACT program, which two of the schools currently used and one school had recently ordered. All of the schools used a baseline test, either the ImPACT or the SCAT-2 test.

In following with the Zurich Consensus Statement, a graded return to play protocol was used by all schools. The athletic trainer from school three discussed this:

> The follow-up care, our policy is they have to see me every day. We do a symptoms checklist; make sure they have no symptoms. If they have any symptoms they still stay at rest. If they have no symptoms then I exert them on a bike, a stationary bike for 10 to 15 minutes, on a stationary bike right in the athletic training room. If they have no symptoms I have them go out on the track, and with coaches, coach knows this, so they are in supervision, if they feel any symptoms at all on the bike they need to let me know. I stop them immediately as soon as they start feeling it, so they are aware that as soon as they start feeling it they have to let me know. Then they get exerted for 10-15 minutes outside on the track and then after that they put their equipment on, they run around for 10-15 minutes… make sure there are no symptoms. Then after that we do contact on the sidelines, one on one, talk to coach, tell them there can be no symptoms,

> cause I can't be outside at every practice, so coach, player and myself have a conversation. Once they show no symptoms at that they are put back into play. They go right back to rest if there are any symptoms and we start back at square one.

The athletic trainer from school two walked through his sideline evaluation for a suspected concussion:

> I ask them how they feel, look in their eyes. Definitely now—we used to do some neuromuscular, check their arm strength and that and their Romberg sign. And now it basically, if I know they have headache or nausea, or dizzy I can tell they're not right, I don't bother to do a whole lot of testing. They are definitely held out and I pursue it from there. I make sure their parents are talked to and they follow up with their doctor. Sometimes it's nice to do some subjective tests but the best thing is to wait a couple of days and take the ImPACT test.

Some people, mostly administrators, were not aware of different testing and assessment methods, however they all were confident that the athletic trainer or emergency medical providers would be sufficient. An assistant principal from school one stated, "If I saw that a player had been severely hit, I would look to the trainer and if the trainer wasn't available or a medical staff member I would probably call 911."

MPA Oversight

The Maine Principals' Association has recently enacted a new rule stating that all football coaches must watch a video released by the CDC regarding identification of concussions. Several people interviewed mentioned this and how it impacts coaching. As mentioned above, the athletic director from school one described how all coaches had to watch a video and take a quiz regarding concussions. This was also mentioned by the coach at school three, "And we all had to take that video before we could coach in our first game." This requirement makes concussion education an important requirement for coaching. The athletic director at school three also mentioned this video, "All of our coaches are required by MPA rules to watch a mandatory concussion video, through the

National Federation of High School Sports, which I watch with them." Through policies like the watching the video and taking the subsequent quiz the Maine Principals' Association is progressing towards a uniform concussion policy statewide.

Changes in Point of View Over Time

Many of the interviewees have been working in their fields for many years; some of the coaches had over 35 years of experience playing and coaching football. The people who have been involved in football or sports for years have witnessed a paradigm shift in terms of concussion management. It has only been in the last 10 to15 years that concussion awareness has really come into the light and currently there are extensive amounts of research occurring in the field of concussions. This increase in knowledge and understanding of concussion has led to many changes in education, diagnosis and management of concussions. Concussions went from a "ding" or "getting your bell rung" to a serious brain injury. This paradigm shift presents a problem, as people who grew up with the older ideas have to adjust with the times and learn to treat concussions as a true problem with potentially catastrophic effects.

These changes over time were mentioned by many people in interviews. The athletic trainer from school one stated, "So I guess we're more careful when a kid reports symptoms of a concussion, when they have any symptoms they sit and they're done. Which wasn't totally the way we handled them 10 years ago." This theme was also mentioned by the coach at school one who said, "But the awareness just wasn't there then, at the time, but now just over the last probably five years I've started to notice now what to look for, tell tale signs." He discussed his process of learning through experience and how he learned to identify potential concussions among his players.

At school two the idea of a change in point of view over time was mentioned by the school nurse, who elaborated on specific changes in concussion management that have occurred over the years:

> I know a whole lot more than I knew previously; I think medical science, all of it, knows more about concussions in the last few years than what we knew before. What I used to think was that if they were symptom free, then they were fine to play. If they were lucid, alert and oriented, if they didn't have any amnesia, if the headache was minimal then they were fine to return to play. What I know now is that that is not necessarily the case, that there are a lot of things going on besides the obvious symptoms and the ImPACT testing that we now do has really brought that home for me that a lot of these kids who are injured we would have returned to play a long time ago and according to the ImPACT testing they're nowhere near going back to play, you know they're still having visual memory issues, verbal memory issues fogginess, even though they might be headache free they can still have those symptoms.

This theme was also mentioned by the athletic director at school three. He mentioned a more personal experience relating to concussions:

> I mean the word concussion just wasn't a buzzword back when I played in the early eighties. So I just, you have to wonder when we played at that time and even the people that played before that and at the NFL level and the collegiate level how many people suffered concussions and didn't know about it? You know? So I mean I can vividly remember games where I came home, and not to the point where I wanted to be sick or anything, I wasn't, I know now that people can vomit and they can feel nausea and those types of things. I can't remember ever feeling that way after a game, and if it was I didn't relate it to a concussion, I thought it might be because I was dehydrated or something like that.

This is a critical point in time in terms of concussions, as this is the time to build an understanding of concussions from a young age with current and upcoming athletes.

Misconceptions

As mentioned above this is a time of greatly increased knowledge in the realm of head injuries. This means that many people involved in sports may not be aware of the

most accurate concussion information. It is important to identify common concussion-related misconceptions in order to correct them and prevent them from being propagated.

One misconception mentioned was from one of the assistant principals from school one:

> I don't know if it's written or just a protocol that you have to sit out for so many practices and games after you've been diagnosed with a concussion and you have to actually bring a note from the physician saying that you're okay to play.

This statement uses an older perception of concussions. Currently a player is not allowed to participate in any kind of activity while they have any symptoms; it is not a matter of sitting out a certain number of practices. The players at school one also do not have to bring in a note from their physician, the return to play decision is based on their symptoms and their ImPACT scores. This misconception of a doctor's note being required to return to play was also stated by the athletic directors at school one and school three. At school three, the athletic director stated:

> So that individual cannot come back to activity until we get cleared through a doctor, not our trainer. Our trainer gives that first direct assessment and then that's followed up with a medical appointment and we go on what the doctor says.

Misconceptions can represent communication discrepancies in schools.

Personal Connection

Another theme that was very apparent was a personal connection to, or understanding of concussions. Many of the coaches, athletic trainers or athletic directors experienced concussions first-hand in their own sports careers. Several of the administrators had family members who had experienced concussions or brain injuries.

This factor may play a role in willingness to comply with concussion management policies, as first-hand experience helps to increase understanding.

The theme of a personal connection was mentioned by the coach at school one who described a basic awareness of a head injury following an impact to his head:

> I think the first time I really experienced it was my sophomore year in high school. I played quarterback, I rolled out and tried to hurdle a kid and got dumped on my head and the next thing I remember was the trainer putting the smelling salt in my nose and I didn't know what concussion was, but I knew something had happened, either I got knocked out or some sort of head trauma had happened.

Several other people mentioned football related injuries and concussions that they had personally experienced.

Several people also mentioned family ties to head injuries. One administrator has a son who experienced a concussion at a young age and is still suffering from side-effects related to his concussion at age 40. The athletic director at school one discussed his daughter's experience with concussion during a college basketball game:

> Well, the only experiences I have is when my daughter played [in college], she got bumped by an elbow and [ATC] held her out for at least 2 weeks. And as a father, who wants his daughter to play, I said "she only had an elbow to the head," a slight elbow I thought. But [ATC] would not let her play until all the symptoms were gone, and to make a long story short she's okay today, probably because of [ATC]'s taking precautions.

A personal connection to concussions can help build awareness and understanding of the severity of concussions. This can help reinforce educational information and can help build advocates for proper concussion management.

Knowledge of Players

Many of the athletic department staff members, including the athletic directors, coaches, and athletic trainers mentioned how important it is for the coaches and medical staff to know the athletes. Knowing the players can mean having an awareness of their medical history, their mannerisms and general characteristics. Having a basic knowledge of the players can help diagnose concussions better as small personality or mannerism changes due to a concussion would be noticed more than they would be by someone who had no idea who the players were or how they acted prior to an injury.

The athletic trainer at school two was new to the school and addressed not knowing the players as a potential disadvantage in not knowing the player's histories, "First of all at [former school] I was fortunate because I'd knew the players for years. At my current school I am just starting to find out." He also discussed working with the school nurse and the benefits of that:

> She [the school nurse] knows the histories, she follows up. I had one the other day a person that was elbowed with 5 seconds left in the game. She followed up because she knew the kid was a hockey player who had a couple of concussions before.

The athletic director at school one stated, "She [ATC] knows every single one of them and I think that's a wonderful thing." While discussing how to determine whether a player may have a concussion the coach from school three stated, "just having a conversation with him about 'where are you,' 'what's your girlfriend's name,' some things I might know about him." Knowing the players and their medical history gives the coaches and medical staff another tool in concussion diagnosis as they may pick up on the more subtle personality changes that can occur with concussions.

Chapter 5- Discussion

Recommendations

Based on the literature and the findings from the research, five recommendations have been created:

1. The first recommendation is that the Maine Principals' Association should make a policy making computerized neurocognitive testing mandatory for all Eastern Maine high schools. Maine has the benefit of the Maine Concussion Management Initiative (MCMI), which helps provide funding to schools interested in signing on with the ImPACT program for the first two years. While ImPACT is an excellent program, there are other computerized neurocognitive tests available for use that are suitable (McGrath, 2010).

One benefit of using a computerized test is that the test cannot be learned. Athletes may become more familiar with the set-up of the test; however it is not easily memorized. A paper test, like the Standard Assessment of Concussion (SAC) can be found online and easily studied to meet standards (See Appendix C). If a test has been memorized, it does not provide an accurate assessment of the athlete's level of function with the concussion. Computerized testing also eliminates tester bias; the results shown are the athlete's results without any input from the tester.

A computerized test also evaluates many aspects of brain function. ImPACT, for example, provides a symptom checklist and tests verbal and visual memory, attention span, processing speed and reaction time, all of which may be affected by a concussion.

Computerized testing also maintains a database of baseline tests and prior tests. For students without a baseline, they also provide norms for age and gender groups to help determine based on the norm whether or not a concussion has occurred.

2. The second recommendation suggested is that along with a permission slip for participation in a baseline computerized testing program, there should be a mandatory meeting for parents and athletes. This meeting would discuss concussions, their symptoms, management strategies and would generally educate both parents and students regarding the seriousness of concussions. Many of the interviewees mentioned honesty as a factor concerning concussions. As concussions are not necessarily a visible injury, it is crucial for students to accurately report their symptoms to their coach or the members of the medical team. If the importance of honesty can be conveyed during the meeting this may help increase concussion reporting.

As mentioned above, this is a crucial time in knowledge development in the field of concussions. Recently a much more conservative method of managing and diagnosing concussions has been recommended. Although this protects the athletes in the long run, many people are resistant and do not see the concussion as a true brain injury. It is crucial to educate both players and parents about this, as they are very important members of the healthcare team. At school two, several of the people interviewed mentioned a case involving a football player who was playing hockey on a private club team, not part of the school athletic department. This athlete had suffered a concussion and was aware that he had not fully recovered. The medical staff and the athlete himself agreed that he should not play in a hockey tournament that weekend; however, his parents were strongly

pushing that he play that weekend. It is cases like these that emphasize the need for proper concussion education, for all stakeholders.

While education about the symptoms and severity of concussions is extremely important, it is also important to address concussion management in these meetings. Like many injuries, rest is a key factor in overcoming a concussion. Brain rest is known as cognitive rest, which involves removing any possible brain stressors. For the athlete this means not texting, watching TV, playing videogames and in some cases not being around noise or light. True cognitive rest involves resting in a darkened room. Like immobilizing an injured joint, cognitive rest allows the brain to focus on healing, rather than adjusting to light changes, texting or trying to focus in class. The nurse at School two emphasizes the concept of cognitive rest stating:

> One of the things I'm finding is most important to educate about is what it means to rest your brain because most athletes when they think of rest think of not moving. With a concussion it's totally different, brain rest is totally different, and what most teenagers don't want to hear is that I'd prefer they not play video games, computers, things that require a lot of brain activity and that they get a lot of stimulation from. That it really means sleeping as much as you can, being in a dark room, not having a whole lot of exposure to multiple stimuli.

This concept may not be emphasized enough in concussion management programs, as evidenced by Austin Trenum's story in the introduction; he played video games, went to a concert and went fishing, which does not constitute rest, let alone cognitive rest.

3. The third recommendation is for the athletic trainer or chief medical provider in the concussion management program to hold a meeting for school administrators and teachers to educate them regarding concussion management in the classroom. This helps to provide a more global treatment plan, to help set the student-athletes up for success. Certain accommodations may need to be made for an athlete recovering from a

concussion, and teachers should be made aware of this. The accommodations listed in Neal McGrath's article "Supporting the Student-Athlete's Return to the Classroom After a Sport-Related Concussion" (2010) can provide a jumping-off point for individual schools to decide which accommodations they can provide for their students. The athletic director at school three discussed information distribution to the teachers, "You know the importance of getting that information out from our trainer to the individual's teachers to try to make accommodations for them in the classroom is something that we just really started doing a couple years ago." The nurse at School two also discussed involving teachers in the concussion management plan, "I also give recommendations to teachers about what they [the student-athletes] can and can't do right now with their concussion."

These meetings would also help administrators better understand concussions and the effects they can have on students. Several of the administrators interviewed were not aware of concussion management plans or even who was in charge of administering the concussion management plan. School one is a part of the Maine Concussion Management Initiative, which uses the return to play guidelines provided in the ImPACT program, these state that an athlete will not return to play unless their test scores have returned to the baseline level. One administrator was unaware of the guidelines stating, "And if any parents want to go above her in any way, then we're going to have to have a doctor's note saying that she or he is allowed to participate." This demonstrates a lack of knowledge of the MCMI protocol, which states that unless the ImPACT scores have returned to baseline level, no doctor's signature should be allowed to override the return to play decision.

4. The fourth recommendation is promoting the more widespread use of objective concussion screening tools to rule out the question of honesty. Many people do not yet appreciate the seriousness of an injury like a concussion. This, compounded with a strong desire to play, can lead to players underreporting their concussions (Denke, 2008). Several people mentioned honesty as a factor in concussion diagnosis and management in interviews. It was consistently mentioned by coaches and the athletic trainers, which is logical as they have the most interaction with the players.

A great deal of the work in increasing honesty among players is education, as shown by the interview with the athletic trainer from School one, "we actually kind of talk about being a good teammate and sharing with the staff when one of their teammates doesn't look well or is having trouble with remembering things on the field." Education with the players is a key element; however, in order to prevent a question of honesty, more objective concussion assessment tools should be used. These tools include computerized neurocognitive testing. Because a computer administers these tests, there is no chance of bias from test administrator interpretation. Another such tool is the Balance Error Scoring System (BESS test), which assesses the vestibular system and balance. This is a test that cannot be learned, and a baseline can be established pre-injury. Other concussion testing tools like the Sport Concussion Assessment Tool 2 (SCAT-2) use the BESS test as a component. Both the BESS and the SCAT-2 are easily available for download on the internet. Tests like the Standard Assessment of Concussion (SAC test) are widely used and may give the clinician a good idea of whether or not the athlete has a concussion; however, there are 3-5 readily available forms, and the test can be learned

easily by athletes (See Appendix C). This test may lose effectiveness unless the clinician is guarded and uses varying forms or changes the test elements himself.

5. The fifth recommendation is to enact a uniform testing and return to play protocol at all Eastern Maine high schools. This would ensure that all students in Eastern Maine are operating on the same playing field. If all schools are evaluating their players with the same tools and using the same return to play protocol, this will help establish a standard of care for the whole area. If a student suffers a concussion at one school, he will receive the same treatment that he would have received at his own school, something that does not happen currently. Both the coach and athletic trainer at school three mentioned an incident where students received concussions at another school, and were not seen until the end of the game. The school they had travelled to did not have an athletic trainer on staff, so these students were seen by the emergency medical technicians covering the game and referred to their athletic trainer on Monday. If there had been a uniform testing procedure, these athletes would have been seen immediately and they would have received the appropriate care much sooner.

Conceptual Framework for Concussion Management Involvement

In accordance with the above mentioned recommendations, a conceptual framework for concussion management has been designed. This framework emphasizes a web-like organization, where all members of the medical team, including coaches, players, parents, teachers, administrators, school nurses, and athletic trainers, are involved in decision making. It is very important that each of these groups be kept in the loop and apprised of the athlete's progress. The goal of a concussion management program is to maintain a general framework and to tailor it to each athlete's needs.

Bearing in mind that concussions do not stay on the athletic field, it is important to integrate teachers into the process as these athletes are primarily students. If these students are suffering from the effects of a concussion, they may not be able to take a test, focus in class or do their homework. It is important for teachers to understand that these students are suffering from a medical problem, not being lazy. Students with concussions may not be able to focus in class, or be able to deal with the bright lights and noises of a classroom.

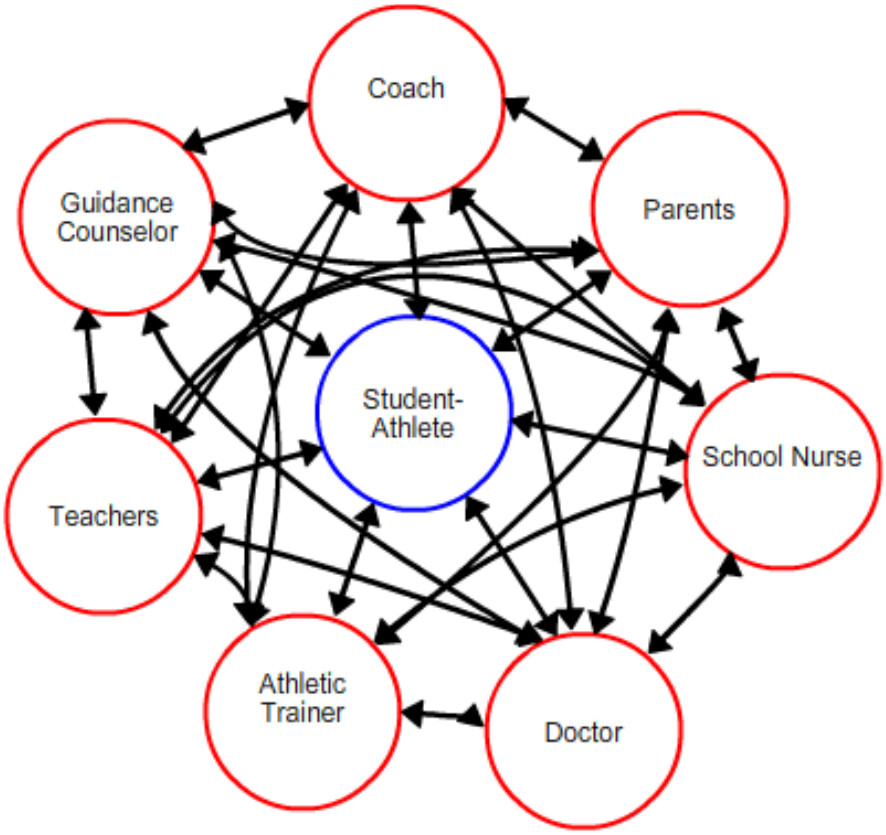

Figure 1: Conceptual Framework for Concussion Management

A multidisciplinary team approach was selected for the framework of this concussion management plan. A multidisciplinary team consists of professionals from

diverse professions (Sherrill, 1998). They work as equals and communicate equally to develop the best treatment plan for each player. In this case the student-athlete would be the center of the web. As seen above in Figure 1, each member of the team works and communicates with each other for the benefit of the student athlete. Communication is one of the most important aspects of concussion management, because without effective communication, members of the medical team would not be aware of the student-athlete's current status and treatment plan. Members of the team would include the coach, the parents, the school nurse, the certified athletic trainer, the teachers, the guidance counselor, and the doctor. With concussion management it is vital that information is distributed to all members of the team; the recommendations from the doctor, nurse and athletic trainer must reach all people in the team. Each member of the team has a definite role as delineated below:

Coach

The role of the coach is to be alert and aware of the state of his or her players. In many cases the coach is the primary responder at practices and as such, must monitor athletes for suspected concussions incurred at practices and games. The coach must also learn not to pressure athletes into returning to play early and must provide encouragement throughout the season for his or her athletes to be honest about potential signs or symptoms of injury.

Parents

The parents have the role of home care provider. If the parents do not receive or understand instructions for care at home after a concussion then the athlete may not

follow through correctly with care instructions. The parents know their child better than anyone else in the team and can serve as the most accurate judge in determining whether the athlete has changed due to his or her injury. In many cases the parents are also the gateway to treatment as most high school students are below the age of 18 and must have parent or guardian consent.

School Nurse

The school nurse is underutilized in many schools. The role played by the school nurse is to provide care during the school-day, to administer neurocognitive testing and to contribute to the return to play decision. The school nurse has access to the students during the day and can administer baseline and post-injury tests during the students' study hall periods. In many cases the school nurse is more familiar with the teachers and can help distribute information to the teachers. The school nurse can also provide a place for concussed student-athletes to rest in a quiet area for brief periods when school becomes overwhelming and their symptoms worsen.

Athletic Trainer

The certified athletic trainer is the chief provider of emergency care and concussion education and evaluation. As a healthcare provider the athletic trainer understands concussions and the dangers associated with concussions. In the team, an athletic trainer provides care during practices and games, and oversees testing. The athletic trainer can administer baseline tests, contribute to the return to play decision and oversee the return to play process.

Teachers

Teachers play a key role in the multidisciplinary team. The teachers work with the athletes and must be aware of concussions and the side-effects that may be apparent in the classroom. Teachers should be flexible and help work with the team to reduce academic stressors on the student-athlete and if necessary, provide assistance for the athlete to help deal with his or her symptoms.

Guidance Counselor

The guidance counselor plays a role in helping the athlete interact with teachers and monitoring the athlete's educational status. The athlete may fall behind as a result of symptoms of his or her concussion and the guidance counselor monitors grades and checks in with the athlete regarding their classes. The guidance counselor can oversee the assignment of a tutor or help the athlete receive copies of notes or other study tools that support the athlete. The guidance counselor can also help reschedule non-critical tests that the athlete may have to take to prevent poor scoring due to a concussion.

Doctor

The doctor plays a critical role in concussion management. He or she can receive training to interpret neurocognitive testing results and can also provide care guidelines for teachers, parents and the athletic trainer. The doctor can also serve as a gateway to further medical care, including CT scans or MRIs, and access to other professionals like neuropsychologists and neurologists.

These professionals can all work together to help establish a working relationship that tailors the concussion management plan to each student-athlete's individual needs. This is key as no two concussions are alike, just as no two student-athletes are alike. A multidisciplinary team enables each professional to play a role and communicate equally with one another.

Potential Sources of Research Error

A major source of possible error in the data collection was the primary researcher's interference. At the third observed practice for school two the primary researcher became concerned that one of the players had suffered from a concussion. She monitored the situation, and 15 minutes following the original incident the player was still playing, and complaining of a headache. The researcher had heard the player discussing with a teammate his desire to play on Monday's junior varsity game. The researcher felt it was prudent to protect the athlete rather than maintain the quality of her data. The question was for the safety of the athlete, and so she brought the incident up to a coach, who subsequently removed the athlete from play for follow-up by the nurse at school the next day.

Another possible source of error in this experiment is lack of experience on the part of the primary researcher. At certain points the researcher found it hard to distance herself from her research, leading to the error mentioned above. Her personality and educational experiences are such that she felt compelled to intervene when a student may have been placing himself in danger by not reporting a potential concussion.

One possible source of error is that all schools studied were the first respondents in their respective athletic classes. This could mean that these schools have better concussion management programs than schools that did not respond, or took longer to respond to the letter of inquiry. It is certainly of note that all three schools studied had a certified athletic trainer on staff, who attended all football games.

Potential Research Bias

There are several sources of possible bias in this study. The first and most likely is the fact that the primary investigator has a great deal of educational background regarding head injury. This was an influencing factor in the decision to report the school two student who was complaining about a headache at a practice. The investigator knew from her education that many athletes do not report concussions to their coaches, due to a fear of being pulled from play; however, she felt that it was more dangerous for the player to continue playing with a potential concussion.

A second possible source of bias is the investigator's knowledge of the general socioeconomic status of the schools. As a Maine resident, she is aware of the general stratification of wealth around cities and large towns. The percentage of students eligible and utilizing the free or reduced hot lunch program acts as an indicator of socioeconomic status (SES). School one has approximately 50% of its students eligible for free or reduced hot lunch as of October 31, 2011. School two has approximately 25% of its students eligible and school three has approximately 27% (Maine Department of Education, 2011) These factors may have played a role in the investigator's bias as it may have been expected for the suburban schools (two and three) to have better concussion management strategies due to more funds being available. School one is in a more urban

area, where generally there is less funding available. Some may also believe that the larger schools would have larger budgets available to fund concussion management programs; however, the investigator did not think this would be true due to geographical location.

Future Research Recommendations

If this research was to be conducted again the researcher would spend an entire season with each team. A longer time spent with each team would help negate any changes at the practices due to an observer being present. The coaching staff, medical team members and the administrators would be more comfortable with the researcher, as his or her presence would become a normal occurrence. A greater amount of time spent with each school would also potentially allow the researcher to see more concussions, which would generate more valid data. An inherent problem with interviews is that the person being interviewed may feel uncomfortable with the interview process, which may prevent them from accurately conveying the depth of their knowledge.

Another aspect of research that could be examined is the student-athletes' awareness of concussions and their symptoms and risks. This could be done using a survey or by using interviews. This could help researchers learn how well students retain information or how seriously they take concussion education. If a survey was used it could be validated and these kinds of studies could take place in more locations than Eastern Maine. This could help health care providers and coaches ascertain how seriously the players take concussions. Research could also be performed examining coaches and other members of the medical team to determine their on-field evaluation and treatment of suspected concussions.

Conclusion

Concussion in sport is currently the up-and-coming topic in terms of research and medical awareness. While there are many studies and efforts being put into concussion education, diagnosis and management in professional sports, it is also crucial to perform these studies at the youth and high school level, as children are at a great risk of complications due to concussions.

Following observations and interviews, recommendations have been made to help develop the Eastern Maine concussion management protocol. These include developing a uniform treatment plan for all schools, educating players, parents and teachers regarding concussions and integrating objective testing measures to assess concussions. While the focus of this research was high school football, these findings and recommendations can help guide all schools in Maine to develop better concussion diagnosis and management strategies in all sports. Information like this can help prevent the people of Maine from experiencing the tragedy of a young athlete dying as a result of a concussion.

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Appendix A: IRB Application

APPLICATION FOR APPROVAL OF RESEARCH WITH HUMAN SUBJECTS
Protection of Human Subjects Review Board
114 Alumni Hall, 581-1498

PRINCIPAL INVESTIGATOR: Sarah Lockhart
EMAIL: sarah.lockharta@umit.maine.edu **TELEPHONE:**
CO-INVESTIGATOR(S):
FACULTY SPONSOR (Required if PI is a student): Christopher Nightingale
TITLE OF PROJECT: A Study of Concussion Education, Diagnosis, and Management in Three Eastern Maine High School Football Programs

START DATE: 08/24/2011 **PI DEPARTMENT:** EDHD
MAILING ADDRESS: 65 Crossing Brook Road, Cumberland, ME 04021
FUNDING AGENCY (if any):
STATUS OF PI:
FACULTY/STAFF/GRADUATE/UNDERGRADUATE U

1. If PI is a student, is this research to be performed:

X	for an honors thesis/senior thesis/capstone?	☐	for a master's thesis?
☐	for a doctoral dissertation?	☐	for a course project?
☐	other (specify)		

2. Does this application modify a previously approved project? N (Y/N). If yes, please give assigned number (if known) of previously approved project:

3. Is an expedited review requested? Y (Y/N).

SIGNATURES: All procedures performed under the project will be conducted by individuals qualified and legally entitled to do so. No deviation from the approved protocol will be undertaken without prior approval of the IRB.

Faculty Sponsors are responsible for oversight of research conducted by their students. By signing this application page, the Faculty Sponsor ensures that the conduct of such research will be in accordance with the University of Maine's *Policies and Procedures for the Protection of Human Subjects of Research*.

Date	Principal Investigator	Faculty Sponsor
	Co-Investigator	Co-Investigator

****

FOR IRB USE ONLY Application # 2011-08-06 Date received 8/15/2011 Review (F/E): E
Expedited Category: _____

ACTION TAKEN:

X Judged Exempt; category 2. Modifications required? Y (Y/N) Accepted (date) 9/6/2011
___ Approved as submitted. Date of next review: by _____. Degree of Risk: _____
___ Approved pending modifications. Date of next review: by _____. Degree of Risk: _____
Modifications accepted (date): _____.
___ Not approved. (See attached statement.)
___ Judged not research with human subjects

Date: 8/18/11 Chair's Signature: Cynthia A. Erdley 10/09

Appendix B: Interview Questions

Interview Questions

- How many years have you been involved in football?
- How many years have you been involved in high school or youth athletics?
- What do you know about concussions?
- What are your experiences with concussions?
- Are there any school policies on concussions? If so, what are they?
- Do you give your players a baseline test? If so, what kind of baseline testing?
- How do you determine if a player has a history of concussion?
- How do you assess a player on the field who you think might have a concussion?
- What kind of follow-up care and assessment should a player with a concussion receive?
- After a player has had a concussion what is your return to play protocol?
- How do you check a helmet's fit on a player?
- How do you teach your players to prevent head injury?
- What are the symptoms of a concussion?
- What do you tell your athletes about concussion?

Appendix C: Concussion Diagnosis Tools

Standardized Assessment of Concussion (SAC Test)

Assessment of Concussion - SAC

Name:_____

Team:_____ Examiner:_____

Date of Exam:_____ Time:_____

Exam (Circle One): **Bline** **Injury** **Post-Game**

Follow-Up Day:_____

Introduction:

I am going to ask you some questions.
Please listen carefully and give your best effort.

Orientation

What Month is it?	0 1
What's the Date today?	0 1
What's the Day of Week?	0 1
What Year is it?	0 1
What Time is it right now? (within 1 hour)	0 1

Award 1 point for each correct answer.

Orientation Total Score	

Immediate Memory

I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order.

List	Trial 1	Trial 2	Trial 3
Candle	0 1	0 1	0 1
Paper	0 1	0 1	0 1
Sugar	0 1	0 1	0 1
Sandwich	0 1	0 1	0 1
Wagon	0 1	0 1	0 1
Total			

Trials 2 & 3 I am going to repeat that list again. Repeat back as many words as you can remember in any order, even if you said the word before.

Complete all 3 trails regardless of score on trial 1 & 2. 1 point for each correct response. Total Score equals sum across all 3 trials.

Do not inform subject that delayed recall will be tested.

Immediate Memory Total Score	

Exertional Maneuvers

If subject is not displaying or reporting symptoms, conduct the following maneuvers to create conditions under which symptoms likely to be elicited and detected. <u>These measures need not be conducted if a subject is already displaying or reporting any symptoms</u>.

If no conducted, allow 2 minuets to keep time delay constant before testing Delayed Recall. These methods should be administered for baseline testing of normal subjects.

Exertional Maneuvers	
5 Jumping Jacks	5 Push-Ups
5 Sit-ups	5 Knee Bends

Neurologic Screening

Loss of Consciousness/ Witnessed Unresponsiveness	☐ No Length:	☐ Yes
Post-Traumatic Amnesia? Poor Recall of events after injury	☐ No Length:	☐ Yes
Retrograde Amnesia? Poor recall of events before injury	☐ No Length:	☐ Yes

	Normal	Abnormal
Strength	☐	☐
Right Upper Extremity	☐	☐
Left Upper Extremity	☐	☐
Right Lower Extremity	☐	☐
Left Lower Extremity	☐	☐
Sensation - examples: Finger-to-Nose/Romberg	☐	☐
Coordination - examples: Tandem Walk/Finger-Nose-Finger	☐	☐

Concentration

<u>Digits Backward:</u> **I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9,1,7.**

If correct, go to next string length. If incorrect, read trial 2. 1 pt. possible for each string length. Stop after incorrect on both trails.

5-2-6	4-1-5	0 1
1-7-9-5	4-9-6-8	0 1
4-8-5-2-7	6-1-8-4-3	0 1
8-3-1-9-6-4	7-2-4-8-5-6	0 1

<u>Months in Reverse Order:</u> **Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November…Go ahead.** 1 pt. for entire sequence correct.

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0 1
Concentration Total Score	

Delayed Recall

Do you remember the list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order. Circle each word correctly recalled. Total score equals number of words recalled.

Candle Paper Sugar Sandwich Wagon

Delayed Recall Total Score	

SAC Scoring Summary

Exertional Maneuvers & Neurologic Screening are important for examination, but not incorporated into SAC Total Score.

Orientation	/ 5
Immediate Memory	/15
Concentration	/15
Delayed Recall	/ 5
SAC TOTAL SCORE	/30

Sport Concussion Assessment Tool 2 (SCAT-2)

SCAT2

Sport Concussion Assessment Tool 2

Name

Sport/team

Date/time of injury

Date/time of assessment

Age Gender M F

Years of education completed

Examiner

What is the SCAT2?[1]

This tool represents a standardized method of evaluating injured athletes for concussion and can be used in athletes aged from 10 years and older. It supersedes the original SCAT published in 2005[2]. This tool also enables the calculation of the Standardized Assessment of Concussion (SAC)[3,4] score and the Maddocks questions[5] for sideline concussion assessment.

Instructions for using the SCAT2

The SCAT2 is designed for the use of medical and health professionals. Preseason baseline testing with the SCAT2 can be helpful for interpreting post-injury test scores. Words in Italics throughout the SCAT2 are the instructions given to the athlete by the tester.

This tool may be freely copied for distribtion to individuals, teams, groups and organizations.

What is a concussion?

A concussion is a disturbance in brain function caused by a direct or indirect force to the head. It results in a variety of non-specific symptoms (like those listed below) and often does not involve loss of consciousness. Concussion should be suspected in the presence of **any one or more** of the following:

- Symptoms (such as headache), or
- Physical signs (such as unsteadiness), or
- Impaired brain function (e.g. confusion) or
- Abnormal behaviour.

Any athlete with a suspected concussion should be REMOVED FROM PLAY, medically assessed, monitored for deterioration (i.e., should not be left alone) and should not drive a motor vehicle.

Symptom Evaluation

How do you feel?

You should score yourself on the following symptoms, based on how you feel now.

	none	mild		moderate			severe
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
Trouble falling asleep (if applicable)	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6

Total number of symptoms (Maximum possible 22)

Symptom severity score
(Add all scores in table, maximum possible: 22 x 6 = 132)

Do the symptoms get worse with physical activity? Y N
Do the symptoms get worse with mental activity? Y N

Overall rating

If you know the athlete well prior to the injury, how different is the athlete acting compared to his / her usual self? Please circle one response.

no different | very different | unsure

Cognitive & Physical Evaluation

1 Symptom score (from page 1)

22 **minus** number of symptoms ____ of 22

2 Physical signs score

Was there loss of consciousness or unresponsiveness? Y N
If yes, how long? ____ minutes
Was there a balance problem/unsteadiness? Y N

Physical signs score (1 point for each negative response) ____ of 2

3 Glasgow coma scale (GCS)

Best eye response (E)

No eye opening	1
Eye opening in response to pain	2
Eye opening to speech	3
Eyes opening spontaneously	4

Best verbal response (V)

No verbal response	1
Incomprehensible sounds	2
Inappropriate words	3
Confused	4
Oriented	5

Best motor response (M)

No motor response	1
Extension to pain	2
Abnormal flexion to pain	3
Flexion/Withdrawal to pain	4
Localizes to pain	5
Obeys commands	6

Glasgow Coma score (E + V + M) ____ of 15

GCS should be recorded for all athletes in case of subsequent deterioration.

4 Sideline Assessment – Maddocks Score

"I am going to ask you a few questions, please listen carefully and give your best effort."

Modified Maddocks questions (1 point for each correct answer)

At what venue are we at today?	0	1
Which half is it now?	0	1
Who scored last in this match?	0	1
What team did you play last week/game?	0	1
Did your team win the last game?	0	1

Maddocks score ____ of 5

Maddocks score is validated for sideline diagnosis of concussion only and is not included in SCAT 2 summary score for serial testing.

5 Cognitive assessment

Standardized Assessment of Concussion (SAC)

Orientation (1 point for each correct answer)

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1

Orientation score ____ of 5

Immediate memory

"I am going to test your memory. I will read you a list of words and when I am done, repeat back as many words as you can remember, in any order."

Trials 2 & 3:

"I am going to repeat the same list again. Repeat back as many words as you can remember in any order, even if you said the word before."

Complete all 3 trials regardless of score on trial 1 & 2. Read the words at a rate of one per second. Score 1 pt. for each correct response. Total score equals sum across all 3 trials. Do not inform the athlete that delayed recall will be tested.

List	Trial 1	Trial 2	Trial 3	Alternative word list		
elbow	0 1	0 1	0 1	candle	baby	finger
apple	0 1	0 1	0 1	paper	monkey	penny
carpet	0 1	0 1	0 1	sugar	perfume	blanket
saddle	0 1	0 1	0 1	sandwich	sunset	lemon
bubble	0 1	0 1	0 1	wagon	iron	insect
Total						

Immediate memory score ____ of 15

Concentration

Digits Backward:

"I am going to read you a string of numbers and when I am done, you repeat them back to me backwards, in reverse order of how I read them to you. For example, if I say 7-1-9, you would say 9-1-7."

If correct, go to next string length. If incorrect, read trial 2. One point possible for each string length. Stop after incorrect on both trials. The digits should be read at the rate of one per second.

			Alternative digit lists		
4-9-3	0	1	6-2-9	5-2-6	4-1-5
3-8-1-4	0	1	3-2-7-9	1-7-9-5	4-9-6-8
6-2-9-7-1	0	1	1-5-2-8-6	3-8-5-2-7	6-1-8-4-3
7-1-8-4-6-2	0	1	5-3-9-1-4-8	8-3-1-9-6-4	7-2-4-8-5-6

Months In Reverse Order:

"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say December, November ... Go ahead"

1 pt. for entire sequence correct

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan 0 1

Concentration score ____ of 5

[1] This tool has been developed by a group of international experts at the 3rd International Consensus meeting on Concussion in Sport held in Zurich, Switzerland in November 2008. The full details of the conference outcomes and the authors of the tool are published in British Journal of Sports Medicine, 2009, volume 43, supplement 1.
The outcome paper will also be simultaneously co-published in the May 2009 issues of Clinical Journal of Sports Medicine, Physical Medicine & Rehabilitation, Journal of Athletic Training, Journal of Clinical Neuroscience, Journal of Science & Medicine in Sport, Neurosurgery, Scandinavian Journal of Science & Medicine in Sport and the Journal of Clinical Sports Medicine.

[2] McCrory P et al. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. British Journal of Sports Medicine. 2005; 39: 196-204

[3] McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sports Medicine. 2001; 11: 176-181

[4] McCrea M, Randolph C, Kelly J. Standardized Assessment of Concussion: Manual for administration, scoring and interpretation. Waukesha, Wisconsin, USA.

[5] Maddocks, DL; Dicker, GD; Saling, MM. The assessment of orientation following concussion in athletes. Clin J Sport Med. 1995;5(1):32–3

[6] Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003; 2: 24-30

6 Balance examination

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)*. A stopwatch or watch with a second hand is required for this testing.

Balance testing

"I am now going to test your balance. Please take your shoes off, roll up your pant legs above ankle (if applicable), and remove any ankle taping (if applicable). This test will consist of three twenty second tests with different stances."

(a) Double leg stance:

"The first stance is standing with your feet together with your hands on your hips and with your eyes closed. You should try to maintain stability in that position for 20 seconds. I will be counting the number of times you move out of this position. I will start timing when you are set and have closed your eyes."

(b) Single leg stance:

"If you were to kick a ball, which foot would you use? [This will be the dominant foot] *Now stand on your non-dominant foot. The dominant leg should be held in approximately 30 degrees of hip flexion and 45 degrees of knee flexion. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."*

(c) Tandem stance:

"Now stand heel-to-toe with your ***non-dominant foot*** *in back. Your weight should be evenly distributed across both feet. Again, you should try to maintain stability for 20 seconds with your hands on your hips and your eyes closed. I will be counting the number of times you move out of this position. If you stumble out of this position, open your eyes and return to the start position and continue balancing. I will start timing when you are set and have closed your eyes."*

Balance testing – types of errors

1. Hands lifted off iliac crest
2. Opening eyes
3. Step, stumble, or fall
4. Moving hip into > 30 degrees abduction
5. Lifting forefoot or heel
6. Remaining out of test position > 5 sec

Each of the 20-second trials is scored by counting the errors, or deviations from the proper stance, accumulated by the athlete. The examiner will begin counting errors only after the individual has assumed the proper start position. **The modified BESS is calculated by adding one error point for each error during the three 20-second tests. The maximum total number of errors for any single condition is 10.** If a athlete commits multiple errors simultaneously, only one error is recorded but the athlete should quickly return to the testing position, and counting should resume once subject is set. Subjects that are unable to maintain the testing procedure for a minimum of **five seconds** at the start are assigned the highest possible score, ten, for that testing condition.

Which foot was tested: ☐ Left ☐ Right
(i.e. which is the **non-dominant** foot)

Condition	Total errors
Double Leg Stance (feet together)	of 10
Single leg stance (non-dominant foot)	of 10
Tandem stance (non-dominant foot at back)	of 10
Balance examination score (30 **minus** total errors)	of 30

7 Coordination examination

Upper limb coordination

Finger-to-nose (FTN) task: *"I am going to test your coordination now. Please sit comfortably on the chair with your eyes open and your arm (either right or left) outstretched (shoulder flexed to 90 degrees and elbow and fingers extended). When I give a start signal, I would like you to perform five successive finger to nose repetitions using your index finger to touch the tip of the nose as quickly and as accurately as possible."*

Which arm was tested: ☐ Left ☐ Right

Scoring: 5 correct repetitions in < 4 seconds = 1

Note for testers: Athletes fail the test if they do not touch their nose, do not fully extend their elbow or do not perform five repetitions. Failure should be scored as 0.

Coordination score of 1

8 Cognitive assessment

Standardized Assessment of Concussion (SAC)

Delayed recall

"Do you remember that list of words I read a few times earlier? Tell me as many words from the list as you can remember in any order."

Circle each word correctly recalled. Total score equals number of words recalled.

List	Alternative word list		
elbow	candle	baby	finger
apple	paper	monkey	penny
carpet	sugar	perfume	blanket
saddle	sandwich	sunset	lemon
bubble	wagon	iron	insect

Delayed recall score of 5

Overall score

Test domain	Score
Symptom score	of 22
Physical signs score	of 2
Glasgow Coma score (E + V + M)	of 15
Balance examination score	of 30
Coordination score	of 1
Subtotal	**of 70**
Orientation score	of 5
Immediate memory score	of 5
Concentration score	of 15
Delayed recall score	of 5
SAC subtotal	**of 30**
SCAT2 total	**of 100**
Maddocks Score	**of 5**

Definitive normative data for a SCAT2 "cut-off" score is not available at this time and will be developed in prospective studies. Embedded within the SCAT2 is the SAC score that can be utilized separately in concussion management. The scoring system also takes on particular clinical significance during serial assessment where it can be used to document either a decline or an improvement in neurological functioning.

Scoring data from the SCAT2 or SAC should not be used as a stand alone method to diagnose concussion, measure recovery or make decisions about an athlete's readiness to return to competition after concussion.

Athlete Information

Any athlete suspected of having a concussion should be removed from play, and then seek medical evaluation.

Signs to watch for

Problems could arise over the first 24-48 hours. You should not be left alone and must go to a hospital at once if you:

- Have a headache that gets worse
- Are very drowsy or can't be awakened (woken up)
- Can't recognize people or places
- Have repeated vomiting
- Behave unusually or seem confused; are very irritable
- Have seizures (arms and legs jerk uncontrollably)
- Have weak or numb arms or legs
- Are unsteady on your feet; have slurred speech

Remember, it is better to be safe.
Consult your doctor after a suspected concussion.

Return to play

Athletes should not be returned to play the same day of injury. When returning athletes to play, they should follow a stepwise symptom-limited program, with stages of progression. For example:

1. rest until asymptomatic (physical and mental rest)
2. light aerobic exercise (e.g. stationary cycle)
3. sport-specific exercise
4. non-contact training drills (start light resistance training)
5. full contact training after medical clearance
6. return to competition (game play)

There should be approximately 24 hours (or longer) for each stage and the athlete should return to stage 1 if symptoms recur. Resistance training should only be added in the later stages.
Medical clearance should be given before return to play.

Tool	Test domain	Time	Score			
		Date tested				
		Days post injury				
SCAT2	Symptom score					
	Physical signs score					
	Glasgow Coma score (E + V + M)					
	Balance examination score					
	Coordination score					
SAC	Orientation score					
	Immediate memory score					
	Concentration score					
	Delayed recall score					
	SAC Score					
Total	**SCAT2**					
Symptom severity score (max possible 132)						
Return to play			☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N	☐ Y ☐ N

Additional comments

Concussion injury advice (To be given to concussed athlete)

This patient has received an injury to the head. A careful medical examination has been carried out and no sign of any serious complications has been found. It is expected that recovery will be rapid, but the patient will need monitoring for a further period by a responsible adult. Your treating physician will provide guidance as to this timeframe.

If you notice any change in behaviour, vomiting, dizziness, worsening headache, double vision or excessive drowsiness, please telephone the clinic or the nearest hospital emergency department immediately.

Other important points:

- **Rest and avoid strenuous activity for at least 24 hours**
- **No alcohol**
- **No sleeping tablets**
- **Use paracetamol or codeine for headache. Do not use aspirin or anti-inflammatory medication**
- **Do not drive until medically cleared**
- **Do not train or play sport until medically cleared**

Patient's name

Date/time of injury

Date/time of medical review

Treating physician

Contact details or stamp

Clinic phone number

Balance Error Scoring System (BESS Test)

The Balance Error Scoring System (BESS)

Obtain Preseason Baseline Score; Compare with Post-Concussion Score[33-34]

The Balance Error Scoring System[33-34] provides a portable, cost-effective and objective method of assessing static **postural stability**. The BESS can be used to assess the effects of mild head injury on static postural stability. Information obtained from this clinical balance tool can be used to assist clinicians in making return to play decisions following mild head injury. The BESS can be performed in nearly any environment and takes approximately 10 minutes to conduct.

The balance-testing regime consists three stances on two different surfaces. The three stances are **double leg stance**, **single leg stance** and **tandem stance**. The two different surfaces include both a **firm** (ground) and **foam** surface. **Athletes' stance should consist of the hands on the iliac crests, eyes closed and a consistent foot position depending on the stance**. Shoes should not be worn.

In the **double leg stance**, the feet are flat on the testing surface approximately pelvic width apart.

In the **single leg stance** position, the athlete is to stand on the non-dominant leg with the contralateral limb held in approximately 20° of hip flexion, 45° of knee flexion and neutral position in the frontal plane.

In the **tandem stance** testing position, one foot is placed in front of the other with heel of the anterior foot touching the toe of the posterior foot. The athlete's non-dominant leg is in the posterior position. Leg dominance should be determined by the athlete's kicking preference.

Administering the BESS: Establish baseline score prior to the start of the athletic season. After a concussive injury, re-assess the athlete and compare to baseline score. Only consider return to activity if scores are comparable to baseline score. Use with Standardized Symptom Scale Checklist.

Scoring the BESS: Each of the trials is **20 seconds.** Count the number of errors (deviations) from the proper stance. The examiner should begin counting errors only after the individual has assumed the proper testing position.


Double Leg Stance Firm Surface


Single Leg Stance Firm Surface


Tandem Stance Firm Surface


Double Leg Stance Foam Surface


Single Leg Stance Foam Surface


Tandem Stance Foam Surface

Errors:
- **Moving the hands off the hips**
- **Opening the eyes**
- **Step, stumble or fall**
- **Abduction or flexion of the hip beyond 30°**
- **Lifting the forefoot or heel off of the testing surface**
- **Remaining out of the proper testing position for greater than 5 seconds**

The maximum total number of errors for any single condition is 10.

If a subject commits multiple errors simultaneously, only one error is recorded.

B.E.S.S. SCORECARD		
Count Number of Errors max of 10 each stance/surface	FIRM Surface	FOAM Surface
Double Leg Stance (feet together)		
Single Leg Stance (non-dominant foot)		
Tandem Stance (non-dominant foot in back)		
TOTAL SCORES: total each column		
B.E.S.S. TOTAL: (Firm+Foam total)		

Airex™ Foam Balance Pads available at **www.power-systems.com** or through most sporting goods stores.

Appendix C: Sample Interview Transcript

S: OK so this is the interview with the athletic Trainer at School 3.

How many years have you been involved with football?

ATC: This is my first year here at this HS. But I've experienced it with in my education, with the clinical experience, for 3 months.

S: How many years have you been involved with high school athletics or youth athletics?

I just started in August and I was also, within my school experience, I was with [another] High school from August until December.

What do you know about concussions?

Concussions can lead to death, obviously, so anytime an athlete gets hit to the head, it's an immediate...I immediately go to them, get a history, no questions asked. Just make sure that they are ok, I always look for the signs and symptoms. If they are in a daze. I always observe on the field make sure mechanism of injury, that I'm observing how they are responding. That's very, very crucial.

What are your experiences with concussions? Have you had any, seen any?

I had a concussion in high school. I was out for a week and a half, during basketball. I've seen… we had one at the middle school; he's back, returned to play. I had two last Friday. I was not there at the game at [another school]. There was no athletic trainer there, they got treated by EMS. They came in to see me on Monday. And I evaluated them. First what we did, I had them fill out a symptoms check list. Then I went through and I did a SCAT-2 test. After that one was cleared to play. Another one, we're still...he had a doctors appt yesterday. To make sure everything was OK, but his memory is not with it, so he's still not practicing yet. So I've had a few.

Are there any school policies on concussions, and if so what are they?

Yep, so our policy is, when there is a concussion, I immediately, we had a baseline test, every one, every single athlete, before, within the first 3 days of preseason, they get a baseline. Once they do…, I suspect a concussion they fill out a symptoms check list and we got thru the same exact SCAT-2 test that we did with them at baseline. Compare, make sure things are back at baseline before they're even sent in, and then we put them on the bike, exert them , put them running around, then we have them with equipment on, running around, then we have them one-on-one contact with one of their teammates, as long as they're asymptomatic. As soon as they feel one symptom they go right back to rest and we start through the same.

Do you give your players a baseline test and what kind of Baseline test

Yep, we do the SCAT 2 baseline test; we did that within the first 3 days of preseason. I had two other athletic trainers help me out to do all the baseline tests, just to make sure we got them done, so there were no concussions during preseason . I did make sure, had a coaches meeting, set up times, for when we meet, so we did that.

How do you determine if a player has a history of concussion?

During our SCAT 2 I ask them, and also they have to have physicals. So, that will be in the physical. They cannot even practice at all without having a physical –that's part of the requirement. So it will be in the history of that. And I also ask them during the SCAT 2, have you ever had one before.

How do you assess a player on the field who you think may have a concussion?

I obviously look at signs and symptoms, observe, I ask them history – how are you feeling, do you have any symptoms. I make sure that their memory is there- their short term memory, long term memory. I make sure that there is nothing wrong with their neck, first off. I don't move them if they are lying down. I haven't had any of those yet. But once I feel like I can get them off the field, Make sure there is no nerve damage, no neck injury, make sure that they are conscious, I get them off the field, then I continue to do my symptom checklist, and continue with the SCAT 2 test-- orientation, concentration, memory.

What kind of follow-up care and assessment should a player with a concussion receive?

The follow-up care, our policy is they have to see me every day. We do a symptoms checklist; make sure they have no symptoms. If they have any symptoms they still stay at rest. If they have no symptoms then I exert them on a bike, a stationary bike for 10 to 15 minutes, on a stationary bike right in the athletic training room. If they have no symptoms I have them go out on the track, and with coaches, coach knows this, so they are in supervision, if they feel any symptoms at all on the bike they need to let me know. I stop them immediately as soon as they start feeling it, so they are aware that as soon as they start feeling it they have to let me know. Then they get exerted for 10-15 minutes outside on the track and then after that they put their equipment on, they run around for 10-15 minutes… make sure there are no symptoms. Then after that we do contact on the sidelines, one on one, talk to coach, tell them there can be no symptoms, because I can't be outside at every practice, so coach, player and myself have a conversation. Once they show no symptoms at that they are put back into play. They go right back to rest if there are any symptoms and we start back at square one.

How do you check a helmet's fit on a player?

I didn't do any of these for when they got their equipment, cause coaches did that. But I make sure that it's not moving around, it's secure, their belt straps, they can actually talk, two finger widths down, make sure they have enough air. Some of them, the new ones can't add air, so I do have a pump where I can add air to the...uh...air bladders. Make sure that it is two finger widths from their chin, so that's what I do.

And how do you teach players to prevent head injury?

Technique. So, especially with football, coach goes over technique with them, they should not be going head first into a player. If they get a head injury they need to immediately come see me, so we really need to make sure that technique is proper. I talk to them about making sure they do. I don't care if they're in an adrenaline rush, and they just want to pound them, they need to make sure they are using proper technique. And I tell them about all the risks and injuries of spinal injury, head injury, death.

What are the symptoms of concussion?

Dizziness, headache, nausea, increased pressure, point tender, vision's gone. Also if they are unbalanced, I do the BESS test which is part of the SCAT 2. Concentration- so what we do is the finger to nose test, make sure they can do that. I test their memory so anterograde, retrograde, whether they can remember things short term, long term. I always make sure I ask questions about that. Also we do numbers, traverse and back order for concentration.

What do you tell your athletes about concussion?

What I tell them is that it can lead to death and that they need to be very honest with me about their symptoms. And I explain to them that second impact syndrome, that's a concussion where you have symptoms, and then you get another concussion, you can die like that. Not to try to scare them but to try and put it into what can actually happen, so that they will be very honest with me because I know that they just want to play. And I tell them, I 'm not just to take you out, I'm here for your health, I don't want you to die on the field. That's the last thing I want. That's why we have this protocol, and that is why we go step to step to step. And then they thank me after once they go in.

Appendix D: Sample Post-Concussion ImPACT Report

ImPACT™ Clinical Report

[redacted]

[redacted]

Organization:	[redacted]	Age:	[redacted]
Date of Birth:	[redacted]	Height:	
Gender:	Male	Weight:	
Handedness:			

Native country/region:	Second language:
Native language:	Years Speaking:

Years of education completed excluding kinder garden:	Repeated one or more years of school:
Received speech therapy:	Diagnosed learning disability:
Attended special education classes:	Problems with ADD/hyperactivity:

Current sport:	Current level of participation:
Primary position/event/class:	Years of experience at this level:

Number of times diagnosed with a concussion (excluding current injury):

Concussions that resulted in loss of consciousness:

Concussions that resulted in confusion:

Concussions that resulted in difficulty remembering events that occurred immediately after injury:

Concussions that resulted in difficulty remembering events that occurred:

Total games missed as a result of all concussions combined:

Concussion history:

Treatment for headaches by physician:	History of meningitis:
Treatment for migraine headaches by physician:	Treatment for substance/alcohol abuse:
Treatment for epilepsy/seizures:	Treatment for psychiatric condition (depression, anxiety):
History of brain surgery:	

Diagnosed with ADD/ADHD:	Diagnosed with Autism:
Diagnosed with Dyslexia:	Strenuous exercise in the last 3 hours:

ImPACT™ Clinical Report

[redacted]

Exam Type	Post-Injury 1	Post-Injury 4	Post-Injury 2		
Date Tested	11/06/2011	11/13/2011	11/21/2011		
Last Concussion					
Exam Language	English	English	English		
Test Version	2.1	2.1	2.1		

Composite Scores	Percentile scores if available are listed in small type.									
Memory composite (verbal)	73	12%	90	69%	92	76%				
Memory composite (visual)	68	28%	82	73%	82	73%				
Vis. motor speed composite	36.05	28%	40.13	47%	37.28	33%				
Reaction time composite	0.51	78%	0.55	55%	0.44	98%				
Impulse control composite	9		8		14					
Total Symptom Score	1		1		0					
Cognitive Efficiency Index:	**0.31**		**0.41**		**0.5**					

The Cognitive efficiency Index measures the interaction between accuracy (percentage correct) and speed (reaction time) in seconds on the Symbol Match test. This score was not developed to make return to play decisions but can be helpful in determining the extent to which the athlete tried to work very fast on symbol match (decreasing accuracy) or attempted to improve their accuracy by taking a more deliberate and slow approach (jeopardizing speed). The range of scores is from approximately zero to approximately .70 with a mean of .34. A higher score indicates that the athlete did well in both the speed and memory domains on the symbol match test. A low score (below .20) means that they performed poorly on both the speed and accuracy component. If this score is a negative number, the test taker performed very poorly on the reaction time component.

Hours slept last night	6	9	9		
Medication					

The information provided by this report should be viewed as only one source of information regarding an individual's level of [neurocognitive] functioning. Even though impact is based on demonstrated scientific principles and research, external factors such as improper test administration or improper test taking environment may result in inaccurate test results. These factors and others must be considered in making return-to-play decision. The information provided by this report is of a general nature and does not represent medical advice, a diagnosis, or prescription for treatment. Additionally, diagnostic or return to play decisions should not be based solely on the data generated by this report, but on an in-person evaluation made by a professional trained in concussion management in accordance with usual and standard medical practice. An individual suspected of suffering traumatic brain injury or concussion should immediately seek the advice of qualified and trained personnel for interpretation of test results and should be monitored closely for the emergence of symptoms. Impact is not responsible for any decisions based on information contained in the report. A test-taker's qualified and trained personnel has the sole responsibility for establishing diagnosis and suggesting appropriate treatment.

ImPACT™ Clinical Report

[redacted]

Word Memory					
Hits (Immediate)	11	12	12		
Correct distractors (immed.)	12	12	12		
Learning percent correct	96%	100%	100%		
Hits (delay)	11	10	6		
Correct distractors (delay)	12	12	12		
Delayed memory pct. correct	96%	92%	75%		
Total percent correct	96%	96%	87.5%		

Design Memory					
Hits (immediate)	12	10	12		
Correct distractors (immed.)	11	11	11		
Learning percent correct	96%	88%	96%		
Hits (delay)	12	12	10		
Correct distractors (delay)	10	10	10		
Delayed memory pct. correct	92%	92%	83%		
Total percent correct	94%	90%	89.5%		

X's and O's					
Total correct (memory)	5	9	9		
Total correct (interference)	118	117	123		
Avg. correct RT (interfer.)	0.44	0.45	0.37		
Total incorrect (interference)	9	8	13		
Avg. incorrect RT (interfer.)	0.36	0.39	0.32		

Symbol Match					
Total correct (visible)	27	27	27		
Avg. correct RT (visible)	1.35	1.6	1.3		
Total correct (hidden)	5	8	8		
Avg. correct RT (hidden)	2	1.48	1.3		

Color Match					
Total correct	9	9	9		
Avg. correct RT	0.65	0.68	0.52		
Total commissions	0	0	1		
Avg. commissions RT	0	0	0.48		

Three Letters					
Total sequence correct	3	4	5		
Total letters correct	10	13	15		
Pct. of total letters correct	66.67%	86.67%	100%		
Avg. time to first click	1.66	2.41	2.18		
Avg. counted	14.2	17	14.8		
Avg. counted correctly	14.2	17	14.6		

ImPACT™ Clinical Report

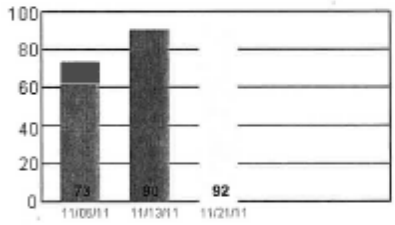
[redacted]

Headache	1	1	0		
Nausea	0	0	0		
Vomiting	0	0	0		
Balance Problems	0	0	0		
Dizziness	0	0	0		
Fatigue	0	0	0		
Trouble falling asleep	0	0	0		
Sleeping more than usual	0	0	0		
Sleeping less than usual	0	0	0		
Drowsiness	0	0	0		
Sensitivity to light	0	0	0		
Sensitivity to noise	0	0	0		
Irritability	0	0	0		
Sadness	0	0	0		
Nervousness	0	0	0		
Feeling more emotional	0	0	0		
Numbness or tingling	0	0	0		
Feeling slowed down	0	0	0		
Feeling mentally foggy	0	0	0		
Difficulty concentrating	0	0	0		
Difficulty remembering	0	0	0		
Visual problems	0	0	0		
Total Symptom Score	1	1	0		

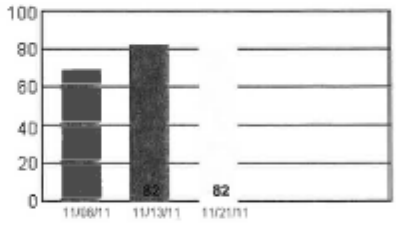
ImPACT™ Clinical Report

[redacted]

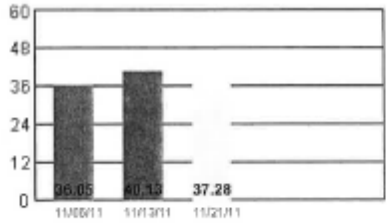
Memory Composite (Verbal)



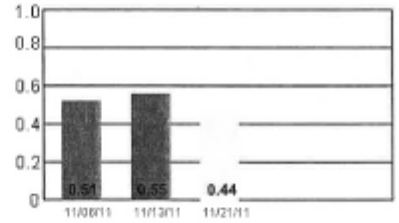
Memory Composite (Visual)



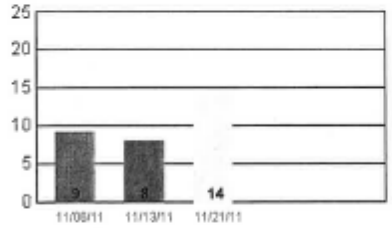
Visual Motor Composite



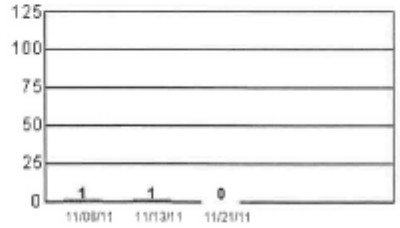
Reaction Time Composite



Impulse Control Composite



Symptom Score



Appendix E : Maine Concussion Management Initiative Forms

School Application Form

Maine Concussion Management Initiative
School Application Form

School Name:

School Address:

Athletic Director: **Email:**

Phone Number:

Athletic Trainer: **Email:**

Phone Number:

Is your school Public or Private?

Does your school currently use ImPACT or another neurocognitive testing software? Yes ☐ No ☐

If yes what program? _____

Is your school applying for funding through MCMI? Yes ☐ No ☐
If yes, please complete the following section

Funding Source

Contact Person **Email**

Address **Phone**

What staff resources does your school currently have? (Please check all that apply.)

☐ Full-time Athletic Trainer ☐ Part-time Athletic Trainer ☐ Full-time School Nurse

☐ Part-time School Nurse ☐ Team Physician ☐ Occupational Therapist

☐ Physical Therapist ☐ Speech Therapist ☐ Paraprofessionals

☐ Librarian (s) ☐ IT Staff

What IT equipment does your school already have?

☐ Computer Lab ☐ Laptop Program

1

Your Plan for Utilizing Computerized Testing

For a better understanding of neurocogntive test models in high schools please see the attached Information Sheet.

Who will be administering baseline tests at your school?

Where will you be administering these tests?

Do you have a doctor in the area who is familiar with the program?

If so, who?

School Physician: **E-mail:** **Phone:**

Number of athletes you plan to test

Year 1 _____ **Subsequent Years** _____

What teams will you test? Please check all that apply.

☐ Football	☐ Field Hockey	☐ Wrestling	☐ Tennis
☐ Soccer	☐ Skiing	☐ Baseball/ Softball	☐ Track
☐ Swimming	☐ Basketball	☐ Lacrosse	☐ Other _____
☐ Cheerleading	☐ Ice Hockey	☐ Rugby	

Please discuss your plan for post-concussion testing.

Please return the application and Expectations form to Dr. Paul Berkner by fax at 207-859-4475.

Disclaimer: The Maine Concussion Management Initiative (MCMI) supports the use of cognitive testing (also known as neuropsychological testing or NP testing) and seeks to promote a shared commitment to best practices regarding concussion treatment and return to play (RTP) guidelines. MCMI information, testing, and guidelines are not intended as a standard of care and should not be interpreted as such. Information from MCMI is only a guide and is of a general nature consistent with the reasonable practice of a healthcare professional. Individual treatment will depend on the facts and circumstances specific to each individual case and remain the sole responsibility of the health care provider(s).

MCMI supports the perspective on RTP decisions and patient care responsibility set forth in what is commonly referred to as the Zurich Report, November 2008, which is available in its entirety on our website.

2

Maine Concussion Management Initiative

Expectations Form

All schools under the Maine Concussion Management Initiative umbrella are at the forefront of the movement for consistent treatment of mild traumatic brain injuries, more commonly known as concussions. This comes with certain obligations that will not only make your school's program the best it can be, but also assures that your school is setting a good example for those that may want to join in later years. Outlined below are the expectations to which MCMI schools are required to agree to in order to become part of the program.

Please read over the items below to which you agree to pledge. The signature of the principal or the athletic director and the athletic trainer is required on the bottom.

1. I agree to make sure that baseline tests in my school are administered properly, according to ImPACT guidelines.

2. I agree to implement the Zurich guidelines, which includes medical clearance for all concussed athletes prior to the initiation of return-to-play guidelines.

3. I support MCMI's goals for raising awareness for concussion management to reduce concussions, post-concussion syndrome, and second impact syndrome through education and unified best practices.

4. I agree that MCMI can hold an educational session, as deemed necessary, with my coaches, parents, and athletes to teach them:
    - How to recognize a concussion
    - The biology of concussions and the purpose of neurocognitive testing
    - The short and long term consequences of concussions
    - Proper return-to-play guidelines

5. I agree with the policy that the de-identified baseline data from the ImPACT test will be accessible to researchers pending approval from a Data Management Committee.

6. I understand that the school will be required to keep a permission slip on file for every athlete taking the ImPACT test.

7. I understand that my school is eligible to receive funding for 2 years at which time schools must re-apply. Limited funds are available for school after the first 2 years, and schools are encouraged to consider alternated funding sources. Applications for funding are considered on a case-by-case basis.

School _____

Signature (Principal/Athletic Director)	**Name (Please Print)**	**Date**
Signature (Athletic Trainer)	**Name (Please Print)**	**Date**

Please return the application and Expectations form to Dr. Paul Berkner by fax at 207-859-4475.

Disclaimer: The Maine Concussion Management Initiative (MCMI) supports the use of cognitive testing (also known as neuropsychological testing or NP testing) and seeks to promote a shared commitment to best practices regarding concussion treatment and return to play (RTP) guidelines. MCMI information, testing, and guidelines are not intended as a standard of care and should not be interpreted as such. Information from MCMI is only a guide and is of a general nature consistent with the reasonable practice of a healthcare professional. Individual treatment will depend on the facts and circumstances specific to each individual case and remain the sole responsibility of the health care provider(s).

MCMI supports the perspective on RTP decisions and patient care responsibility set forth in what is commonly referred to as the Zurich Report, November 2008, which is available in its entirety on our website.

ImPACT Permission Form

Goldfarb Center for Public Affairs and Civic Engagement at Colby

Maine Concussion Management Initiative

Dear Parent/ Guardian,

Your school is currently implementing an innovative program for evaluating and mild traumatic brain injuries (mTBI), more commonly known as a concussion. In order to better manage concussions sustained by our student athletes, your school has partnered with the Maine Concussion Management Initiative (MCMI) to acquire a software tool called ImPACT™ (Immediate Past Concussion Assessment and Cognitive Testing). ImPACT™ is a computerized exam developed by concussion experts at the University of Pittsburgh Medical Center (UPMC) and used in many professional, collegiate, and high school sports programs across the country to assist with the diagnosis and management of mTBI's. Neurocognitive tests, such as ImPACT™ are fast becoming the "gold standard" in recognizing and managing mTBI's. Additional information about ImPACT™ can be found at www.impacttest.com.

Your school is asking students to take the computerized exam before beginning the sports season. The test is set up in a "video-game" format and takes about 20-25 minutes to complete. The ImPACT™ test is a pre-season physical of the brain. It records information such as memory, reaction time, speed, and concentration, but it is NOT an IQ test. The ImPACT™ test is non-invasive and poses no risk to your child.

If your child suffers a head injury and a concussion is suspected, your child will be referred to a physician or clinician for an evaluation. The physician or clinician may recommend that your child take the post-injury ImPACT™ test. Your child's baseline (pre-season) and post-injury test data, if any, will be maintained on a secure server by ImPACT™. Your child's test data will only be available to his/her physician or clinician, except as described below.

Your child's test data may be available to persons other than the physician or clinician evaluating your child, as follows:

- The physician or clinician evaluating your child may choose to make your child's test data available to other healthcare providers who are being consulted regarding the treatment of your child.
- You child's de-identified data may be utilized by the Maine Concussion Management Initiative at Colby College and UPMC for research purposes. However, the identity of your child will not be disclosed to MCMI, UPMC, or any researcher if the test results are used for this purpose

Your child's health and safety are at the forefront of the student athletic experience, and we are excited to work with your school to implement this program. Please sign and return this form with your child.

Sincerely,
Maine Concussion Management Initiative

PERMISSION SLIP

For use of ImPACT™

I have read an understood the above information and give permission for my son/daughter to take the ImPACT™ ***baseline test.***

Printed Name of Athlete

Signature of Athlete Date

Signature of Parent Date

Sample MCMI Return To Play Protocol

Date: _____

Anytown High School
Concussion Management Protocol

1. Athletes participating in contact and collision sports will be administered a baseline neurocognitive exam. At this time Anytown High School will be utilizing ImPACT™ for both baseline testing and as a post-concussive tool for return to play.
2. Any athlete suspected of sustaining a concussion will not return to play that day.
3. Parents of any athlete suspected of sustaining a concussion will be notified by attending athletic trainer or coach.
4. Any athlete suspected of sustaining a concussion will be referred to a physician, preferably an ImPACT™ familiar physician.
5. Once asymptomatic and neurocognitive scores return to normal, the athlete will begin a graduated return-to-play protocol.
6. Athlete will be cleared by physician for return to full athletic participation.

Graduated Return to Play Protocol

1. No activity
2. Light aerobic exercise: Intensity below 70%; no resistance training
3. Sport-specific exercise: Running, skating drills; no head impact drills
4. Non-contact training drills: Progression to more complex training drills, may start resistance training
5. Full-contact practice: Following physician clearance, participate in normal training
6. Return to play: Normal game play

* If at any time post concussion symptoms occur during the graduated return, there will be at minimum a 24hr rest period. Once asymptomatic following the rest period the athlete will drop back to the previous asymptomatic level and the progression will resume.

Physician Name (Please Print):_____

Physician Signature: _____ **Date:** _____

Author's Biography

Sarah K. Lockhart was born in Portland, Maine on May 3, 1990. She was raised in Cumberland, Maine and graduated from Greely High School in 2008. At the University of Maine she studied Athletic Training. She was a member of the Sophomore Eagles Honors Society and was a member of the track team. After graduation, Sarah plans to attend graduate school and hopes to become a physician assistant.