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Guidelines for the Diagnosis, Evaluation, and Management of Sports-Related Concussions in Adolescent Athletes: Translating Evidenced-Based Recommendations into Primary Care Practice

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GUIDELINE FOR THE DIAGNOSIS, EVALUATION, AND MANAGEMENT OF SPORTS-RELATED CONCUSSIONS IN ADOLESCENT ATHLETES: TRANSLATING EVIDENCED-BASED RECOMMENDATIONS INTO PRIMARY CARE PRACTICE

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ABSTRACT

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Sports-related concussions in adolescent athletes are a significant health concern. Evidence demonstrates that despite increased published literature on concussions, many providers are still practicing with outdated information that is not evidenced-based. This puts adolescent athletes at risk for potentially detrimental consequences such as second-impact syndrome. This syndrome can result in devastating results such as collapse, death, permanent neurological damage, respiratory failure, and loss of consciousness. Since second-impact syndrome can result from a second injury before complete symptom resolution from the initial concussion, it is imperative for providers to ensure adequate recovery and prevent the athlete from returning to play prematurely. Furthermore, repetitive concussions over time have been linked to conditions such as depression, mild cognitive impairment, prolonged recovery from future concussions, and potentially chronic traumatic encephalopathy.

The literature supported the creation of a concussion guideline and algorithm that would assist providers in caring for adolescents with a sports-related concussion. Therefore, this capstone project created a guideline and algorithm based on the literature and expert opinions gathered with the Delphi survey. The Stetler (2001) model provided the theoretical framework for the project. An educational in-service was developed for

providers at the primary care clinic. The guideline along with the pathophysiology of concussions and negative consequences were presented and discussed. Anticipated outcomes included adherence to evidenced-based literature, standardized management of concussions, increased provider knowledge, and improved patient outcomes. Furthermore, anticipated long-term outcomes were decreased negative sequelae from concussions including reduced incidence of second-impact syndrome.

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LIST OF ABBREVIATIONS

AAN: American Academy of Neurology

ACE: Acute Concussion Evaluation

BESS: Balance Error Scoring System

CDC: Centers for Disease Control

CISG: Concussion in Sport Group

CSI: Concussion Symptom Inventory

CTE: Chronic Traumatic Encephalopathy

GCS: Glasgow Coma Scale

LOC: Loss of Consciousness

PCSS: Post-Concussion Symptom Scale

RT_{clin}: Clinical Reaction Time

RTP: Return-to-play

SAC: Standardized Assessment of Concussion

SCAT3: Sport Concussion Assessment Tool 3

SOT: Sensory Organization Test

TBI: Traumatic Brain Injury

CHAPTER I

STATEMENT OF THE PROBLEM

Background and Significance

A concussion is "a clinical syndrome involving a disturbance in brain function that is generally time-limited and results from biomechanical forces, such as a bump, blow, or jolt to the head or body" (Graham, Rivara, Ford, & Spicer, 2014, p. 27). Concussion is a term describing a functional injury that has not been well understood throughout history despite it having been described more than 3,000 years ago in the writings from Greek medicine (King, Brughelli, Hume, & Gissane, 2014). The term concussion, which represents low-velocity injuries that result in brain shaking, was not utilized until the 17th century when a physician described it as a short "alienation of the mind with privation of sense and motion" (King et al., 2014, p. 451). By the 19th century, a physician described clinical signs and symptoms to distinguish various types of brain injuries (King et al., 2014). Until more recently, loss of consciousness was considered a defining characteristic of concussions. "In 1966, the Congress of Neurological Surgeons proposed a consensus definition of concussion that persisted for many years and was limited by the lack of knowledge of the pathophysiology of concussion" (Adirim, 2007, p. 2). This lack of understanding has made universal agreement difficult, resulting in confusion regarding the diagnosis, management, and safe time at which individuals can return to activity. For this reason, a group came together at

the First International Concussion in Sport Conference to form a consensus on the definition (King et al., 2014). The Concussion in Sport Group (CISG; 2013) developed a unanimously agreed upon definition and update to the recommendations for the medical management of concussions (King et al., 2014). For the first time, loss of consciousness was not considered a defining characteristic (King et al., 2014).

Terms such as *mild traumatic brain injury*, *traumatic brain injury* (TBI), and *concussion* often appeared interchangeably in the literature. While the terms represent neurocognitive dysfunction, a TBI refers to symptoms on a spectrum, whereas a concussion refers to a very specific definition within mild TBI (King et al., 2014). For the purposes of this capstone project, the term concussion was used when describing a mild TBI, TBI, and concussion.

Concussions are a mild TBI that result from linear and/or rotational forces that cause the brain to be violently shaken within the skull (Adirim, 2007). This impact disrupts normal brain functioning and causes a neurometabolic cascade (King et al., 2014). "The 'neurometabolic cascade' underlying the clinical presentation of a concussive injury describes a complex cascade of ionic, metabolic, and pathophysiological events that is accompanied by microscopic axonal injury" (Harmon et al., 2013, p. 17). This disruption of balance and metabolism requires an increase in energy to re-establish homeostasis. Normally, mitochondria are able to increase the production of adenosine triphosphate (ATP) to meet the increased energy demand but there is mitochondrial dysfunction as a result of the injury (Grady, Master, & Gioia, 2012). Not only this but "fuel sources that generate ATP, such as glucose and to a lesser degree, selected amino acids, are less bioavailable after a concussion, further

compounding the problem" (Grady et al., 2012, p. 378). Cerebral blood flow also decreases, further slowing the delivery of essential fuel sources. Rat models have demonstrated the release of neurotransmitters that lead to increased cell wall permeability, allowing an influx of sodium and an efflux of potassium (Grady, 2010). These changes alter the pH of the cell, leading to further damage and the release of cytokines that cause an inflammatory response (Grady, 2010). Furthermore, secondary injury occurs with this inflammatory response. "This cascade of cell injury may explain why concussive symptoms can worsen clinically over the first 6-24 hours after the initial injury" (Grady, 2010, p. 156). While most individuals will recover from a concussion within 7 to 10 days, numerous studies have indicated repeat concussions might result in long-term problems in mood, memory, cognitive functioning, balance, and concentration.

This capstone project focused on sports-related concussions in adolescents since adolescents have been found to be more susceptible to catastrophic injury after a concussion. This susceptibility is hypothesized to be due to physiological differences between the developing versus mature brain. When compared to the adult brain, the adolescent brain has shown lower auto regulation of blood flow and higher blood velocities, which lead to a greater metabolic mismatch (Grady et al., 2012; Graham et al., 2014). Not only this but the development of gray matter in the brain, which is responsible for processing and cognition, is slower during adolescence than in childhood and adulthood (Graham et al., 2014). Gray matter does not develop uniformly and in adolescence the primary sensorimotor regions mature initially; whereas the areas responsible for attention and working memory, which are in the parietal and prefrontal regions of the brain, develop over a longer period of time into young adulthood (Graham

et al., 2014). Concussions also result in changes in the white matter, which is responsible for coordination between different regions of the brain (Graham et al., 2014).

Sports-related concussions due to contact sports in adolescents are a significant health concern in the United States (Rivera, Roberson, Whelan, & Rohan, 2015). Increased public awareness has caused the reported incidence in concussions to increase. However, it is important to recognize that approximately 50% of sport-related concussions continue to go unreported (Harmon et al., 2013). A study of high school athletes in a large public high school system demonstrated the overall increase in reporting of concussions from 1.2 to 4.9 per 10,000 between the 1997-1998 and 2007-2008 academic years (Graham et al., 2014). This is a 16.5% average annual increase (Graham et al., 2014). It is estimated 3.8 million concussions occur during competitive sports (Harmon et al., 2013). Athletes between the ages of 10 and 19 are at particularly high risk and approximately 1 in 10 high school sports injuries is a concussion (Rivera et al., 2015).

The Centers for Disease Control's data have shown an increase in TBIs seen in the emergency departments that might be sports-related (Graham et al., 2014):

> Between 2001 and 2009 the number of children and adolescents age 19 years and younger in the United States who were treated in emergency departments for concussions and other nonfatal, sports- [and recreation-] related concussions [TBIs] increased from approximately 150,000 to 250,000. (p. 28)

This is an increase of 57%. In high school athletes, the leading causes of concussions are football, ice hockey, soccer, boxing, and rugby (Aminoff & Moreira, 2017). In fact, concussions are second only to road trauma in the United States as the most common cause of brain injury for the ages of 15- to 24-year-olds (King et al., 2014).

Despite increased public awareness of concussion, the actual financial cost of concussions to society is difficult to quantify since it is reported as TBI. This is because confusion regarding concussion's defining characteristics has persisted for a long period of time. Despite this, the Centers for Disease Control and Prevention (CDC; 2017) estimated the cost of TBI in the United States, which includes sports related concussions in adolescents, was approximately $76.5 billion in 2010. This included both direct and indirect costs. Besides the tangible fiscal costs, the sequelae from concussions are burdensome to families, individuals, and society. Relationships might change, productivity decreases, and school and work absences pose significant indirect costs (Faul, Xu, Wald, & Coronado, 2010). Colorado ranks ninth in the nation in fatalities due to TBI and 13th in the nation in hospitalizations due to a TBI (Brain Injury Alliance Colorado [BIAC], 2017). Data collected on sports-related concussions in emergency departments across the United States demonstrated the following:

- In 2008, 44,000 ED visits were due to sports-related concussions
- 58% of sport-related concussions were youth between the ages of 14 and 18 (high school age)
- 17% were between 11-13 years of age
- 8% were between the ages of 19 to 23
- 95% of the sport-related concussions were discharged home
- 25% of those patients hospitalized suffered moderated or prolonged loss of consciousness
- 51.6% of the patients diagnosed with a sports-related concussion did not experience loss of consciousness, as opposed to 21.1% of those who did. (Zhao, Han, & Steiner, 2011, pp. 1-2)

Historically, a concussion was not considered a serious injury so athletes would just shrug it off and return to the game (Graham et al., 2014). Despite published guidelines for concussion management, lack of consistency amongst providers caring for concussed athletes persists, putting individuals at increased risk for detrimental

consequences. The recognition of concussions as a serious injury is an evolving and controversial topic in the United States.

Adolescents are more susceptible to neurological dysfunction and prolonged recovery (Harmon et al., 2013). Studies have demonstrated that adolescents who have suffered from a concussion take longer to heal than adults. "In high school football players suffering from a concussion (average age 16), more than half of them took longer than one week to heal, and 10% took longer than three weeks" (Grady, 2010, p. 160). Other studies have demonstrated prolonged healing greater than six months (Grady, 2010). It is believed neurological maturation affects recovery time (Sprouse, Harris, Sprouse, Humerick, & Miller, 2016). Animal studies have demonstrated the developing brain might be more susceptible to the "pathologic release of excitatory amino acid neurotransmitters (glutamine and aspartate) following trauma than adult brains" (Grady, 2010, p. 159). Returning to full activity before the resolution of symptoms could lead to a rare condition called second impact syndrome, which is reported almost exclusively in teens (Rivera et al., 2015). The initial concussion causes the brain to be more susceptible to serious injury if a subsequent impact occurs before complete symptom resolution (Adirim, 2007). Second-impact syndrome was first described in 1973 as a condition that might occur if an athlete experiences a second blow to the head before recovering from the initial concussion (Harmon, 1999). The results can be devastating and lead to collapse, permanent neurological damage, loss of consciousness, respiratory failure, and death (Adirim, 2007; King et al., 2014). "These events have been attributed to cerebrovascular dysregulation, vascular engorgement, herniation of brain tissue, worsening cellular metabolic changes and more significant cognitive deficits, although

the exact pathophysiological pathway remains unknown" (King et al., 2014, p. 458). The results of concussions are cumulative and permanent. In fact, "repeat concussions may result in long-term outcomes, which include depression, mild cognitive impairment, prolonged recovery from subsequent concussions, electrophysiological changes, and chronic traumatic encephalopathy" (King et al., 2014, p. 450). Chronic, repetitive head injury has been linked to chronic traumatic encephalopathy (CTE). Autopsies have demonstrated CTE in athletes as young as 18-years-old who died with a history of concussions (King et al., 2014). "Athletes with multiple concussions can have neurobehavioral manifestations of CTE, such as changes in memory, behavior, personality, gait and speech, and Parkinsonism-type symptoms" (King et al., 2014, p. 458). Autopsies of brains of athletes who have been involved in collision sports for years have shown increased deposits of tau proteins at the surface of the brain; these same proteins are also seen in other neurodegenerative conditions such as Parkinson's (Grady, 2010). There is speculation that concussions are a risk factor for CTE. Much research is still necessary to determine the exact causes. It is important to note that even concussions that begin in the childhood and teen years can lead to cumulative and compounding results with time. Therefore, it is essential to properly diagnose and manage adolescents with concussions to ensure adequate recovery and prevent complications such as re-injury, second-impact syndrome, or chronic repetitive head injuries (Gillooly, 2016).

Since a subsequent concussion before full recovery from the original impact could lead to such detrimental results, the safe window when an athlete might return to play has been a debate for quite some time. While previous guidelines were not evidence-based, they did attempt to reduce the consequences. In 1999, the American Academy of Family

Physicians guideline stated, “If concussion symptoms clear within 15 minutes and if no associated loss of consciousness or post-traumatic amnesia has occurred, the athlete may return to play that day” (Harmon, 1999, p. 888). Loss of consciousness was the most defining characteristic at the time (Harmon, 1999). As of 2007, guidelines recommended athletes wait to return to play until free of any symptoms including headache and dizziness but data did not indicate it could be harmful (Ropper & Gorson, 2007). Since then, a considerable amount of research has been aimed at concussion and a variety of guidelines exist including the CDC (Graham et al., 2014), the Zurich Consensus (McCrory et al., 2013), and the American Academy of Neurology (AAN; Giza et al., 2013).

There has also been a national response and increased public awareness of concussions. In 2011, the Jake Snakenberg Youth Concussion Act was enacted in response to the death of a high school football player who likely experienced second-impact syndrome (BIAC, 2017). The player passed away on the field from a typical blow to the head when he had not recovered from the initial concussion (BIAC, 2017). The Jake Snakenberg Youth Sports Concussion Act requires coaches to be educated on concussions, remove the student athlete from play, and be cleared by a healthcare professional before returning to play (BIAC, 2017). All 50 states now have return to play legislation that requires student athletes be removed from play until a provider allows them to return (Rivera et al., 2015). However, despite this legislation, healthcare professionals are not required to receive training on the management of concussions. Multiple campaigns including the CDC’s (2017) Heads Up! initiative have been created to raise awareness and promote education on concussions. Since education for healthcare

providers is not mandatory, providers might be unaware of the changes in management and be practicing with outdated information that is not research-based (Wandling & Guillamondegui, 2015). Since the consequences of concussions can be extremely detrimental, it is extremely important that healthcare providers have the necessary education, tools, and resources in appropriately diagnosing, evaluating, and managing sport-related concussions in adolescents.

Problem Statement and Purpose

Sports-related concussions in adolescents are a significant concern for athletes participating in collision sports (Grady et al., 2012). Since concussions cannot be visualized with imaging, diagnosis and management rely on the provider's ability to recognize vague signs and symptoms (King et al., 2014). Additionally, since universal agreement regarding the definition of a concussion has persisted over time, evaluation and management have not been evidenced-based (Adirim, 2007). While there has been an increase in the literature and public awareness regarding concussions, approximately 50% continue to go unreported (Harmon et al., 2013). Legislation mandates that coaches receive education on concussions but there is no such obligation for providers (Wandling & Guillamondegui, 2015). Providers might therefore be practicing with outdated information and practices. The results from repeat concussions over time are cumulative and permanent and might result in psychological and/or cognitive impairments (King et al, 2014). Chronic traumatic encephalopathy is a potentially devastating long-term result of repetitive concussions that can occur over the life-span (Grady, 2010). Because of these devastating sequelae from concussions, it is imperative that providers implement the most evidenced-based practices in the diagnosis, evaluation, and management of

sports-related concussions in adolescents. Therefore, this capstone project focused on translating the most updated evidenced-based literature into practice in the form of a concussion guideline and algorithm that could serve as a guide for providers caring for adolescents suspected of enduring a sports-related concussion.

Theoretical Framework

The Stetler (2001) model was utilized to guide the planning, development, and implementation of this capstone project. Since a lack of consistency in caring for adolescents with sports-related concussions persists, there was a need to create a concussion guideline to ensure standardized, evidenced-based practices. The Stetler model is an evidenced-based model developed in 1976 to simplify the necessary steps for translating research into practice (see Figure 1). The model consists of five phases in a step-wise fashion to achieve this goal: preparation, validation, comparative evaluation/ decision making, translation/application, and evaluation (Stetler, 2001). A description of each phase and how it applied to this capstone project are described as follows:

- Phase I: Preparation. Phase I involved identifying the purpose of the capstone project based on evidence from the literature. Additionally, the project design, proposal, and Institutional Review Board (IRB) approval occurred during this phase (see Appendix A).
- Phase II: Validation. Phase II entailed the completion of a thorough literature review. This involved evaluating evidence for its clinical significance, applicability, and credibility. All included literature was assessed pragmatically for its value in improving practice and its utilization in the capstone's purpose.

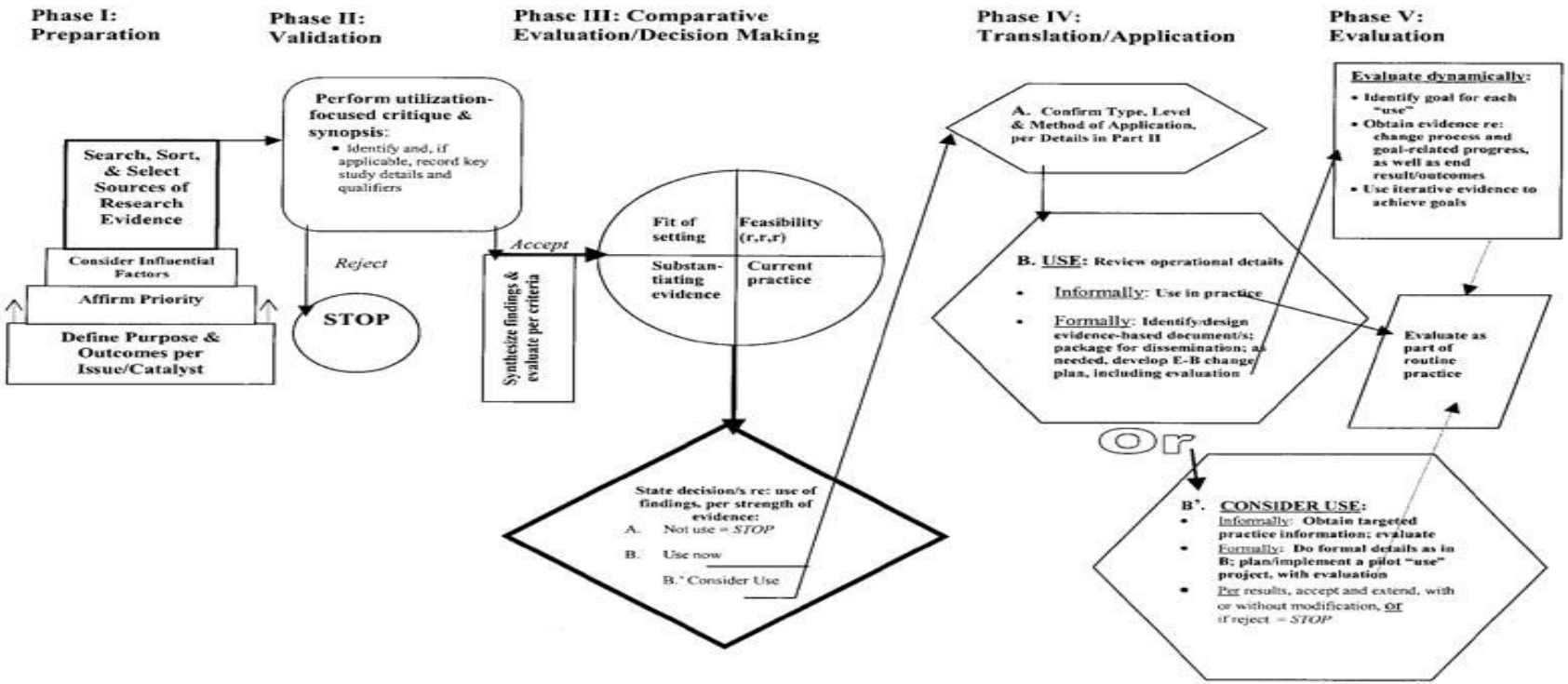

Figure 1. The Stetler model: Steps of research utilization to facilitate evidenced-based practice (Stetler, 2001, figure 3A, p. 276).

- Phase III: Comparative Evaluation/Decision making. In this phase, the literature was synthesized and decisions were made regarding which evidence could be applied to the given practice. The Delphi survey method was utilized in this phase to ascertain consensus amongst a panel of experts regarding appropriate components to be included in the clinical practice guideline. The expert panel also further identified obstacles and facilitators to implementing the evidence into practice.
- Phase IV: Translation/Application. Phase IV was the development of the guideline and algorithm, which was based on findings from the Delphi survey and literature review. The exact methods of implementing change at the specific site were determined during this phase. Due to time constraints, the guideline was not implemented into practice but an educational in-service for the providers was delivered.
- Phase V: Evaluation. In the evaluation phase, the implementation, goals, and progress are typically evaluated. If the developed guideline were implemented into practice, a cost-benefit analysis, negative outcomes, or any unexpected outcomes would be analyzed. Instead, pre- and post-tests were used to evaluate the learning of the providers at the facility, and the significance of the educational in-service. Furthermore, the providers were asked to rate their likelihood of utilizing the presented guideline.

Literature Review

Parameters

To build the foundational basis for sports-related concussions in adolescents for this capstone project, a thorough literature review was undertaken. Electronic databases used to gather the literature included Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, Google Scholar™, and Cochrane Database of Systematic Reviews. Of the articles included, many provided citations that further expanded the literature review. Keywords and phrases searched included concussions, mild traumatic brain injury, concussion in sports, concussion in sport in adolescents, head injury, diagnostic tools, current concussion treatment management, brain injury, concussion guidelines, concussion pathophysiology, and concussion management. Additionally, the term *brain concussion* was searched in PubMed and CINAHL for a more focused and thorough search. Inclusion criteria comprised of scholarly literature published between 2004 to 2017 and those written in the English language. Study designs within the literature review included systematic reviews, cross-sectional studies, retrospective studies, prospective cohort studies, prospective observational cohort studies, descriptive studies, and integrative reviews.

Altering Definition of Concussion and Resistance to Change

The definition of concussion has changed over time and a uniform agreement has been attempted for a long period of time without success. Its definition needs to be understood and standardized to accurately diagnose, understand, and manage concussions. The term concussion or *commotio cerebri* dates as early as 1700 BC to Roman, Byzantine, Arabic, and French medical writings (King et al., 2014). As recently

as 2007, it was still believed a "concussion refers to an immediate and transient loss of consciousness accompanied by a brief period of amnesia after a blow to the head" (Ropper & Gorson, 2007, p. 166). It was also believed the extent of the injury correlated with the duration of the loss of consciousness (LOC). Studies have since shown LOC is not predictive of concussion but instead, the presence of amnesia is a more sensitive indicator (King et al., 2014). Terms such as "ding" or having one's "bell rung" have been common ways to describe concussion (King et al., 2014). These terms reduce the perceived severity of concussion. Since the term concussion, which is more frequently used in describing sport-related mild traumatic brain injuries, was first used, various attempts to establish a uniform definition have been made (King et al., 2014). The term concussion is the preferred term and is also best understood by patients receiving information about the condition (King et al., 2014). Since a concussion is a functional rather than structural injury, i.e., it is typically associated with normal neuroimaging findings, its diagnosis therefore relies on understanding its definition and defining characteristics (Hobbs, Young, & Bailes, 2016; King et al., 2014; Reddy, Collins, & Gioia, 2008;).

Ever since the appearance of the term concussion in the medical literature, many attempts have been made to standardize its meaning (King et al., 2014). An elaborate definition was first made in 2001 at the First International Concussion in Sport Group Conference (McCrory et al., 2013). The definition has been altered since 2001; the most recent is an update from previous recommendations (West & Marion, 2014). The current international consensus definition as determined at the Fourth International CISG in 2012 (McCrory et al., 2013) is as follows:

> Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic and biomechanical injury constructs that may be utilized in defining the nature of a concussive head injury include:
> 1. Concussion may be caused either by a direct blow to the head, face, neck, or elsewhere on the body with an "impulsive" force transmitted to the head.
> 2. Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously. However, in some cases, symptoms and signs may evolve over a number of minutes to hours.
> 3. Concussion may result in neuropathologic changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.
> 4. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. However, it is important to note that in some cases symptoms may be prolonged. (p. 555)

The American Medical Society for Sports Medicine (Harmon et al., 2013) defined concussion as "a traumatically induced transient disturbance of brain functions and involves a complex pathophysiological process" (p. 15). The American Academy of Neurology (Giza et al., 2013) defined a concussion as "a clinical syndrome of biomechanically induced alteration of brain function, typically affecting memory and orientation, which may involve loss of consciousness (LOC)" (p. 2250). The American Congress of Rehabilitation Medicines (Hobbs et al., 2016) defined concussion as

> a traumatically induced physiological disruption of brain function resulting from the head being struck or striking an object or the brain undergoing an acceleration and deceleration movement as manifested by at least one of the following: a period of LOC up to 30 minutes; posttraumatic amnesia that does not exceed 24 hours; any period of confusion or disorientation; transient neurological abnormalities (focal neurological deficits, seizures, nonsurgical intracranial lesions); and a Glasgow Coma Scale (GCS) score of 13-15 within 30 minutes of presentation. (p. 2)

Variation amongst providers in the management of concussions causes concern for premature return to physical and cognitive demands (Eady, Moreau, Horsely, & Zemek, 2016). Despite the existence of various concussion guidelines and campaign

efforts, inconsistencies, unawareness, and non-adherence to evidenced-based practices continue to persist. A retrospective study by Carson et al. (2014) of 170 electronic health records in a sport medicine and family practice in Ontario, Canada demonstrated that over a five-year period, 43.5% of the concussion cases returned to playing sports too soon and 44.7% of the individuals returned to school too soon. Another study at Children's Hospital of Philadelphia (Arbogast et al., 2013) revealed that despite primary care provider's awareness of cognitive rest as part of the concussion management, only 2% of the providers were able to actually translate this evidence into practice. Not only this, yet another study (Kinsman, Mannix, Comstock, &Meehan, 2014) demonstrated providers felt uncomfortable delivering the plan of care and educating families on return to play instructions. Providers might be unaware of the changes in practice guidelines but even amongst those who were aware of the guidelines, only 19% to 28% conveyed they had changed their practices (Eady et al., 2016).

Concussion Pathophysiology

Concussions are difficult to diagnose and involve a spectrum of symptoms. While research has expanded drastically, many answers regarding the underlying pathology of certain symptoms remain largely unknown (Graham et al., 2014):

> The biomechanics of concussions is defined broadly as the interrelationships among the forces experienced during impact, head and neck movements, stiffness of the tissues that composes the head/neck complex, deformation of structures at the macroscopic and microscopic level, and the biological responses to the various loading conditions imposed on the head. (p. 59).

These biological responses might occur structurally or functionally. Structural changes that cannot be visualized with neuroimaging are due to torn vessels and axons, whereas functional changes are from changes in blood or neurological status (Graham et al.,

2014). These responses might occur immediately or be delayed, which could explain why symptoms might not occur for a few hours to days after the injury (Grady, 2010; Graham et al., 2014). Furthermore, "it is widely accepted that smaller deformations may be associated with brief functional changes (deficits in synaptic transmission, signaling pathways, and membrane permeability) and that larger deformations may cause permanent structural changes" (Graham et al., 2014, p. 2). Concussions are associated with these smaller macroscopic and microscopic deformities that are brief and transient and not visualized by neuroimaging; whereas, more severe brain injuries lead to more permanent changes and gross anatomical changes seen on imaging (Graham et al., 2014).

Evidence demonstrated the primary cause of concussions is from the velocity of an initial external force the brain experiences at the moment of the impact, followed by subsequent kinematic responses to the head (Graham et al., 2014; Meaney & Smith, 2011). Acceleration forces experienced by the head are typically both linear and rotational, which are influenced by the location of the initial impact and the head in relationship to the location of the neck and body (Graham et al., 2014). Rapidly experienced rotational forces generate a shearing force greater than others that deforms brain tissues more rapidly (Meaney & Smith, 2011). It is understood that this shearing deformation from rotational forces is the main mechanism of injury in concussions (Graham et al., 2014; Meaney & Smith, 2011). The degree of tissue deformation is dependent on the location of the force, intracranial membranes, and the material properties of the brain (Meaney & Smith, 2011):

> The ventricular system may have an important damping effect on the strains that appear throughout the brain during rotational motions, and the membranes that partition the cerebral hemispheres and the cerebellum from the cerebrum also influence the patterns on deformation that appear for a given head motion. (p. 4)

The injury causes permeability of the plasma membrane, a neurometabolic cascade and mismatch, neurotransmitter release, an increase in brain glucose uptake, alteration in receptors and intracellular signaling, changes in neuron responses, and various oxidative injuries to the brain (Graham et al., 2014; King et al., 2014; Meaney & Smith, 2011).

Guidelines

While previous guidelines for concussion management aimed at reducing increased risk for further injury, the pathophysiology was not well understood and the guidelines were not evidenced-based. "Past studies have been flawed due to lack of consensus of the definition of a concussion, no objective cognitive measurements, and subjective recall of concussions" (Goldberg & Dimeff, 2006, para 21). The following section summarizes three concussion guidelines: the CISG (McCrory et al., 2013), CDC (Graham et al., 2014), and the AAN (Giza et al., 2013). More detailed information discussing specifics of each guideline will be discussed following these summaries.

Summary of Zurich Consensus guideline. Due to the absence of evidenced-based guidelines for return-to-play, the CISG group held a symposium in Vienna in 2001 to develop a consensus recommendation based on the literature (Goldberg & Dimeff, 2006). The CISG consisted of experts who had authored the most widely accepted concussion guidelines. In 2004, the group decided to abandon previous grading scales and create a

> more individualized approach to each athlete, including combined measures of recovery to assess severity of injury and prognosis as well as an individual approach of recognition, remove from play, rest until asymptomatic, and step-wise return-to-play. (Goldberg & Dimeff, 2006, para 27)

Furthermore, the CISG recommended a pre-participation physical to include baseline cognitive assessment with a symptom scale (Goldberg & Dimeff, 2006).

Throughout the literature, it became apparent many sources referred to the return to play protocol made by the Zurich Consensus. For instance, a few of these included the *Journal of Family Practice*, the CDC, and *UptoDate* (CDC, 2017; Meehan & O'Brien, 2017; Sprouse et al., 2016). The Zurich Consensus Statement provided various key recommendations in concussion management including:

1. Definition of concussion
2. Signs and symptoms of a concussion
3. On-field or sideline evaluation
    a. Address first aid issues first, then assessment of concussive injury with Sport Concussion Assessment tool-3 (SCAT3) or the Standardized Assessment of Concussion (SAC)
    b. Athlete with concussion should not be allowed to return-to-play same day as injury
4. Initial medical evaluation:
    a. "A medical assessment, including a comprehensive history and detailed neurological examination with a thorough assessment of mental status, cognitive functioning, gait, and balance" (McCrory et al., 2013, p. 556).
    b. Determine if neurological improvement or deterioration
    c. Determine if neuroimaging is necessary
5. Neuropsychological testing
6. Concussion management
    a. Rest: first 24-48 hours after injury
    b. Recovery
        i. Graduated Return-to-school
        ii. Graduated Return-to-play Protocol. (McCrory et al., 2013, p. 556)

Symptoms discussed by the Zurich Consensus included somatic (headache), cognitive (feeling foggy), behavioral, and sleep disturbance (West & Marion, 2014). If any one or more of these symptoms are present, a concussion should be suspected (McCrory et al., 2013). A detailed concussion history is imperative and a multidisciplinary approach for diagnosis and management is advocated (McCrory et al., 2013; West & Marion, 2014). Neuroimaging with a CT scan or MRI is only necessary when a more severe brain injury is suspected since imaging does not contribute to a

concussion evaluation (West & Marion, 2014). These points are also covered by the SCAT3--a recommended tool by the Zurich Consensus (McCrory et al., 2013). Furthermore, balance testing was recommended, whereas the recommendations for neuropsychological testing were mixed. The Zurich Consensus recognized the clinical applicability of neuropsychological testing in conjunction with other assessments to aid in return-to-play decisions. When possible, a neuropsychologist should interpret the results but when not available, conservative return-to-play decisions should be made. Despite its recognized benefits, the committee did not mandate neuropsychological testing since there is insufficient evidence (McCrory et al., 2013).

Rest was the cornerstone of concussion management recommendations by the Zurich Consensus (McCrory et al., 2013). While the optimal amounts and types of rest necessary were unclear, the Zurich Consensus recommended an initial 24-48 hours of rest during the acute symptomatic phase of the concussion (McCrory et al., 2013). Light exercise might be beneficial but the timing remains unknown (McCrory et al., 2013). The Zurich Consensus recommends returning to physical and cognitive demands be individualized and occur in a graduated step-wise manner once the athlete is asymptomatic and not taking any pharmacological agents (McCrory et al., 2013). When proceeding through the return-to-play protocol, the athlete must remain asymptomatic for 24 hours at each step before progressing to the next step. However, if symptoms return, they must return to the previous step (McCrory et al., 2013; West & Marion, 2014). According to this protocol, it might take approximately one week for the athlete to proceed through the rehabilitation protocol (McCrory et al., 2013). In cases when symptoms last greater than 10 days, other conditions might need to be considered (West

& Marion, 2014). Furthermore, mental health issues were discussed since they had been reported as a consequence of concussions (West & Marion, 2014). The treating provider should evaluate for symptoms such as depression and anxiety; however, pharmacological therapy should only be initiated by providers experienced in concussion management and in cases of prolonged symptoms, or to modify the underlying pathophysiology in an attempt to shorten the symptoms of concussion (McCrory et al., 2013).

A pre-participation concussion history was recommended to identify athletes at high risk and to educate individuals on concussions (McCrory et al., 2013). Modifying risk factors that are important to consider in the history were also agreed upon by the CISG and included female sex, loss of consciousness, motor and convulsive movements, and depression (McCrory et al., 2013). The Zurich Consensus noted repeated concussions over time were a risk factor for future concussions, which might lead to a decreased force threshold necessary for causing subsequent concussions (West & Marion, 2014).

Summary of Centers for Disease Control and Prevention guideline. The CDC (2013) launched the Heads Up! initiative in 2003 in an effort to educate coaches, parents, athletes, and healthcare professionals on the prevention, recognition, and management of concussions in athletic youth. A major focus of the public health initiative was disseminating evidenced-based guidelines and literature to reduce the incidence of athletes who return to the game when suspected of enduring a concussion (Graham et al., 2014). The CDC endorsed removal of the athlete from the game, referral to a healthcare provider, and clearance from a provider before returning to play (Graham et al., 2014). The recommendations from the CDC were very similar to the Zurich Consensus.

Major points covered in the CDC guideline include the diagnosis, use of evaluation tools, ongoing clinical evaluation of symptoms, neuropsychological testing, serum biomarkers, and recovery management (Graham et al., 2014). Diagnosis is based on the symptoms of concussion in the four domains as discussed by the Zurich Consensus: physical (somatic), cognitive, emotional (affective), and sleep (Graham et al., 2014). Concussion should be suspected in those with symptoms in one or more of these categories (Graham et al., 2014). For sideline concussion screening, the following tools were recommended: Standardized Assessment of Concussion (SAC), Sport Concussion Assessment Tool 3 (SCAT3; Concussion in Sport Group [CISG], 2013), Balance Error Scoring System (BESS), King-Devick Test, and Clinical reaction time (RT_{clin}; Graham et al., 2014). Initial medical evaluation focused on a comprehensive concussion assessment including a thorough history of present illness (HPI) along with "symptoms scores, objective measures of postural stability, and cognitive testing as is often done with neuropsychological testing" (Graham et al., 2014, p. 105). Use of various tools together was recommended since the use of multiple test batteries might improve the sensitivity and specificity of a concussion diagnosis. While the exact combination of tools is unknown since evidence is insufficient, it was concluded that evaluation should consist of symptom scales/checklists, balance testing, and neurocognitive testing (Graham et al., 2014). A study found many forms of testing together resulted in a sensitivity of 89 to 96% (Graham et al., 2014).

Use of neuroimaging should be reserved for severe neurological injury suspicion such as a hemorrhage or skull fracture (Graham et al., 2014). While newer imaging techniques such as magnetic resonance spectroscopy, positron emission tomography,

single-photon emission computed tomography, functional magnetic resonance imaging, and diffusion tensor imaging might be useful in the future, they cannot be endorsed by the CDC at this time since they have not been validated (Graham et al., 2014). Also, while there is some research on serum biomarkers being helpful for diagnosis and prognosis in concussions, there is insufficient evidence so the CDC did not recommend it at this time (Graham et al., 2014).

The CDC (2013) recommended ongoing use of a symptoms scale with each visit to evaluate recovery and determine necessary interventions of those with a concussion (Graham et al., 2014). The Concussion Symptom Inventory (CSI) and the Acute Concussion Evaluation (ACE) were recommended since they are research-based and their psychometric evidence is strong (Graham et al., 2014). A study evaluated the various published symptom scales and found among the 20 different scales, 14 of them were variants of six core scales (Graham et al., 2014). The CDC discussed the role for neuropsychological testing for not only diagnosis but also the evaluation of symptoms throughout recovery as a baseline for comparison to assist in return-to-play decisions (Graham et al., 2014). Despite this recommendation, further research is necessary on the effectiveness of neuropsychological testing in the management of sport concussions (Graham et al., 2014).

The CDC (2013) referred to the Zurich Consensus, the American Medical Society for Sports Medicine, the American Academy of Pediatrics, and the American Academy of Neurology for guidance on managing recovery from a sport-related concussion (Graham et al., 2014). The acute phase of recovery focuses on limiting physical and cognitive demands (Graham et al., 2014). More prolonged recovery is considered around

two to four weeks after the injury when more aggressive medical management can begin (Graham et al., 2014). The CDC recommended following the same graduated return-to-play protocol as the Zurich Consensus once the athlete is symptom free. Again, if symptoms reappear with increased activity, the athlete will need to return to the prior level of activity for at least 24 hours (Graham et al., 2014; McCrory et al., 2013).

Since evidence has shown neurocognitive impairments might last longer than physical symptoms, the CDC (2013) stressed the importance of slowly returning to cognitive activity (Graham et al., 2014). Since missing school might be a significant burden for the athlete, school accommodations such as the Individual Educational Plan and the 504 Plan are recommended (Graham et al., 2014). Despite these recommendations, little empirical evidence has dictated the ideal duration of physical and cognitive rest (Graham et al., 2014).

Summary of American Academy of Neurology guideline. The AAN (Giza et al., 2013) had very comparable recommendations with slight variations in their guideline. Athletes should be immediately removed from play if a concussion is suspected, a multidisciplinary approach is encouraged, tools for evaluating concussion are recommended, and recovery should be graded and monitored by a health care provider (Giza et al., 2013; West & Marion, 2014). This guideline further addressed specific risk factors that increase the risk of concussion, diagnostic tools recommended for identifying concussion, and risks for prolonged post-concussion impairments. Risk factors for recurrent concussion discussed were a history of concussions and a repeat concussion experienced within 10 days after the initial injury (Giza et al., 2013). Symptoms recognized by the AAN to be risk factors for severe or prolonged impairments include

headache, fatigue/fogginess, and dizziness (West & Marion, 2014). The signs are "headache, fatigue/fogginess, early amnesia, alteration in mental status, disorientation reported [as] probable risk factors for persistent neurocognitive problems or prolonged return to play" (West & Marion, 2014, p. 161).

Diagnostic tools recommended by the AAN include Post-Concussion Symptom Scale (PCSS) or Graded Symptom Checklist (GSC), the SAC, computerized and/or Neuropsychological Testing, the BESS, and the Sensory Organization Test (SOT). The AAN also recommended a combination of diagnostic tests but due to insufficient evidence could not recommend the best combination (Giza et al., 2013). Neuropsychological testing was recommended when a neuropsychologist could accurately interpret it since its usefulness in identifying concussion was recognized (Giza et al., 2013). Neuroimaging was not recommended except for cases when a more serious brain injury is suspected such as a skull fracture, neurological deterioration, and those with loss of consciousness, altered mental status, and posttraumatic amnesia (Giza et al., 2013).

Returning to play should be determined by evaluating recovery with system checklists, neurocognitive testing, and balance testing (Giza et al., 2013). The AAN (Giza et al., 2013) concluded progressive return to physical activity might be beneficial but there was insufficient evidence to support specific recommendations for applying a specific activity program that normalized impairments. Instead, it was concluded an athlete should not return to play if he/she continued to have symptoms or was taking medication for lingering symptoms (Giza et al., 2013). The influence of age was discussed and it was concluded adolescent athletes should be treated more conservatively.

Absolute rest was not found to be evidence-based by the AAN (Giza et al., 2013). The AAN suggested resolution of symptoms be evaluated with symptom checklists, return to age-matched normative values, and baseline information (Giza et al., 2013). Returning to cognitive demands was not discussed. Cognitive restructuring was recommended for enhancing recovery and decreasing the likelihood of developing chronic post-concussion syndrome (Giza et al., 2013; West & Marion, 2014). Pre-participation counseling was also discussed. The AAN recommended providers discuss concussion risk factors with athletes and their families during pre-participation counseling including: (a) age or competition level (however, evidence was inconclusive); (b) type of sport (football, rugby, hockey, soccer highest risk); (c) gender (concussion risk greater for females); (d) equipment (moderate evidence that helmets reduce risk if well-fitting and good design); (e) position (insufficient regarding increased risk); and (f) prior concussion (strong evidence that history of previous concussion is significant risk for subsequent ones; Giza et al., 2013).

Symptom Assessment

Recognizing the signs and symptoms of a concussions is essential since imaging is not beneficial for diagnosis (Graham et al., 2014; Hobbs et al., 2016; King et al., 2014; McCrory et al., 2013). Loss of consciousness only occurs in 8 to 9% of all concussions (King et al., 2014). Headaches are the most commonly reported symptom and have been reported by 70% of athletes who have a concussion (Reddy et al, 2008). Balance problems are also frequently observed in the concussed athlete since the vestibular system is susceptible to injury from the concussion (Reddy et al., 2008):

> Benign paroxysmal positional vertigo, labyrinthine concussion, perilymphatic fistulae, central vestibular disorders, endolymphatic hydrops, and cervicogenic

> vertigo have been reported after concussion, and several studies have documented balance deficits in athletes who have concussion. (p. 253)

"Fogginess" after a concussion is a frequently reported symptom that has been studied. Data suggest this fogginess after a concussion might be associated with a worse course and longer recovery period (Reddy et al., 2008). A study demonstrated those with fogginess had slower reaction times, worse memory, and slower processing times on computerized neurocognitive testing (Reddy et al., 2008).

Symptoms are typically divided into four domains: physical, cognitive, emotional, and sleep (Harmon et al., 2013). Physical (somatic) signs and symptoms included headache, fuzzy or blurry vision, vomiting (early on), dizziness, visual problems, fatigue, sensitivity to light, sensitivity to noise, numbness/tingling, dazed, stunned, and balance problems (Graham et al., 2014; Harmon et al., 2013). Cognitive symptoms reported included feeling mentally "foggy," difficulty remembering or thinking clearly, feeling slowed down, difficulty concentrating, forgetting recent dialogues, confusion, repeating questions, and slow responses (Graham et al., 2014; Harmon et al., 2013). Emotional symptoms were irritability, sadness, feeling more emotional, nervousness, and/or anxiety (Graham et al., 2014; King et al., 2014). Sleep symptoms might include drowsiness, difficulty falling asleep, and sleeping more or less than usual (Graham et al., 2014; King et al., 2014). Furthermore, these deficits might or might not be present for each individual (King et al., 2014).

Symptoms are not only subjective but also depend on the willingness of the athlete to report them.

> A study of high school athletes found that female athletes reported more somatic symptoms (drowsiness and sensitivity to noise) while their male counterparts reported more cognitive symptoms (amnesia and confusion/disorientation),

> although the number of symptoms reported did not differ by sex. (Graham et al., 2014, p. 104)

Since these symptoms are typically vague, those observing the individual might not perceive them as signs and symptoms of concussion. Vague signs of concussion include general confusion, forgets play, moving clumsily, forgets events before play, forgets after being hit, and unsure of game, score, or opponent (Reddy et al., 2008).

Diagnostic Tools for Identifying Suspected Concussion

A single gold standard exam or imaging test to diagnose concussions does not exist and guidelines vary in their recommendations. However, various tools and assessments can aid in the diagnosis since imaging cannot (Guskiewicz et al., 2013). Concussion assessment tools recommended by each of the guidelines are presented and discussed in this section.

The Zurich Consensus (McCrory et al., 2013) recommended the ACE, SAC, SCAT3, and neuropsychological testing. The CDC (Graham et al., 2014) recommended: the ACE, SAC, SCAT3, BESS, King-Devick Test, and $RT_{clin.}$ The CDC also recommended the CSI, ACE, and neuropsychological testing for ongoing symptom evaluation. The AAN (Giza et al., 2013) recommended the PCSS, GSC, SAC, BESS, SOT, and neuropsychological testing. As mentioned previously, a combination of tools greatly improves the sensitivity and specificity for concussions but should not take the place of clinical judgment. It is important to remember that "worsening symptoms, pronounced amnesia, progressive balance dysfunction or focal neurological deficits on examination could be signs of intracranial pathology and should prompt neurological imaging (level of evidence C)" (Harmon et al., 2013, p. 22).

Acute Concussion Evaluation. The ACE is intended to be administered by healthcare providers to their patients. It consists of questions about the injury characteristics, a symptom checklist, risk factors, red flags, diagnosis, and a follow-up action care plan (Gioia, Collins, & Isquith, 2008). It can be used as a clinical protocol for diagnosis, tracking symptoms, and the creation of a plan to return to activities (Graham et al., 2014). While normative data on the ability of the ACE to determine concussion diagnosis were not found, Coldren, Russel, Parish, Dretschz, and Kelly (cited in Graham et al.,2014) concluded the Military Acute Concussion Evaluation (MACE) lacked the "sensitivity and specificity necessary to determine a concussive event 12 hours post injury" (p. 312). Despite this, Kennedy et al. (2012) showed it could be useful in evaluating concussion symptoms serially if the original tool was administered within six hours of the injury. Zuckerbraun, Atabaki, Collins, Thomas, and Gioia (2014) looked at the modified version of the ACE for use in the emergency department and its effect on patient follow-up and post-injury behaviors. Results showed an improvement in follow-up by 29% at week four and improved recall of concussion education regarding symptoms and activity restrictions (Zuckerbraun et al., 2014).

Standard Assessment of Concussion. The SAC was designed for use by non-professionals on the sideline of a sporting event (Giza et al., 2013). It can be rapidly administered and addresses the neurocognitive domains of memory, orientation, immediate concentration, and delayed recall (Gillooly, 2016; Giza et al., 2013). It is highly reliable, its sensitivity for concussion is 80 to 94%, and the specificity is 76 to 91% (Sprouse et al., 2016).

Sport Concussion Assessment Tool 3. The SCAT3 (CISG, 2013) was designed for individuals 13 years of age and older and contains the following components: the Glasgow Coma Scale, Maddocks questions, SAC, BESS, a neck evaluation, yes/no symptoms checklist, information regarding the mechanism of injury, and background information (Graham et al., 2014; Rivera et al., 2015). The SCAT3 was developed out of the SCAT2 (Pocket SCAT 2, 2009) to be used on the sidelines or in the office for evaluation, diagnosis, and recovery decisions (Graham et al., 2014). It provides a detailed assessment of the essential components necessary for a concussion diagnosis. Its reliability is 54% to 94%, sensitivity is 83% to 96%, and specificity is 81% to 91% (King et al., 2014; Sprouse et al., 2016). It is for use by healthcare providers; however, in an aim to standardize assessments of concussions, the CISG developed two forms of the tool in 2008. They included (a) the SCAT2--for medical professionals to assess concussion in great detail and (b) the PocketSCAT2--for non-health care professionals to assist in screening for concussion on the sideline (Guskiewicz et al., 2013).

Glasgow Coma Scale. While the GCS is not as reliable in the athletic setting as memory assessment, it was included in the SCAT3 since it evaluates for and rules out more severe injuries that would require immediate attention (McCrory et al., 2013). The standard orientation questions in the GCS were developed in 1974 to evaluate the severity of neurological impairment in adults (Guskiewicz et al., 2013). An individual's LOC is scored from 3 (lowest) to 15 (highest) based on three domains: eye opening, motor response, and verbal response. "An initial score of less than five is associated with an 80% chance of a lasting vegetative state or death. An initial score of greater than 11 is associated with a 90% chance of complete recover" (Graham et al., 2014, p. 309). Since

concussions are a relatively mild brain injury, individuals generally score a 14 or 15 (Guskiewicz et al., 2013).

Maddocks questions. Maddocks questions are used to evaluate orientation, particularly recall of recent events, i.e., "Where are we now?' What team did you play last week?" (Guskiewicz et al., 2013). It is scored from zero (lowest) to five (highest). The questions are more sensitive to concussion injury than standard orientation questions (Guskiewicz et al., 2013). The sensitivity is 32% to 75% and specificity is 86% to 100% (Sprouse et al., 2016).

Balance Error Scoring System. The balance component is very important in concussion evaluation (Guskiewicz et al., 2013).

> Studies indicate that the regions of the brain responsible for coordinating the sensory modalities (thalamus and its inter-connective pathways to the cerebral cortex) may be disrupted post-injury and that the vestibular system is often affected following a concussion. (Harmon et al., 2013, p. 21)

The BESS is a quantifiable test for measuring postural stability (Giza et al., 2013). It has been studied extensively in the concussed population and has been found to have high test-retest reliability at 0.87 to 0.97 intra-class correlations (Riemann, Guskiewicz, & Shields, 1999). While the sensitivity is low to moderate at 0.34 to 0.64 when used alone, the specificity is high at 0.91 (Giza et al., 2013). Using the BESS in conjunction with the SAC and Maddocks questions, as seen in the SCAT3, has been shown to increase the sensitivity (Giza et al., 2013).

Sensory Organization Test. The SOT measures equilibrium with a force plate that alters orientation and visual inputs (Giza et al., 2013). It has been found to have low sensitivity for concussion when used alone (Graham et al., 2014). One study reported sensitivity of 0.61 for the SOT and a later study by the same group reported sensitivity of

0.57 and specificity of 0.80 (at 75% confidence interval; Giza et al., 2013). Using it as a baseline with a follow-up assessment led to an increased sensitivity of 55% and specificity of 80% at the 75th% confidence interval (Graham et al., 2014).

King-Devick test. The King-Devick test assesses saccadic eye movements. It works by

> measuring the speed of rapid number naming as well as errors made by the athlete, with the goal of detecting impairments of eye movement, attention, and language as well as impairments in other areas that would be indicative of suboptimal brain function. (Graham et al., 2014, p. 313)

There is currently not enough evidence to support use of the tool since studies involved 10 or fewer concussed athletes (Giza et al., 2013; Graham et al., 2014).

Clinical Reaction Time Test. The $RT_{(clin)}$ is a simple test that evaluates the reaction time to catch a dropped, weighted stick (Eckner, Kutcher, & Richardson, 2010). Its validity was evaluated in conjunction with another test--the CogSport simple reaction time measure. It was found to be 79% sensitive and 61% specific using a 60% confidence interval by Eckner and colleagues in 2013 (Graham et al., 2014). However, further research on its independent validity is necessary.

Post-Concussion Symptom Scale and Graded Symptom Checklist. The PCSS or GSC is a self-reported scale of concussion symptoms that can be used throughout recovery (Giza et al., 2013). Both are intended to be administered by a trained employee who does not need to be a provider. The AAN (Giza et al., 2013) conducted a systematic review and concluded elevated post-concussive symptoms are likely to be associated with more severe or prolonged early post-concussive cognitive impairments (six studies: one Class I, two Class II, three Class III). Furthermore, “evidence indicates that a GSC or PCSS will accurately identify concussion in athletes involved in an event during which

biomechanical forces were imparted to the head [sensitivity was 64%-89%, specificity was 91%-100%; multiple Class III studies; Giza et al., 2013, p. 2252).

Neuropsychological testing. "Neuropsychology is the study of brain-behavior relationships, that is, the ways in which specific neural (brain) structure and activity are reflected in cognitive and physical behavior" (Graham et al., 2014, p. 134). Neurocognitive testing is a data-driven, reliable, valid method for assessing manifestations of concussions and tracking recovery from the injury (Reddy et al., 2008).

> Designed to identify occult cognitive impairment post-injury, neuropsychological testing has been able to identify neurocognitive deficits within 2-48 hours post injury and can show cognitive deficits despite athletes reporting they are asymptomatic. (King et al., 2014, p. 454)

A study conducted by Goldberg and Dimeff (2006) reported substantial differences between athletes with concussion versus a control group of athletes without concussion in memory and response speeds. Memory, concentration, attention, information processing speed, and reaction speed were all assessed (Goldberg & Dimeff, 2006).

Neuropsychological testing may be performed via paper-and-pencil or the computer (Giza et al., 2013). Computerized tests include Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT), CogSport, Headminders, and Automated Neuropsychological Assessment Metrics (ANAM; Goldberg & Dimeff, 2006). Computerized testing is the most accurate evaluation of response times as they are accurate to 0.01 seconds as opposed to traditional testing that allows for accuracy up to one to two seconds (Reddy et al., 2008). A trained neuropsychologist should interpret the test since he/she might be aware of subtle deficits that persist beyond the extent of the acute injury (McCrory et al., 2013). However, the test might be administered by

someone who is not a neuropsychologist. "The sensitivity has been found to be 71%-88% of athletes with concussion" (one Class II study, multiple Class III studies; Giza et al., 2013, p. 2252). A study comprised of 81 concussed athletes, aged 13 to 21, in comparison to 81 controls to analyze the ImPACT testing validity. It was found to have a high sensitivity at 91% and sufficient specificity at 69% (Schatz & Sandel, 2013).

While neuropsychological testing should not be used alone or serve as the mainstay of diagnosis or management decisions, it is suggested that it aid in return-to-play (RTP) decisions (McCrory et al., 2013). The AAN (Giza et al., 2013) recognized the utility of neuropsychological testing but noted 12-29% of athletes with concussion would not be identified as such by neuropsychological testing.

> Although in most cases, cognitive recovery largely overlaps with the time course of symptom recovery, it has been demonstrated that cognitive recovery may occasionally precede or more commonly follow clinical symptom resolution, suggesting that the assessment of cognitive function should be an important component in the overall assessment of concussion and, in particular any RTP decisions. (McCrory et al., 2013, p. 557)

While the guidelines did not feel that requiring baseline neuropsychological testing was necessary, it was decided it was helpful. It could be used in evaluating many domains of cognitive functioning for documentation of recovery (King et al., 2014).

Symptom Management

The primary intervention in the literature was rest before returning to physical or cognitive demands (Grady et al., 2012; Graham et al., 2014; King et al., 2014; McCrory et al., 2013; Meehan & O'Brien, 2017). While the literature was non-conclusive on the adequate amount, timing, and effect of rest on recovery after a sport-related concussion, issues underlie this consensus (McCrory et al., 2013).

> First, concussed athletes are usually instructed to avoid any activity that will increase their heart rate, as this may worsen symptoms and potentially increase recovery time; second, a premature return to contact or collision activities may increase the risk of repeat injury. (Graham et al., 2014, p.156)

Generally, symptoms should be managed without medications (McCrory et al., 2013). Anti-inflammatory medications are not recommended for headaches in the acute phase (Harmon et al., 2013). If they must be used, it should be for less than three days (Sprouse et al., 2016). An antiemetic is an acceptable treatment for nausea during only the first day or two after a concussion (Meehan & O'Brien, 2017). Instead of medications, a quiet, dim, therapeutic environment is suggested for those experiencing increased sensitivity to light and noise (Meehan & O'Brien, 2017). Sleep disturbances should also be managed without medications and with proper sleep hygiene (Harmon et al., 2013). Low-level exercise has been shown to be beneficial but the appropriate timing of it remains unknown (McCrory et al., 2013). Alteration in mood has been found to be a common symptom. "Neuroimaging studies using fMRI suggest that a depressed mood after a concussion may reflect an underlying pathophysiological abnormality consistent with a limbic-frontal model of depression" (McCrory et al., 2013, p. 559). Antidepressant therapy and/or cognitive therapy may be considered if symptoms persist beyond 6 to 12 weeks (level of evidence C; Harmon et al., 2013). It is important to note that evaluation for return-to-play can only occur once the athlete is symptom free and not taking any medications (McCrory et al., 2013).

Balance dysfunction and vertigo are important symptoms that require further evaluation (Harmon et al., 2013). While certain medications are typically beneficial, it is recommended that they be used cautiously in the concussed athlete. Such medications may increase fatigue and obscure evaluation of symptom resolution (Harmon et al.,

2013). Evidence is limited but Harmon et al. (2013) recommended vestibular therapy be considered for treatment of vertigo or dizziness. Furthermore, a referral to physical therapy might be beneficial for monitoring the injured athlete (Sprouse et al., 2016). In cases of persistent symptoms, a referral needs to be considered. Meehan and O'Brien (2017) conducted a randomized-controlled study of 49 adolescents that evaluated the effects of a multidisciplinary treatment approach with cognitive-behavioral therapy and psychopharmacology treatment at six months as compared to usual treatment. Significant decreases in depression and post-concussive symptoms were found in their results: an 87% reduction vs. 58% reduction in post-concussive symptoms and 78% vs. 46% with more than or equal to 50% reduction in depression symptoms. Statistical analysis information was not reported (Meehan & O'Brien, 2017).

Return-to-School

There are currently no standardized guidelines for returning to school (Harmon et al., 2013). However, school work might increase the metabolic demands on the injured brain at a time when it is vulnerable (Grady et al., 2012). Evidence showed resolution of neurocognitive impairments might take longer than physical symptoms (Graham et al., 2014). Furthermore, observational studies have shown worsening of symptoms could persist from cognitive overextension (Meehan & O'Brien, 2017). In one study of students who exerted themselves cognitively after a concussion, 80% of the 72 students reported worsening of symptoms one month after the injury (Meehan & O'Brien, 2017). In another small observational study, resting from cognitive demands for at least one week along with physical rest from 1 to 30 days after the injury was associated with improved neurological functioning on a standardized assessment tool (Moser & Schatz,

2012). Moser and Schatz (2012) found those athletes who cognitively rested for at least a week showed significant improvement on a concussion symptoms scale and neurocognitive tests even if it was prescribed weeks to months after the injury. However, other studies have shown little to no benefit on recovery length with rest (Graham et al., 2014). Worsening of symptoms has been found in studies with strict rest as well. In one study, longer periods of strict cognitive rest were correlated with worsening of daily post-concussive symptoms when compared to usual care (Meehan & Bachur, 2015). Five days of strict rest were associated with a slight increase in duration of symptoms but were not significant; the median was seven days versus four days ($p = 0.08$; Thomas, Apps, Hoffman, McCrea, & Hammond, 2015).

Despite mixed evidence, current guidelines recommend reducing activities that exacerbate concussion symptoms. Reducing screen time, video games, loud music, and other activities that require a high level of concentration are endorsed (Meehan & O'Brien, 2017). The CDC (2017) recommends athletes ease back into the demands of school; their website has educational resources for schools, administrators, and teachers. Grady et al. (2012) recommended that to avoid increased symptoms, the athlete should transition back to school gradually after an initial complete brain rest. Once concentration increases to a few hours without any significant symptoms, the progression back to school should begin with half-day classes (Grady et al., 2012). It is important to ensure the athlete has extra time for academic demands such as homework, tests, and note-taking (Grady et al., 2012). Returning to school, however, does not clear an athlete for returning to physical activity.

Return-to-Play

When evaluating the ability of an athlete to return to activity or cognitive demands, medications should be avoided since they might mask neurological symptoms (Harmon et al., 2013). Once the individual is asymptomatic and not taking any medications, he/she may gradually return to activities (McCrory et al., 2013). "In the absence of evidence-based recommendations, a sensible approach involves the gradual return to school and social activities (before contact sports) in a manner that does not result in a significant exacerbation of symptoms" (McCrory et al., 2013, p. 557). There is moderate to strong evidence that ongoing symptoms are associated with ongoing cognitive dysfunction and slowed reaction time after sports concussions (Giza et al., 2013).

> In a prospective, nonrandomized study of 635 high school and college athletes with concussion, McCrea and colleagues (2009) found that the more time that elapsed between an athlete's injury and returning to play, the less likely the athlete was to have a repeat concussion during the same season. (Graham et al., 2014, p. 156)

Furthermore,

> there are data demonstrating that, at the collegiate and high school level, athletes who were allowed to return to play on the same day demonstrated neuropsychological deficits post-injury that may not have been evident on the sidelines, and they were more likely to have delayed onset of symptoms. (McCrory et al., 2013, pp. 557-558)

Waiting to return to play until asymptomatic and off medications diminishes the risk for recurrent injury (Giza et al., 2013).

Second impact syndrome is a complication that can occur from returning to the game too soon after a concussion (Hobbs et al., 2016):

> This syndrome, which is also called 'diffuse cerebral swelling,' is thought to involve the loss of autoregulation of the brain's blood supply, leading to vascular

> engorgement and elevated cerebral blood volume, as well as a marked increase in intracranial pressure, and ultimately can cause a herniation event resulting in coma or death. (p. 7)

The brain needs time to recover from the metabolic changes that occur as a result of a concussion (Graham et al., 2014). A retrospective cohort study (Majerske et al., 2008) of 95 high school student athletes demonstrated that who engaged in high levels of activity after a concussion did not perform as well on neurocognitive testing as individuals who engaged in moderate activity such as light jogging.

The first return to play rule was in 1945 and was known as the "three strikes rule" (King et al., 2014). This rule recommended an athlete be terminated from sport participation if they had experienced three concussions (King et al., 2014). Further guidelines expanded this rule with the intention of preventing further injuries and cumulative effects from concussions. In fact, previous Colorado guidelines supported return to play the same day as the first concussion when asymptomatic for 20 minutes (King et al., 2014). These original guidelines were based on clinical experience and results of devastating events (King et al., 2014). The CISG more recently determined the previous guidelines were not adequate and have published a stepwise return-to-play (RTP) protocol to be used in conjunction with symptom and cognitive assessment (King et al., 2014).

The Zurich guideline is widely accepted as the protocol for return-to-play and their step-wise protocol is frequently cited (McCrory et al., 2013). The graduated return-to-play protocol was designed to allow for adequate time for the brain to heal. The committee decided unanimously at the Fourth International Conference on Concussion in Sport that an athlete should never return to play the same day as a concussion (McCrory

et al., 2013). Aside from risk of re-injury, the rest period is to protect the brain during its cerebral vulnerability following a concussion (Graham et al., 2014). Another aspect of the protocol is light aerobic exercise. While there has been no random-controlled trial studying the effects of light exercise on youth, animal studies have shown it to be beneficial. The animal studies suggested it promotes neuroplasticity and neurogenesis while decreasing oxidative stress, neuro-inflammation, and cognitive dysfunction (Graham et al., 2014). Table 1 presents a graduated return-to-play protocol.

Table 1

Graduated Return-to-Play Protocol

Rehabilitation Stage	Functional Exercise at Each Stage of Rehabilitation	Objective(s) of Each Stage
1. No activity	Symptom-limited physical and cognitive rest	Recover
2. Light aerobic exercise	Walking, swimming, or stationary cycling, keeping intensity <70% of maximum permitted heart rate; no resistance training	Increase heart rate
3. Sport specific exercise	Skating drills in ice hockey, running drills in soccer; no head-impact activities	Add movement
4. Noncontact training drills	Progression to more complex training drills in football and ice hockey; may start progressive resistance training	Exercise, coordination, and cognitive load
5. Full-contact practice	After medical clearance, participation in normal training activity	Restore confidence and assessment of functional skills by coaching staff
Return to play	Normal game play	Normal activity

Adapted from McCrory et al. (2013).

The athlete needs to progress through these steps prior to returning to regular activity and should not begin the progression until they are asymptomatic and not taking any medications (McCrory et al., 2013). Individuals need to remain at each stage for a minimum of 24 hours prior to progressing to the next phase (Meehan & O'Brien, 2017). Despite this guide, it is important to handle each case uniquely. The progression through these steps might take days to months (McCrory et al., 2013). If the athlete develops symptoms during any level of increased activity, they need to revert to the previous activity level where they need to remain asymptomatic for at least 24 hours (Harmon et al., 2013).

A more conservative approach for adolescents returning to play has been recommended by Sprouse et al. (2016). In this approach, the return-to-play progression begins when the athlete is completely symptomatic free, exhibits a normal neurological examination, is back to school full time, and not taking any medication. Sprouse et al. suggested returning to play be supervised by an athletic trainer or physical therapist. Furthermore, if symptoms resurface at any stage along the progression, the athlete must rest for 24 hours and remain asymptomatic. The athlete will then resume activity at the last stage they were asymptomatic (Sprouse et al., 2016). Sprouse et al. provided three different progressions of returning to play: the first is one that begins after a symptom free period of one week, the second begins after symptom free for one to four weeks, and the third begins after symptom free for over four weeks. McCrory et al. (2013) also discussed the need for a more conservative treatment for adolescents: "It is appropriate to extend the amount of time of asymptomatic rest or the length of the graded exertion in children or adolescents" (p. 559). The exact amount of asymptomatic rest was not

discussed. High school athletes have been found to have a longer recovery time post-concussion than college athletes (Reddy et al., 2008). Reddy et al. (2008) demonstrated that "high school athletes with less than 15 minutes of on-field symptoms required at least 7 days before full neurocognitive and symptom recovery" (p. 263).

Multiple sources supported the use of a symptom checklist for evaluating concussion symptoms. The CDC (2013) recommended the use of the ACE to evaluate diagnosis, symptoms, risk factors, and develop a return-to-play plan for the athlete. Harmon et al. (2013) also discussed the need to evaluate cognition and balance to track recovery (Level C evidence). Graham et al. (2014) discussed various tools to track symptoms and recovery including the CSI, GSC, PCSS, Health and Behavior Inventory, Post-Concussion Symptom Inventory, and the Rivermead Post-Concussion Symptoms Questionnaire. Of the previous tools listed, the Post-Concussion Symptom Scale was found to have the strongest data supporting its use in adolescents (Graham et al., 2014).

Pre-Participation Evaluation

The role of pre-participation concussion evaluation was stressed by the Zurich Consensus (McCrory et al., 2013) and American Academy of Neurology (Giza et al., 2013). An evaluation prior to participation in a sport, as described by McCrory et al. (2013), should assess past medical history of concussions and aim to identify athletes who might be at higher risk for concussion. "A history of concussion is associated with a 2-5.8 times higher risk of sustaining another concussion" (Harmon et al., 2013, p. 18). Despite this, the evidence is conflicting regarding if a past concussion is correlated with a prolonged length of recovery time (Harmon et al., 2013). The American Medical Society for Sports Medicine position statement also stressed the importance of preseason

evaluation of concussion along with mood, learning, attention, or migraine disorders (Harmon et al., 2013). The evidence for this is a level C and studies have not been completed regarding baseline testing with one of the diagnostic tools (Harmon et al., 2013). Despite level C evidence, Harmon et al. (2013) recommended baseline neurocognitive testing in high-risk athletes and sports with higher incidence of concussions. This baseline testing might be beneficial in the management of a concussion. Lehman and Carl (2017) recommended a complete neurologic examination with cognitive function testing in individuals with a history of concussion. The presence of delayed recovery from concussion should alert a physician to withhold the athlete from clearance to play (Lehman & Carl, 2017).

Complications of Repetitive Concussions

Second impact syndrome is a complication that can result from a second force to the head before adequately recovering from the initial injury (Hobbs et al., 2016). This phenomenon has only been seen in adolescent athletes (Reddy et al., 2008): "Morbidity is 100% in the case of second impact syndrome, whereas mortality is reported to occur in up to 50% of cases" (p. 263). Furthermore, returning to play too soon predisposes an athlete to risk for prolonged severity and duration of symptoms (Hobbs et al., 2016; Meehan & O'Brien, 2017). Strong empirical evidence of the consequences of repetitive concussions is lacking (Hobbs et al., 2016). In fact,

> although high school athletes represent the largest cohort of at risk athletes, there is a considerable gap in the literature evaluating potentially persistent cognitive and motor performance alterations beyond the acute recovery period in this population. (Martini, Eckner, Meehan, & Broglio, 2017, pp. 1420-1421)

Certain complications have a direct correlation to concussions, whereas others are not conclusive.

Post-traumatic headaches are extremely common and the risk of epilepsy doubles in the first five years after a concussion (Evans, Aminoff, Moreira, & Wilterdink, 2015). Post-traumatic vertigo is a complication of concussions that is not well explained by studies. Cranial nerve injuries can occur; their incidence is 0.3% (Evans et al., 2015).

> Based upon animal studies and observational evidence from adult athletes, concern exists that young athletes who sustain repetitive head impacts and multiple concussions, may be at risk for neurodegenerative disease, such as Chronic Traumatic Encephalopathy (CTE) or Alzheimer disease later in life. (Meehan & O'Brien, 2017)

Summary and Synthesis of Literature

This literature review discussed concussion pathophysiology, the definition of concussions, and variations in practice. It further examined guidelines from the CDC (2017), AAN (Giza et al., 2013), and the Zurich Consensus (McCrory et al., 2013). While these guidelines are similar, variations between them exist. Furthermore, data for the recommendations of each guideline were analyzed. While the literature established the definition of a concussion, signs and symptoms, and diagnosis, confusion regarding the most appropriate evaluation tools and management techniques continues to persist. The literature supported a need for a consistent approach to evaluation and management of a concussed adolescent athlete.

Since the definition and severity of a concussion have remained misunderstood for an extended period of time, care and management for a concussion were not evidenced-based. Since LOC is not a defining characteristic and neuroimaging is not valuable in diagnosing a concussion, its recognition remains largely on the provider's

understanding of its definition and defining characteristics (King et al., 2014). The provider's ability to recognize rather vague signs of concussion is very important. As discussed in the literature, many providers were not aware of evidenced-based concussion guidelines and even those who were might feel uncomfortable implementing them (Eady et al., 2016). Confusion regarding the most appropriate evaluation tools and management techniques persists. Symptoms are generally categorized into four domains: somatic, cognitive, behavioral, and sleep (McCrory et al., 2013). Fogginess was noted to be a risk factor for prolonged or worsening symptoms (West & Marion, 2014). Headache was identified as the most commonly reported symptom (Reddy et al., 2008; West & Marion, 2014).

Diagnosis begins from the time of the injury on the field. The athlete should be removed from play immediately, evaluated, and cleared by a healthcare provider before returning to physical or cognitive demands. One specific diagnostic tool for evaluation could not be determined at this time based on the review of the literature. Despite variation between the guidelines, the consensus in the literature was the use of multiple evaluation tools greatly increased the sensitivity and specificity for concussion (Graham et al., 2014). Appendix B provides these evaluations tools. A thorough history of the injury, neurological status, balance testing, orientation status, and symptom assessment are essential components that need to be addressed by the evaluating provider (Graham et al., 2014). Neuroimaging is only necessary when a more severe injury is suspected (McCrory et al., 2013). Neuropsychological testing is noted to be a very reliable, helpful, and accurate method for evaluation and recovery decisions but was not deemed to be necessary (West & Marion, 2014).

Rest remains the mainstay treatment and the athlete must not return to play the day of concussion. Strong evidence is lacking regarding how much or what type of rest is necessary (Meehan & O'Brien, 2017). Gradually returning to physical and cognitive demands is recommended, especially for adolescents, since it decreases the risk for ongoing symptoms and recurrent injury (Giza et al., 2013). Returning to play and returning to school should occur in an incremental fashion once the athlete is symptom free and not taking any medication that might mask lingering symptoms (McCrory et al., 2013). At this time, strong evidence does not support a specific protocol for returning to physical and cognitive demands but evidence for a more conservative approach was acknowledged. Recovery should be evaluated with ongoing symptom scales. Of the tools evaluated in the literature review, the Post-Concussion Symptom Scale has the strongest data for use in adolescents (Graham et al., 2014). Prolonged symptoms of greater than 10 days should alert the provider to consider other conditions (Meehan & O'Brien, 2017).

Complications of concussions can occur when the athlete endures another concussion while still symptomatic from the initial injury (Hobbs et al., 2016). However, strong evidence regarding the long-term consequences of repetitive concussions is lacking (Hobbs et al., 2016). Pre-participation evaluation before the sport season is emphasized as way to evaluate and identify individuals at an increased risk for concussions and prolonged recovery time (Harmon et al., 2013). Baseline neurocognitive testing for comparison might be beneficial in concussion management (Lehman & Carl, 2017).

The literature supported the need for the development of a concussion guideline and program to educate providers on concussions. While there has been a surge in research on concussion recently, gaps in the literature exist. Topics for further research include

- Identification of specific validated tools for evaluation and diagnosis of concussion in adolescents.
- Determination of symptom assessment tool(s) for evaluating recovery.
- Empirical evidence for amount and type of rest.
- Studies on effectiveness of specific return-to-learn and return-to-play protocols.

CHAPTER II

PROJECT DESCRIPTION

Project Purpose

The literature supported the need for a clinical practice guideline and algorithm for concussion diagnosis and management. Therefore, the purpose of this capstone project was to evaluate the empirical evidence and its applicability for a guideline that would address concussion diagnosis, evaluation, and management. Furthermore, it was created for the primary care providers at Sunrise Kids Care Clinic. The evidenced-based guideline was developed with expert consensus and the literature. The anticipated benefit was improved adherence to evidenced-based literature in caring for concussions in adolescents. Anticipated long-term outcomes were decreased incidence of second-impact syndrome and decreased prevalence of long-term sequelae from repeat concussions.

Project Objectives

Accurate diagnosis and management of adolescents with a sports-related concussion is an essential component of primary care practice. The long-term goal is to prevent further damage and decrease the likelihood of second-impact syndrome after a concussion has been endured by an athlete. Objectives for this capstone project entailed the creation of a concussion guideline and algorithm to aid providers at Sunrise Kids Care Clinic in proper diagnosis and management of adolescents who present with complaints

of a sports-related concussion. Specific objectives for this capstone project were as follows:

1. Gained knowledge regarding current practices in concussion evaluation and management
    - Surveyed current providers' practices at Sunrise Kids Care Clinic (the organization).
    - Obtained and evaluated the most current concussion guideline recommendations and applicability to the population in the care setting.
    - Surveyed expert panel's opinions and knowledge regarding concussion diagnosis and management utilizing the Delphi method.
2. Developed concussion guideline and algorithm for medical providers.
    - Guideline included signs and symptoms, evaluation, diagnosis, tools, symptom assessment, and management of concussed adolescent athlete. Protocol was developed for return-to-play and return-to-learn activities.
    - Developed step-wise algorithm for concussion diagnosis and management.
3. Presented concussion guideline and algorithm to primary care providers at Sunrise Kids Care Clinic. This guideline will not be physically implemented into the clinical practice for this capstone project due to time constraints.

- Evaluated provider's learning with a pre- and post-test.
- Evaluated likelihood the providers would implement the presented guideline.

Congruence with Organization's Strategic Plan to Project

This quality improvement project took place at a pediatric care clinic that focuses on population health. Sunrise Kids Care Clinic is a satellite of Sunrise Community Health--a non-profit, patient-centered care organization that serves the community at affordable costs. The mission of Sunrise Community Health (2016) is "Supporting the health of individuals, families, and our community through affordable, integrated, quality care and organization" (para 1). The organization integrates care amongst primary care services and serves all individuals, regardless of their ability to pay. The strategic plan includes maintaining a healthy community, containing costs, and ensuring quality health care for its community members (Sunrise Community Health, 2016).

This capstone project assisted providers in the diagnosis and management of sports-related concussions as the organization moves forward with their strategic plan. It was in alignment with both the mission and strategic plan. Each element of the strategic plan was reflected in this capstone project. Maintaining costs, improving quality, and ensuring the health of the community are important aspects of care for Sunrise Community Health (2016) and this capstone project was in alignment with each one of those values. The goal of maintaining a healthy community might be improved and children might perform better academically with less risk of long term neurological sequelae.

Project Design

Evidenced-Based Project Plan

Upon analysis of the literature, it became evident a significant need for a concussion guideline and algorithm existed. Furthermore, a concussion guideline could increase the quality of care by aiding providers in proper diagnosis and management of adolescents with sport-related concussions. This capstone project translated the highest quality evidence into practice through the creation of a guideline and algorithm. The appraised literature served as the basis for input from an expert panel for the creation of such a guideline. The Delphi survey method was selected as the method for determining consensus of expert opinions. This guideline and algorithm were then delivered to the providers at Sunrise Kids Care Clinic during an educational in-service.

The Delphi survey method was used to gather expert opinions and achieve consensus amongst professionals through a multistage process of data collection with a series of questionnaires (Hasson, Keeney, & McKenna, 2000). It is useful for areas where insufficient or conflicting information exists. It is a popular technique in medical, nursing, and health services (Hasson et al., 2000). Purposive sampling was utilized wherein the participants were not random but chosen by the researcher (Hasson et al., 2000). Therefore, the participants were quasi-anonymous as they were known to the researcher and perhaps one another but their responses, opinions, and judgments remained completely anonymous and confidential (Hasson et al., 2000). Participants for the survey included eight individuals who were termed *experts*. These experts were knowledgeable in the topic in which they were being questioned (Hasson et al., 2000).

For this project, they were nurse practitioners, medical doctors, and psychologists who had experience caring for adolescents with sports-related concussions.

The survey method process involves multiple rounds of questionnaires to achieve consensus on opinions (Hasson et al., 2000). This capstone project involved two rounds. The initial questionnaire allowed for anonymous qualitative responses from the panel (Hasson et al., 2000). From these responses, the researcher analyzed, consolidated, and summarized the information. Central tendencies were computed to determine collected opinions so the participants could see how their responses compared to the group's responses (Hasson et al., 2000). The amended version and central tendencies were then returned to the participants for the second round of the survey. The second round allowed the researcher to ascertain consensus opinions and collect quantitative data collection on topic themes (Hasson et al., 2000). A 70% agreement level amongst the participants on each theme was required for consensus (Hasson et al., 2000).

Phases of Project Plan

Phase one. Phase one entailed the completion of a thorough literature review, a needs assessment, and the development of the capstone proposal. Upon completion of the literature review and a successful proposal of the first three chapters, the next steps included approval from the University of Northern Colorado's IRB (see Appendix A), along with coordination with stakeholders at the clinic and the professionals of the expert panel. Following these steps, a needs assessment was completed to gather information regarding current practices at the clinic.

This needs assessment was completed with an electronic survey of the six primary care providers at Sunrise Kids Care Clinic. The participants included the office manager,

medical doctors, physician assistants, and nurse practitioners who received the survey consisting of an open-ended questionnaire. Providers' current practices were determined, which allowed for examination of their disparities and/or similarities in practice. Current practices at the clinic were analyzed and compared to the recommendations from the literature. Gaps and/or similarities between the literature and practice were identified and described.

Phase two. Phase two was the development of the clinical practice guideline. As discussed above, the Delphi survey method was employed to determine medical experts' consensus on the necessary components of the guideline. Literature the author deemed applicable to the Sunrise Kids Care Clinic served as the basis for the first round of survey questions (see Appendix C). Responses from the first round formulated questions for the second round and a consensus level of 70% was achieved amongst the experts (see Appendix D). Components of the guideline as determined by the expert panel included (a) pre-participation counseling, (b) diagnostic signs and symptoms of concussion, (c) initial medical assessment, (d) best diagnostic tools for evaluation, (e) symptom management, (f) return-to-play and return-to-school protocols, and (g) symptom checklist for evaluating neurological status/recovery. These expert opinions were derived from physicians, nurse practitioners, and psychologists involved in the diagnosis and management of concussions in adolescents.

Phase three. Phase three was the plan for implementation. The guideline and algorithm were presented to the providers at Sunrise Kids Care Clinic during an educational in-service. Pre- and post- tests were administered directly before and after the educational in-service to evaluate the knowledge gained regarding concussion

diagnosis and management. Methods used in the presentation included a PowerPoint presentation and handouts.

Phase four. Phase four was the analysis of the stakeholders' (providers) pre- and post- tests from the educational in-service. The providers also rated their likelihood of implementing the presented guideline. If the guideline were to be physically implemented in the future, this phase would also include disbursement of the clinical practice guideline to the providers at Sunrise Kids Care Clinic for review and modification. The providers could then offer valuable information on the feasibility of the guideline at their clinic. Furthermore, a pilot study could be implemented. The review of the guideline and pilot study did not take place in this capstone project.

Project Timelines

The researcher utilized the following timeline for the capstone project:

- Approval of phenomenon of interest—Spring 2017
- Defense of first three chapters of capstone proposal; IRB approval from University of Northern Colorado and Sunrise Kids Care Clinic (see Appendix A); and coordination with stakeholders at Sunrise Kids Care Clinic and expert panel members—June 2017-August 2017
- Needs Assessment completed (see Appendix E); initial round of Delphi survey questionnaire sent to panel of experts (see Appendix C); evaluated, analyzed, and summarized literature and panel of experts' opinions—September 2017
- Second round of Delphi survey questionnaire sent (see Appendix D); development of clinical practice guideline and algorithm (see Appendix F);

development of plan for implementation for educational in-service—September 2017-October 2017

- Educational in-service took place; analyzed results of pre- and post-tests—October 2017
- Submission of capstone project to University of Northern Colorado; final defense of capstone project; thank-you letters sent to participants containing summary of results—November 2017.

Resources: Budget, Setting, Personnel, and Technology

This researcher's efforts and time were the main resource for this project. The time coordinating with stakeholders, creating the project, implementing the survey, analyzing results, and developing the guideline and algorithm were crucial to the success of the project. Furthermore, transporting to Greeley from Denver, copying, printing, and use of computer technology were vital resources. Approval from the medical staff and leadership at Sunrise Kids Care Clinic was completed with a statement of mutual agreement signed by this Doctor of Nursing Practice (DNP) student, agency member, and DNP capstone chair.

The setting for this capstone project implementation was Sunrise Kids Care Clinic located in Evans, Colorado, on the school grounds of Centennial Elementary School. Since the clinic is independent from the school system, approval from the school board was not necessary. The office is composed of six primary care providers along with a counselor, outreach coordinator, and a dental hygienist. Services at the clinic include well-child visits, school and sports physicals, sick visits, vaccinations, dental visits, behavioral health, and Medicaid/CHP+ (Colorado Health Plan) assistance (Sunrise

Community Health, 2016). In 2015, the clinic saw 740 patients and 2,210 visits were completed (Sunrise Community Health, 2016).

Financial resources were not considered significant for this capstone project. The Delphi survey was completed electronically to ascertain expert consensus and did not require financial resources. The professional's time was considered; for this reason, only two rounds of the survey were completed. This researcher synthesized the responses to determine consensus, pertinence, feasibility, and applicability to the setting. The guideline was then presented during lunch hour in a free educational in-service at the clinic. The researcher provided the PowerPoint presentation and written material. Time for the educational in-service and completion of pre- and post-tests were not considered burdensome since the clinic does not see patients during the lunch hour. Necessary technology included a computer and projector. Other resources included adequate space and time for both the presentation and pre- and post- test completion.

CHAPTER III

EVALUATION PLAN

The purpose of this DNP capstone project was to enhance the quality and consistency in the diagnosis, evaluation, and management amongst primary care providers treating adolescents who present with a sports-related concussion. This was achieved with the development of an evidenced-based concussion guideline and algorithm along with a presentation during an educational in-service for primary care providers. Extensive research along with expert opinions delineated the components of the guideline and algorithm.

Sunrise Kids Care Clinic does not currently have a guideline in place to assist providers in the proper evaluation and management of concussions. As evidenced by the literature, some specific diagnostic tools have substantially higher specificity and sensitivity for concussions than other tools. Thus, a step-wise return-to-play and return-to-learn protocol should be implemented for the recovering athlete. Unfortunately, as the literature depicted, poorly managed concussions can lead to detrimental effects and long-term neurological conditions. The following sections review the evidenced-based evaluation methods for each of the three objectives described in Chapter II.

Objective One

Objective one was to gain knowledge regarding current practices in concussion evaluation and management. This objective was accomplished with various modalities:

(a) a needs assessment was completed; (b) the literature was critically appraised; and (c) surveys of experts assisted in determining the best practices and applicability for the specified organization. Since the clinic does not currently have a guideline in place, a survey was electronically sent to the providers to ascertain their current practices. It consisted of open ended questions developed by the researcher. Analysis of their responses revealed consistencies and/or differences between the provider's practices. The responses to the questionnaire were then be compared to the published literature. The literature deemed to be high-quality, along with the responses, helped identify areas needing clarification for the creation of the guideline

The first round of the Delphi survey method was then used to gather the experts' opinions on the necessary components of the guideline (see Appendix C). The RE-AIM framework (reach, effectiveness, adoption, implementation, and maintenance) assisted in evaluating the essential elements for practice, feasibility of practice changes, barriers to adoption, adaptations necessary for the target audience, and the feasibility of maintenance over time (Schwingel, Gálvez, Linares, & Sebastião, 2017). This RE-AIM framework and literature review served as guides for the questions. These questions were developed by the researcher since the needs of the organization were unique. This first round allowed for insight into concussion diagnosis and management and also the feasibility and probability of adopting various components of the guideline into practice at Sunrise Kids Care Clinic. For instance, two areas of importance were keeping costs at a minimum and ensuring timeliness. Therefore, the clinical practice guideline was based on quality evidence and was pertinent and individualized to the facility.

The responses from the first round were used for the second round of the Delphi method in order to obtain a 70% consensus level amongst the experts (see Appendix D). The final results from the second round of the Delphi method were compared to the findings from the literature review. Analysis of the comparison allowed for the creation of the guideline and algorithm.

Objective Two

Objective two was the development of the concussion guideline and algorithm for primary care providers. This was generated from the information collected from the needs assessment, literature, and Delphi survey method. At the time of the post-test, the providers were asked to rate their likelihood of utilizing the guideline and algorithm by circling "Yes" or "No." The number of "Yes" responses were totaled and compared to the number of "No" responses to determine the group's likelihood. Furthermore, recommendations for modifications were asked in an open-ended question format.

Objective Three

Objective three was the presentation of and education on the concussion guideline and algorithm to the primary care providers at the organization. Pre- and post-tests were administered to evaluate their knowledge both before and after the educational in-service. The questions were developed by the researcher and consisted of a combination of multiple choice and true/false. The questions evaluated the providers' knowledge of concussions both before and after the educational in-service. The tests were scored and compared to one another to evaluate knowledge gained from the in-service. The mean scores from the pre- and post-tests were compared to one another with statistics to

determine if the intervention of the educational in-service resulted in increased knowledge of the providers..

Implementing the guideline and algorithm into practice was not part of this project. However, if the facility chose to implement in the future, it would be beneficial for the providers to evaluate the guideline using the RE-AIM framework (Schwingel et al., 2017) so they could evaluate its suitability to their practice setting, population, and needs. A pilot study would be beneficial in evaluating pros and cons to the new guideline. Additionally, it would also be prudent to perform a retrospective chart review that compared practices before and after the implementation of the guideline. Finally, after the evaluation and trial period of the guideline, appropriate revisions should be made.

CHAPTER IV

RESULTS AND OUTCOMES

The primary goal of this DNP capstone was to create a guideline for the diagnosis and management of sports-related concussions in adolescents. As the literature review demonstrated, various guidelines are available and providers might be practicing outdated or non-evidenced-based practices. Creating a guideline to follow in the clinical setting establishes uniformity and ensures adherence to evidenced-based practices in the literature. The first objective of this capstone project was to gain knowledge regarding current practices in concussion evaluation and management at Sunrise Kids Care Clinic. The second objective was the development of a concussion guideline and algorithm for primary care providers at Sunrise Kids Care Clinic. The third objective was the delivery of the guideline in the form of an educational in-service at the clinic. The likelihood the providers would implement it in the future was also evaluated during the educational in-service.

Objective One Outcomes

The first objective was met through the following methods: (a) a thorough literature review, (b) a needs assessment, and (c) the first round of the Delphi survey. The review of literature from Chapter I provided important information regarding current evidence for concussion diagnosis, evaluation, and management. It also allowed the author to discover areas of concussion management that were vague and required further

research and clarification. This literature review fulfilled the second step of the Stetler (2001) model--validation. The literature also served as a guide for the development of questions in the Needs Assessment survey, thereby ensuring quality and adherence to evidence-based practices. The Needs Assessment allowed for completion of the third step of the Stetler model--comparative evaluation/decision-making. To assess current practices and the feasibility of implementing this quality improvement project, current practices at Sunrise Kids Care Clinic were evaluated through a Needs Assessment online survey of the providers. Once this survey was completed, the Delphi survey ensued to gain expert opinions regarding concussion diagnosis and management. The first round of the Delphi survey also aided in fulfilling the third phase of the Stetler model.

Needs Assessment Survey

The author developed the questions for the Needs Assessment survey based on evidence found in the literature. The purpose of the survey was to gain insight into current practices at Sunrise Kids Care Clinic. The Needs Assessment also allowed the author to evaluate providers' similarities and differences in practice and how they compared to published literature. Consent for participation was obtained and is provided in Appendix G. The survey was made available for 10 days on the online survey platform of Survey Monkey.

Four open-ended questions were asked to gain descriptive, qualitative data. The questions were directed at evaluating the practices of concussion diagnosis, evaluation, and management. The respondents included providers and the office manager from the Sunrise Kids Care Clinic. The office manager, who is a registered nurse, was included in the survey since she was aware of current practice policies and guidelines. Of the

original seven individuals invited to participate in the survey, four responded—an overall response rate of 57%. Of the four respondents, three were female (75%) and one was male (25%). Those invited to participate included three Medical Doctors (MDs), two Physician Assistants (PAs), one Nurse Practitioner (NP), and one Office Manager. The respondents included the two PAs (50%), one NP (25%), and one Office Manager (25%). No other demographic information was collected.

Responses to question one: **Could you tell me about how you diagnose an adolescent with a concussion?** Responses to this question both varied from one another and shared a few overlying themes. Three individuals (75%) mentioned the history and two of them mentioned the SCAT tool; however, there are different versions of it. None of the respondents mentioned diagnostic imaging. Three individuals (75%) mentioned evaluating symptoms but no specific types or domains of symptoms. The participants' individual comments to the question are as follows:

- I try to take the best history I can, regarding the mechanism of injury, and any symptoms that happened at any time after. I use the SCAT2 to guide some of my questions (Participant #1).
- Mainly by the history of the injury and subsequent symptoms (Participant #2).
- Providers have a protocol they use (Participant #3).
- I use the history of the incident, physical/neuro exam, which includes using a SCAT3 tool if symptoms lasted less than 10 minutes from time of incident and no further symptoms since, then this may be a concussion but minor. If the patient has ever had a concussion in the past this also plays a factor in diagnosing a concussion (Participant #4).

Responses to question two: How do you evaluate the signs, symptoms, and severity of an adolescent suspected of having a concussion? Respondents' answers to this question also had some similarities and differences. Three of the participants (75%) stressed the importance of a full neurological exam but did not indicate which aspects of

the exam to include. Participant #1 and Participant #4 mentioned the use of the SCAT2 and SCAT3 for evaluating signs, symptoms, and severity of a concussion. It is important to note the SCAT2 and SCAT3 are very similar but differ in some aspects. They both include a symptom evaluation section, a cognitive assessment (Standardized Assessment of Concussion-SAC), a Glasgow Coma Scale (GCS), and upper limb coordination testing (SCAT2; Pocket SCAT 2, 2009). The SCAT3 (CISG, 2013) further includes neck examination, lower limb balance testing with the modified Balance Error Scoring System (BESS), and a memory section. The two tools can be found in Appendix H. Participant #1 and #2 stressed evaluating the history to assess the symptoms; see following individual responses:

- I do a full physical including a full neurologic exam. I also usually do a SCAT2 exam, depending on the age of the patient. The symptoms are evaluated by the history (Participant #1).
- By taking a good history of the injury and doing a thorough neurologic exam (Participant #2).
- Concussion assessment (Participant #3).
- Physical, neuro exam, and use of SCAT3, no routine neuro imaging (Participant #4).

Responses to question three: What restrictions do you place on the concussed adolescent athlete? This question aimed to determine restrictions providers currently placed on the adolescent athlete. The literature varied immensely when it came to this topic. While the goal was to determine if providers restricted adolescents' activities and/or school participation, it also elicited responses regarding returning to play and school. Participant #1 mentioned the importance of being symptom-free for at least 24 hours before following the return-to-play protocol. While Participants #2 and #4 also stated the need to follow a return-to-play protocol, they did not mention the amount of

rest period needed. Participant #4 also mentioned both school and sport holds, whereas Participant #1 mentioned academic restrictions/accommodations but not a hold. Participant #4 was the only one to mention light aerobic activity. Respondents' individual responses were as follows:

- I do not allow them to return to any sports activity until they are symptom free for at least 24 hours; then they must follow the step-wise return-to-play protocol which takes a minimum of 5 days. Sometimes they must have academic restrictions/accommodations as well (Participant #1).
- I have them follow the Children's Hospital return-to-play guideline. No full return to play until symptom free (Participant #2).
- Depends on severity of concussion (Participant #3).
- School and sport hold, return to school before return to sport with light aerobic exercise ok while completing return to school. The return to sports is a six-level return based on Children's Hospital's recommendations. Return to school is also gradual and based on patient's symptoms (Participant #4).

Responses to question four: How do you manage recovery? How about returning to sports/activities? Question four was similar to question three; instead of determining restrictions placed on the concussed individual, the intent was to determine how the providers managed adolescents returning to sports, school, and activity. The question also aimed to determine how the providers evaluated symptoms throughout the patient's recovery. Participants #4 and #1 mentioned evaluating symptoms in the clinic for progress but did not mention which scale or assessment they used to do so. Participant #2 was the only one to mention including fluids along with rest for management. Three of the four respondents included some sort of stepwise return-to-play protocol. The providers' responses were as follows:

- As mentioned in the prior question, I follow the stepwise return-to-play protocol and have them follow up routinely, with frequency based on severity of symptoms (Participant #1).

- I have them focus on rest and fluids. It is rare that I see anyone who needs "academic rest." Again I have them follow The Children's Hospital return-to-play guideline (Participant #2).
- Depends on child/severity of concussion (Participant #3).
- Frequent evaluations in clinic for progress, return to school must be completed prior to returning to sports. Each level of return to sports must be at least 24 hours and asymptomatic. If any return of symptoms, drop back a level for another 24 hours before progression. Also get behavioral health involved if lasting more than a week. If symptoms last longer than one month, referral to concussion specialists (Participant #4).

Round One of the Delphi Survey

The purpose of the first phase of the Delphi survey was to gain opinions of experts regarding essential components for the concussion guideline and algorithm. The Delphi survey is a method of gaining consensus amongst professionals in areas of insufficient or conflicting information (Hasson et al., 2000). As is often the case in the Delphi survey, the first round of this project involved collecting qualitative comments (Hasson et al., 2000). The questions for the survey were developed by the author using evidenced-based information gained from the literature review as well as responses gathered from the Needs Assessment questions. The RE-AIM framework also served as a guide for the questions asked (Schwingel et al., 2017). Phase III of the Stetler (2001) model (2001), which is comparative evaluation/decision making, was also fulfilled through the completion of the first round of the Delphi Survey.

The first Delphi survey was made available from September 6 to September 21 on the SurveyMonkey online platform. The questions developed by the author aimed to determine experts' opinions regarding concussion diagnosis, risk factors for prolonged symptoms, managing recovery, and referrals. Furthermore, managing time within the clinical setting was an important factor taken into account.

Of the nine individuals who were invited to participate, five (55.5%) responded to the first round of questions. Those invited to partake included two psychologists, three physicians, and four nurse practitioners. Two physicians (40%), one psychologist (20%), and two nurse practitioners (40%) responded. Disciplines represented included experts in concussions and family medicine. The psychologists were invited to participate since they are specialists in concussion care. No other demographic information was collected from the respondents. The survey was originally set to be closed after just nine days but due to requests, it was kept open for an additional five days. The original email inviting participants was sent on September 6th and a reminder email was send on the 13th. All responses were received by September 21st. An informed consent for participation was provided with the first survey (see Appendix G).

Responses to question one. The first part of question one stated: Is there a tool that you recommend for evaluation and diagnosis of an adolescent athlete suspected of having endured a concussion? Responses to this part of the question varied. The literature was unclear regarding a specific tool to utilize for diagnosis and each of the published guidelines reviewed varied in their recommendations. The same was true for the respondents in the survey. Three respondents recommended the SCAT tool (60%), one recommended the ACE (20%), and another did not recommend any one specific tool (20%). Although three individuals recommended the SCAT, two of them recommended the SCAT 5, while one recommended the SCAT 2. Individual comments are provided in Table 2.

Table 2

Responses to Question One of Delphi Survey Round One

Participant	Answer
1	A) Yes, I use the ACE--Acute Concussion Evaluation form. B) Mechanism of injury--any LOC/amnesia/seizure, red flags, prior concussion history, prior headache history
2	A) SCAT 5 and Child SCAT 5 can be helpful for the symptoms scale. Has mental status testing, but not well validated. B) Vestibular and oculomotor screening, c-spine assessment, discussion of sleep hygiene and headache pattern.
3	A) Within 3-4 days of injury, the SCAT5 would be very good to use, and fits into a short appointment slot. B) Symptoms, neuro exam, including vestibular-ocular-movement screening.
4	A) I like the SCAT 2. B) Balance, recall.
5	A) No, there is no number 1 tool. A good evaluation requires a medical history, medical rule outs, a symptom checklist, a mental status screen of some sort, often a neurocognitive, balance evaluation, oculomotor, vestibular evaluation. B) In my opinion, the oculomotor and vestibular issues complicate the concussion the most.

When comparing various responses to question one, it became apparent the author needed to reevaluate the similarities and differences between the SCAT and the ACE tools. The literature review included information on the SCAT3 but not the SCAT5 or SCAT2. The SCAT5 was not published until April of 2017 (Davis et al., 2017) so its normative data are limited. Participant #2 had mentioned this in the response as well. It was important, however, to evaluate the components of the SCAT2, SCAT3, and SCAT5 in comparison to the ACE and the essential components Participant #5 mentioned. The

SCAT5 is similar to the SCAT3 but differs by including the following additional sections: red flags, observable signs, cervical spine assessment, and specific neurological screen (Davis et al., 2017). It includes all of the other sections of the SCAT3 as well including the GCS, memory assessment with Maddocks questions, symptom evaluation, background information, cognitive assessment, balance examination, and delayed recall (CISG, 2013; Davis et al., 2017;). It does not include testing upper limb coordination (Davis et al., 2017). Furthermore, the SCAT2 does not include a background information section, neck evaluation, or red flags section (Pocket SCAT2, 2009). A copy of each tool is included in Appendix H. The ACE, as discussed in the literature review, also included a symptom check list, red flags, a history section that reflected risk factors for protracted recovery, and a history of the injury section (Gioia et al., 2008). While Participant #5 did not suggest a specific tool, the responses reflected many components of the SCAT. Therefore, it was decided to ask participants if they would agree with the components of the SCAT for the second round of the Delphi survey.

The second part of question one asked: In a short appointment slot, what are the most important aspects to evaluate when a concussion is suspected? In evaluating this second part of the question, four of the five respondents (80%) mentioned the importance of evaluating the vestibular and oculomotor system. Headaches were mentioned by two of the participants (40%). Other important aspects mentioned by the participants to evaluate included cervical spine assessment, neuro exam, symptoms, balance, and recall.

Responses to question two: What are the most significant risk factors for prolonged recovery? Respondents' answers to this question had many similarities and aligned with the review of literature completed in Chapter I. Three of the five

participants (60%) mentioned amnesia as a significant risk factor for prolonged recovery. As discussed in the literature review, amnesia is a sensitive indicator of concussion severity (Harmon et al., 2013; King et al., 2014). Prior concussion history was mentioned by four of the respondents (80%). Migraines or headaches were mentioned by four of the five participants (80%). Dizziness was mentioned by two of the participants (40%). Premature returning to sport was mentioned by two of the five participants (40%). Attention or mood disorders was also mentioned by three of the five participants (60%). Each of these symptoms was mentioned in the literature review in Chapter I as important symptoms that might place athletes at risk for delayed or prolonged recovery. Interestingly, only one participant mentioned loss of consciousness. Individual responses are provided as follows:

- LOC, associated amnesia, too soon return to play, prior concussion history, underlying migraines (Participant #1).
- Dizziness, amnesia, and severe symptom burden at the time of injury. History of ADHD, LD, migraine, or mental health issues. Past concussions, especially more recent injuries within the past year (Participant #2).
- Past history of migraines, depression, anxiety, ADD, ADHD, vision abnormalities, prior concussion, with prolonged recovery (Participant #3).
- Returning to activity too soon, delayed diagnosis, repeat injuries (Participant #4).
- Research shows the concussion modifiers are: past concussion, headaches, family history of headaches, learning or attentional problems, mental health issues. There is some thinking that sideline dizziness and amnesia suggest prolonged recovery. Emotional symptoms are concerning (Participant #5).

Responses to question three: **What do you recommend for amount of rest?**

The responses to question three varied tremendously. This was somewhat expected since the literature was highly variable when it came to the amount of rest necessary (Meehan & O'Brien, 2017). The overarching theme from the participants' responses was an individualized approach based on symptoms. One participant mentioned up to 72 hours

of rest, whereas another stated maximize rest for the first few days. Another theme was reintroducing activities as tolerated. Individual comments to the question were as follows:

- Individualized based on scores, usually no sports and reevaluate in seven days. Usually half day of school if having headaches and advance to full days when no headache. Return with half days, no TV, video games, or cell phone use for a week and re-evaluate (Participant #1).
- No strict rest. Rest as needed, start symptom limited daily activities as soon as tolerated (Participant #2).
- Up to 72 hours of cognitive and physical rest, then increase ADLs and return to school with adjustments to help keep from symptom exacerbation (Participant #3).
- Not a set time but until symptoms have cleared (Participant #4).
- Maximize rest for the first few days and then gradual re-introduction of activities at low levels (a little bit of TV, texting, reading). Research shows that being too rigid with the rest recommendation delays recovery (Participant #5).

Responses to question four: What do you recommend regarding aerobic activity? While the answers had slight variations from one another, most of the participants (80%) discussed the need to limit activity for at least the first week and then begin light aerobic activity after the initial rest period. All of the participants (100%) stressed the importance of symptom evaluation when determining aerobic activity tolerance. They also all mentioned light cardio or a gradual return to aerobic activity. One participant mentioned the need to restrict activity to only walking, whereas another mentioned 10-15 minutes of light cardio per day but did not specify the type. Another participant also stressed that light cardio should only be done at home and never at school. Two of the participants (40%) also mentioned restricting activity in those with significant vestibular dysfunction. Individual responses were as follows:

- No aerobic activity for 7 days and reevaluate gradual return- if no symptoms advance (Participant #1).

- Begin gradual symptom limited cardio exercise one to two weeks post injury, may need to restrict to only walking in the patient with significant vestibular dysfunction. For those with prolonged recovery may be best to have an assessment and subsystem threshold exercise with a PT experienced in concussion recovery (Participant #2).
- Around 7-10 days ask patient to start light cardio, gradual, 10-15 minutes per day and increase to sub symptom exacerbation threshold (Participant #3).
- May return to light aerobic activity when symptoms are improving, do not have to be resolved (Participant #4).
- Light cardio at home only, never at school after the first week, if there are not significant vestibular issues (Participant #5).

Responses to question five: At what point should a referral to physical therapy and/or vestibular therapy be considered? This question aimed to determine when a referral to physical therapy and/or vestibular therapy should be considered in the recovery. Two of the participants (40%) mentioned a referral to physical therapy or vestibular therapy early on in the post-injury time window. On the other hand, Participant #1 mentioned rescanning the brain with a CT or MRI after 10-14 days if symptoms persisted and then refer only if negative. Interestingly, Participant #2 mentioned the need for physical therapy in those individuals with neck pain and any persistent headache. Individual responses were as follows:

- If persistent dizziness or headache after 10-14 days, I usually get a CT or MRI and if negative may then refer to PT/OT (Participant #1).
- Very dizzy patients or those with significant visual complaints should be referred for vestibular therapy ASAP. Those with neck pain should have manual PT referral ASAP. Any patient with persistent headache needs a PT evaluation of the neck. Those with positive vestibular/oculomotor screens after two to three weeks should go to vestibular therapy (Participant #2).
- If at one week out if having persistent symptoms, especially if dizzy, severe headache, lightheaded, or risk factors (Participant #3).
- When symptoms are not improving or course of recovery is prolonged (Participant #4).
- We consider if early. We consider it into the second week post-injury (Participant #5).

Responses to question six: How should symptoms be evaluated, and at what frequency? As discussed in the literature review, various tools for symptom evaluation exist but confusion persists regarding the most appropriate ones and at what frequency. Therefore, this question aimed to determine how symptoms should be evaluated, by whom, and at what frequency. None of the participants suggested symptoms should be evaluated daily. Participant #2 mentioned the importance of documenting recovery every few days "but not daily as this may cause them to hyper-focus on their symptoms." Two of the participants (40%) suggested following up in the clinic at least once a week. Participant #3 suggested the school nurse, athletic trainer, or parents evaluate the symptoms multiple times per week with specific checklists. Individual responses were as follows:

- I usually have patient follow up once a week--if severe may check at start and end of week (Participant #1).
- Start with concussion symptoms scale filled out by patient at the start of medical visit. Provider should then review symptoms with the patient for a better understanding. Patients should fill out symptoms scale periodically to document recovery, perhaps every few days, but not daily as this may cause them to hyper-focus on their symptoms. No good data on how often to fill out the symptoms scale (Participant #2).
- Symptoms should be assessed by school RN or athletic trainer (preferably) or parents several times per week using symptom checklist (Participant #3).
- After initial evaluation, I like to see them in three to four days and then follow up is dependent on response, symptom progression, and where they are in their season/desire to return (Participant #4).
- Research suggests at least one time per week. More often if very symptomatic and less often when symptoms begin to subside (Participant #5).

Responses to question seven: **A) How should returning to school and physical demands (including sports) be addressed? B) Do you recommend a graduated return-to-play protocol, and if so at what point during their recovery?** Returning to school is an important factor in recovery for adolescent athletes. As Participant #5

mentioned, holding a student out of school until symptom free would result in a very long period away, which could negatively impact academic performance. Only one participant (20%) mentioned school rest for a week. Consensus amongst the other four participants (80%) was that return to school should occur as soon as possible once the adolescent's acute symptoms improved. Participant #2 stated the school should be asked to provide adjustments for recovery, whereas Participant #1 mentioned partial school days. All of the participants (100%) recommended the graduated return-to-play protocol once the adolescent athlete was completely symptom-free. Three of the participants (60%) also mentioned the graduated return-to-play should not occur until the adolescent was also fully functioning at school. Importantly, Participant #2 also stressed the importance that exercise for recovery is separate and different than the graduated return-to-play protocol. Individual responses are provided in Table 3:

Table 3

Responses to Question Six of Delphi Survey Round Two

Participant	Answer
1	A) Be very specific--no sports and brain /school rest for a week if severe or partial school days. B) Gradual return to sports after a week if symptoms resolved.
2	A) Return to school as soon as symptoms improve but don't wait until symptom free. Ask the school to provide adjustments for the recovery. Should not return to sports until fully functional at school, symptom free, normal physical exam, and documentation of cognitive recovery. B) Must be clear that exercise for recovery is not graduated return-to-sport. Should not do the graduated return-to-sport until they meet the above criteria.
3	A) Return to school should take place as soon as possible, when very acute symptoms have subsided and can tolerate light mental activity for 30 to 45 minutes. B) No sports until has gone through graduated return-to-play which should begin once symptom free and at school doing well without adjustments.
4	A) Return to school needs to come first and students need to be able to function in the classroom before returning to sports. There needs to be an understanding that it is an individual response and coaches, parents, educators, and athletes need to get the same information. B) Yes--when symptoms have resolved and physical exam is negative.
5	A) Research shows a graduated re-introduction of activities (school and home, NOT sports) after a few days of rest. There is NO medical clearance to return to school or return to learn so this should happen earlier rather than later with support to the child to manage symptoms. NEVER hold a student out of school until "symptom-free." That would keep them out of school for up to four weeks and that can seriously impact grades/performance. B) Yes, a graduated return-to-play is non-negotiable, but we are doing the Buffalo Concussion Treadmill Test (BCTT) in PT for the non-athlete.

Responses to question eight: How often should these patients be followed up on? This question aimed to determine how often experts thought concussed adolescent athletes should be followed up on formally in the clinic. The responses varied. Three of

the five participants (60%) suggested an individualized approach. The respondents seemed to all agree that those individuals who were more symptomatic should be seen in the clinic more often. Two participants (40%) said once a week, another participant said every one to two weeks, and yet another participant said every two to three weeks in those who were more stable and recovering. Participant #1 also mentioned seeing the individual back in the clinic once the adolescent was back to full school and sports to ensure symptoms had not returned. While the individual responses varied, they all mentioned that follow-up on the concussed individual should take place. Individual responses were as follows:

- Until symptom free once a week, usually see back at least once after back at full sports/school to ensure no return of symptoms (Participant #1).
- Very symptomatic patients should be seen more often. Patients who are stable and recovering, perhaps every two to three weeks (Participant #2).
- In clinic every one to two weeks (Participant #3).
- Depending on recovery progression, some may need more frequent follow up and other may only need one to two follow up visits (Participant #4).
- Can't put a formula to this. Some need to be seen after one week, some longer. If they want to clear soon, then one week. If we worry they are very symptomatic, then one week. If symptoms are being reasonably managed and we need a few sessions of PT, then a number of weeks (Participant #5).

Responses to question nine: Is there a part of the exam that could be performed by someone other than the provider in order to maximize the provider's time and be more efficient? Ensuring timeliness and containing costs are two priorities for Sunrise Kids Care Clinic. For this reason, this question aimed to determine which aspects of a concussion evaluation might be performed by an individual other than the provider. Two of the participants (40%) mentioned that balance testing could be done by support staff. On the contrary, Participant #4 stated balance testing needed to be done by the provider. Participant #1 mentioned the ACE form could be started by the medical

assistant. Two participants (40%) mentioned neurocognitive testing. Participant #5 mentioned all of the discharge education and school coordination was done by the psychologist at the facility. Two of the participants (40%) also mentioned the symptom checklist could be started by the patient or support staff. Vitals are typically done by the medical assistant so this was not taken into account by the author. Individual responses were as follows:

- The ACE form could be started by MA--however this is not done where I work but likely is at a specialty office (Participant #1).
- Balance testing, orthostatic vitals, and perhaps even Vestibular/Ocular Motor Screening (VOMS) testing (Participant #2).
- Vital signs and balance testing, and computerized neurocognitive testing (if applicable) could be done by support staff. Symptom checklist by patient (Participant #3).
- Symptoms checklists, orientation, and recall could be done by someone else, however, they must be trained in the tool being used. The physical exam with balance testing and review of questionnaires needs to be done by a provider (Participant #4).
- Yes, our ImPACT test is done by either the athletic trainer or psychologist. All the discharge education is done by the Psychologist. All the school coordination is done by the Psychologist (Participant #5).

Objective Two Outcomes

The second objective was the development of a concussion guideline and algorithm for primary care providers at the Sunrise Kids Care Clinic. This objective was achieved by integrating the results from the second round of the Delphi survey with the published literature. Certain aspects of the guideline also integrated comments made in the second round of the Delphi survey. The author also chose to make some modifications to the guideline and included certain aspects of care addressed in the literature but not in the surveys to ensure the guideline was thorough. For instance, the various domains of symptoms, red flags, and pre-participation were discussed in the guideline. Phase IV of the Stetler (2001) model--translation/application--was fulfilled

with the completion of this step of the project. The guideline can be found in Appendix F.

Round Two of the Delphi Survey

The purpose of the second round of the Delphi Survey was to determine consensus in order to develop various components of the guideline. Consensus as defined by the author was an agreement of 70% or greater for each question. Therefore, collection for the second round was quantitative and led to the final version of the concussion guideline, which was then presented to providers at the Sunrise Kids Care Clinic.

Data Collection

Round two of the survey consisted of 13 questions in yes/no and multiple choice formats. Qualitative responses from round one led to the development of the questions for the second round of the survey. All of the participants from the first round, except for one physician who asked to be removed from the survey, were again invited back to participate in the second round. One additional NP was invited to participate. The second survey generated an 88.89% response rate with eight respondents of the nine individuals invited to participate. The respondents consisted of two MDs who specialize in concussions (29%), one psychologist who specializes in concussions (14%), four NPs who specialize in primary care (43%), and one NP who specializes in urgent care (14%).

The responses were again collected using SurveyMonkey, an online survey platform. The original email was sent to the participants on September 26th and a reminder email was sent on October 3rd. The survey was closed on October 5th. Since consent was provided in the first round of the survey, consent was implied for the second

round except for the NP who did not participate in the first round. Therefore, the additional NP was provided consent for participation in this round. For the development of the clinical guideline, the respondents were asked yes/no and multiple choice questions in round two of the Delphi survey (see Appendix D):

The first three questions asked yes/no questions regarding various aspects of evaluating and diagnosing a concussion. Question one, which asked about the use of the SCAT tool for evaluation and diagnosis of a sport-related concussion, resulted in an 87.50% consensus (seven of eight respondents). Respondent #2 (12.5%) answered he/she would not recommend the SCAT tool and made the follow comment:

> SCAT only validated for three to five days after concussion, specific vestibular and I get a motor screening like the VOMS (Vestibular-ocular motor screening), with symptom scale is probably better. Mini mental status on the SCAT has no norms that are well validated for kids.

Question two asked about the most important components of a concussion exam during a short appointment slot; seven of eight respondents (87.5%) agreed that evaluating the vestibular and oculomotor issues, headaches, and concussion symptoms were the most important. Respondent #7 wrote, "I think even in a short appointment slot, we are bound as a provider to complete a thorough assessment." Regarding question three, all of the participants agreed the most significant risk factors for prolonged recovery were amnesia, prior concussion history, migraines or headaches, dizziness, attention disorders, mood disorders, and/or emotional labiality, and/or premature returning to sport.

Question four aimed to seek clarification regarding the amount of rest recommended since the responses in the first survey and the literature varied so much on this topic. There was 100% agreement that strict rest should not be endorsed. Instead, all participants agreed that maximizing rest for the first few days (around 72 hours) was

most appropriate. After the original rest period, then providers should gradually increase activity with an individualized approach as long as no symptoms were exacerbated.

Question five aimed to seek a consensus on aerobic activity; all respondents agreed with the following question: Regarding aerobic activity do you agree with the following? Limit activity for the first week, depending on the severity of the symptoms, then begin light aerobic activity after the initial rest period, as long as there are not significant vestibular issues. May begin with 10-15 minutes per day and increase activity as tolerated. Symptom evaluation is very important, and cardio should only be done at home and never at school or sport until cleared.

Question six was the only multiple choice question; six of eight respondents (78%) chose the answer stating a referral should be made to PT after one-week post-injury when the patient continues to have persistent symptoms or in those with neck pain. On the other hand, two of eight respondents (25%) chose the answer stating a referral should be made to vestibular therapy two weeks after the initial injury, especially in the case of vestibular/oculomotor symptoms.

Symptom evaluation was another important component that needed to be addressed for the development of the guideline (question seven); seven of eight respondents (87.5%) agreed that symptoms should not be evaluated daily but instead multiple times per week. Respondent #4 made the following comment, “I would evaluate symptoms daily and as needed.” Furthermore, the consensus was the school nurse, athletic trainer, or parents should evaluate symptoms with specific checklists. The second part of question seven also addressed the frequency of follow-up in the clinic;

100% of the participants agreed that patients should be followed up on in the clinic at least once a week and less often as symptoms decreased.

Question eight concerned another important topic for the adolescent population--returning to school. Despite a consensus of 75% (six of eight respondents), two of eight respondents (25%) did not agree and three comments were made. Respondent #3 stated,

> Agree with everything above but would say… Ideal is full days with adjustments (or supports). I never say accommodations because that implies a more formalized school plan like a 504 plan and that is not necessary early on in the concussion. For all early, informal and quickly implemented academic supports, I refer to them as adjustments, never accommodations.

Respondent #4 commented, "Return to activity should always be gradual and not as soon as possible." A final comment was made by Respondent #3: "This is case specific--brain rest is encouraged. I would wait 72 hours and then try a couple half days. If no worsening of symptoms, then advance to full days and reevaluate." Despite a consensus of greater than 70% on this question, the author elected to modify and review these comments and responses in comparison to the literature in order to write this section of the guideline.

All of the participants agreed with question nine that a graduated return-to-play should not occur until the adolescent was fully functioning at school and completely symptom free. Furthermore, 100% of the respondents agreed with question 10 that following up in the clinic should be an individualized approach based on symptoms. Respondent #3 made the following comment: "But weekly is helpful so you know when to release back to sports."

Questions 11, 12, and 13 aimed to determine how to utilize support staff and appointment time most efficiently in order decrease the demands on the providers' time.

Seven of eight respondents (87%) agreed that balance testing could be completed by support staff (question 11). Respondent #2 disagreed and made the following comment: "I think the provider who is going to clear the athlete needs to see the response so there is no room for doubt about progress and possible return to play." This comment was also factored in by the author when developing the final version of the guideline. Regarding neurocognitive testing, seven of eight respondents (87%) agreed it could be completed by support staff (question 12). Respondent #2 agreed this was okay as long as the interpretation was overseen. Respondent #6 wrote, "Administration can be provided by support staff but interpretation must be professional." Another comment was made by Respondent #4: "Dependent on severity of concussion and mechanism of injury." All respondents agreed with question 13 that symptom checklists could be completed by the patient or the patient and their parent prior to seeing the provider.

Guideline and Algorithm Development

Creation of the Guideline for the Diagnosis, Evaluation, and Management of Sports-Related Concussions in Adolescent Athletes required the incorporation of steps I through IV of the Stetler (2001) model framework: Preparation (Phase I), Validation (Phase II), Comparative Evaluation/Decision Making (Phase III), and Translation/Application (Phase IV). The author developed the guideline by incorporating evidence gathered from the literature review, responses collected from the Needs Assessment Survey, and responses received from the Delphi surveys. Since 70% or greater agreement was required for consensus, only two rounds of the Delphi method were required for the development of the guideline. The algorithm was then created by the author after the completion of the guideline. Once the guideline and algorithm were

successfully created, the author developed a PowerPoint presentation for the providers at the clinic (see Appendix J).

Objective Three Outcomes

Objective three was achieved with the delivery of an educational in-service to the providers at Sunrise Kids Care Clinic. The in-service, which was developed and delivered by the author, was presented on October 17th at the clinic. It consisted of a PowerPoint presentation, handouts of the newly developed guideline, algorithm, along with background information on concussion tools. The background information included the pathophysiology, sequelae, incidence, and variations in practices. Each component of the concussion evaluation and proper management was discussed. Six providers were in attendance: two PAs, three MDs, and one NP. In addition to the providers, 21 staff members of the clinic were also in attendance including one clinic supervisor, three patient specialists, a case manager, one medical records personnel, one behavioral health consultant, one operations supervisor, one enrollment specialist, one referral coordinator, 10 medical assistants, and one office manager.

While other professions were in attendance, only the providers completed the pre- and post-tests. At the time of the in-service, the providers were given the tests to evaluate their knowledge about concussion both before and after the presentation. The post-test also asked their likelihood of implementing the presented guideline and algorithm into their practice. Phase IV (translation/application) of the Stetler (2001) model was further achieved with the delivery of the presentation. Phase V (evaluation) of the model was accomplished with the evaluation of the pre/post tests and the providers' likelihood to implement the guideline. The full presentation can be found in Appendix J.

Pre- and Post-Test Results

The pre- and post-tests were developed by the author to determine providers' knowledge regarding concussions and specific components of the guideline before and after the presentation. Both tests had the same nine questions (see Appendix K). The author passed out the pre-test before the educational in-service, collected the responses, and then passed out the post-tests after the presentation was completed.

There was an 83.3% response rate since five of the six providers turned in their pre- and post-tests. The responses were completely anonymous to the author. The results were then averaged and compared to one another. It was discovered every individual missed question six (the circle all that apply question). Since this question was missed in both the pre- and post-tests by every participant and the author recognized it might have been confusing, the author made the decision to eliminate this question from the results of both the pre- and post-tests. The average score for the pre-test was 80%. The average score for the post-test was 95%. Since there was an increase in the average by 15%, the educational in-service was deemed helpful to the providers. Furthermore, the author recognized that four of the five respondents answered 100% of the questions correctly and only one individual answered 75% of the questions correctly.

Likelihood That Providers Will Utilize the Guideline

The last question on the post-test asked the providers their likelihood of integrating the presented guideline into practice. Five anonymous providers completed the post-test and all five indicated they would likely integrate the guideline into practice.

Key Facilitators and Barriers to Project Objectives

Facilitators

Many key factors contributed to the completion and success of this DNP project and its objectives. Objective one, which involved the completion of the literature review, needs assessment, and first round of the Delphi survey could not have been completed without the overwhelming support from the author's committee and the office manager at Sunrise Kids Care Clinic. The support from the author's committee, especially the research advisor, was vital to the success of the capstone including the literature review. Support from the office manager was also key to the success of the Needs Assessment Survey in objective one. The manager served as a key facilitator by connecting the author to the providers in the clinic and encouraging them to participate in the survey.

A key facilitator for the completion of both objectives one and two was the Medical Director at Rocky Mountain Youth Center for Concussion in Lone Tree, Colorado. The author was given the opportunity to shadow in the clinic for a day. From there, the author was also invited to a conference on concussions in the South Denver Metro area. At the conference, the author networked with various professionals who had expertise in concussions. Some of these individuals then became participants in the Delphi survey. Their responses were extremely helpful for the creation of the developed guideline and algorithm.

The office manager of Sunrise Kids Care Clinic also facilitated the completion of objective three. The manager assisted by scheduling a time and location for the educational in-service to take place. Furthermore, adequate space, allotted time, and

technology were provided to the author for the completion of the presentation, pre/post-tests, and evaluation of the providers' likelihood of implementation.

Barriers

There were a few barriers to the implementation of the project including lack of participation from professionals in the surveys and lack of individuals' time. Lack of participation from the physicians at Sunrise Kids Care Clinic was a barrier during the Needs Assessment Survey. Unfortunately, it was also a barrier in the first round of the Delphi survey since only five of the nine individuals who were invited to participate followed through and responded to the survey. Fortunately, in the second round, there was a greater response as eight out of nine individuals participated. It would have been helpful and more ideal if there was a greater response for the first round as well. Also, even though five of the six providers completed the pre- and post-tests during the in-service, a 100% completion rate would have been ideal.

Many of the providers who were invited to participate in the surveys had many demands at work, busy clinical schedules, and busy home lives as well, causing their lack of time to be a barrier. Perhaps if there was more time for the project, the author could have invited more individuals to participate and allowed the surveys to stay open for a longer time period. Since the selection of participants was not randomized, there was also potential for bias since the individuals who chose to participate likely had a vested interest in concussions when compared to those who did not participate.

Unintended Consequences

A few unintended consequences resulted during the implementation of the project. A positive unintended consequence was the author discovered even more

information regarding concussions throughout the process. Through the Delphi surveys, the author learned about the most updated version of the SCAT tool and the VOMS assessment. The discussion regarding the various SCAT versions occurred in the Objective One Outcome section. Both of these topics came about during the Delphi survey. Since a few of the participants stressed the importance of the VOMS assessment, the author decided to look into this assessment modality further.

It was discovered the current concussion evaluation tools do not include vestibular and ocular motor function testing (Mucha et al., 2014). The VOMS assessment assesses five domains including (a) smooth pursuits, (b) horizontal and vertical saccades, (c) convergence, (d) horizontal vestibular ocular reflex (VOR), and (e) visual motion sensitivity (Mucha et al., 2014). Evaluation of symptoms involves having patients rate their symptoms before completing each VOMS and after each on a scale of 0 (none) to 10 (severe) after each assessment. The symptoms evaluated include changes in headache, dizziness, nausea, and fogginess (Mucha et al., 2014). The VOMS is a brief screen that has proven to be a valid, highly sensitive, and consistent method of identifying sports-related concussions (Mucha et al., 2014). A copy of the screening test can be found in Appendix I. The VOMS assessment allows the provider greater insight into the athlete's symptoms and deficits and helps guide the management and recovery from a concussion. For instance, deficits in convergence suggests an inability to read and is an indicator of the need to restrict reading until there are significant improvements (Martinez, 2016). The VOMS assessment can also help the provider determine if an adolescent will need to be referred for physical or vestibular therapy.

Another unintended consequence was the presence of other disciplines at the educational in-service. The in-service was intended for just the six providers. However, the day before, the office manager informed the author others would also be present. While this was unexpected, it ended up being helpful since the author was able to address the roles of the whole office team to ensure efficient, thorough concussion care. For instance, the author discussed the components of the guideline that could be completed by the medical assistant in order to maximize the time the provider has with the patient. Not only this, another topic brought up during the in-service was the coordination with schools. Since the other professionals were present, they were able to discuss how they could assist in this aspect of care as well.

CHAPTER V

RECOMMENDATIONS AND IMPLICATIONS FOR PRACTICE

As described by the literature review and supported by the responses from the Needs Assessment Survey and Delphi surveys, the diagnosis, evaluation, and management of concussions continues to be variable and inconsistent. Lack of consistency or use of outdated evaluation tools could result in a missed diagnosis of a concussion, persistent concussion symptoms, long-term issues, or even second-impact syndrome. The following recommendations and implications for practice address the purpose of this capstone project--to translate the most evidenced-based literature into practice in the form of a concussion guideline and algorithm that could serve as a guide for providers caring for adolescents suspected of having endured a sports-related concussion. While an individualized approach to concussion diagnosis and management is important, a checklist and systematic approach in the form of a guideline is essential to ensuring that components of the exam are not missed and the adolescent is managed properly throughout recovery. The guideline in this project was created to ensure quality and consistent care of adolescent athletes with a sports-related concussion. This scholarly, comprehensive, evidenced-based, quality-improvement project utilized the Stetler (2001) model as a guide for the development of the guideline and algorithm to aid providers at Sunrise Kids Care Clinic. The intention of the author of this DNP project is

to continue and expand the project to facilitate providers' diagnosis and care for adolescents with sports-related concussions.

Recommendations for Guideline Implementation and Evaluation

This project should be continued and expanded. After the completion of the DNP capstone project, the next step would be to plan for implementing the guideline into practice at Sunrise Kids Care Clinic. Based on the results gathered from the Needs Assessment Survey, Delphi surveys, and pre/post-tests, the author of this project recommends the project be continued and implemented into practice. The guideline produced during this project allows providers the opportunity to practice with evidenced-based practices that were well validated in the literature and supported by experts.

To ensure the guideline is implemented into practice successfully, the author recommends a number of steps take place beyond the scope of this project. First, current providers in attendance at the educational in-service should review and modify the presented guideline so it is completely applicable to their facility. Next, the providers should come together to discuss the guideline and agree upon each component. From there, the providers should decide on an individual to present the guideline to the support staff. The presentation for this capstone project was intended for the providers only; thus, while some support staff were present at the educational in-service during the project, another one should be designed specifically for all staff involved in patient care. This educational in-service should address each of the professional's specific roles in concussion evaluation and management in more depth. This would require the secretary, medical assistants, nurses, and anyone else involved be present. It is very important that everyone in the clinic have a good understanding of concussions and be able to provide a

consistent approach to caring for these patients. This includes the medical assistant who will need to ask specific concussion questions, perform different tasks than normal, and follow-up with concussion patients in a specific manner. Additionally, the receptionist will need to be aware of certain forms for the patient and/or parent to fill out that are concussion-specific. Not only this, coordination and communication with the school will need to be addressed, which is imperative in ensuring appropriate adjustments are made during the recovery period.

Next, the guideline and algorithm will need to be integrated into the electronic health record. Having the guideline and algorithm assimilated into the chart for providers to follow will be essential in ensuring adherence and consistency. Finally, a pilot study with a specific time frame and implementation dates should be completed. The organization should then evaluate adherence to the guideline and perform a retrospective chart review.

The strategic plan for Sunrise Kids Care Clinic consists of maintaining a healthy community, containing costs, and ensuring quality health care for its community members (Sunrise Community Health, 2016). This project and its continuation aims to address all of these essentials by ensuring that providers have a systematic approach with the correct tools and resources to diagnose, evaluate, and manage adolescent concussions. Furthermore, raising awareness of concussions should help maintain a healthy community. Providers should be urged to discuss the signs and symptoms of concussions with youth and their parents at each well-child physical so they can advocate for their child or friend if a concussion is suspected. Ensuring that providers are knowledgeable

about concussions and their sequelae will lead to a more informed and healthier community.

Recommended Evaluations

A post-implementation evaluation should occur once the pilot study has been completed. The author recommends the guideline be implemented for a trial period of at least three months in order to adequately determine the utility of the guideline. At the close of the pilot study, two methods should be employed to determine adherence to the guideline: (a) a retrospective chart review and (b) an evaluation of providers' perceptions of the guideline. Together, these will not only help determine its utility but also indicate perceived advantages, drawbacks, and barriers to implementation. Based on the results gathered from the chart review and evaluation, it might be necessary to address any concerns raised during the pilot study and modify the guideline and protocol accordingly.

The clinic will need to establish specific inclusionary criteria for the chart review and compare the use of the guideline during the pilot-study to the months prior to guideline implementation. The author suggests the clinic search both males and females between the ages of 10 and19 suspected of having endured a concussion. Other search criteria should include chief complaints, methods used to evaluate symptoms, diagnosis, restrictions placed on the adolescent, and the management, follow-up, and clearance for school and sports activities. Each of these items should be compared to the developed guideline. The post-implementation evaluation should consist of a questionnaire regarding perceived barriers, facilitators, necessary changes, and modifications to the guideline. Furthermore, positive, negative, and unintended outcomes should be

determined. The chart review, questionnaire, and evaluation should be completed by the office manager along with one of the providers.

Application of Project to Other Settings

Once the pilot study has been implemented and evaluated successfully, the clinic might elect to implement the guideline in other Sunrise facilities where adolescents are seen as patients. Concussion evaluation, diagnosis, and management are very important aspects of caring for adolescents' health and well-being. For this reason, the author endorses the use of the guideline in other Sunrise facilities. Sunrise Community Health, a patient-centered organization, has 10 clinics throughout the Greeley, Loveland, and Evans. Since this organization has many locations in three communities, implementing the concussion guideline across the clinics would greatly contribute to the public health of these populations. Ensuring evidenced-based, quality care to adolescents who have suffered a concussion ensures quality standardized care throughout the communities.

With time, the author also recommends the project be even further expanded to include the schools. Since part of the guideline includes working with the schools to provide adjustments for the adolescents as they return to school, this is yet another important piece. Not only this, recognition of a concussion begins from the time on the field. The quicker an adolescent can be removed from play and evaluated, the better the outcomes are likely to be. While training is required for coaches, it is just as important for other members of the school team to be aware of concussions, the rehabilitation process, and necessary school adjustments during the recovery period. Thus, a presentation to the schools is also recommended.

Personal Goals and Contribution to Advanced Practice Nursing

The APN role has continued to progress with the development of the Doctor of Nursing Practice (DNP) degree. As discussed by the American Association of Colleges of Nursing (AACN; 2006),

> The goal of doctor of nursing practice (DNP) programs should be to produce nurses that are uniquely prepared to bridge the gap between the discovery of new knowledge and the scholarship of translation, application, and integration of this new knowledge in practice. (p. 15)

The author's personal goals aligned with the goals of the AACN. Throughout the graduate school process, the author was exposed to various courses that culminated with the capstone project. A specific personal goal of the author was to successfully integrate the knowledge learned throughout the DNP program into the capstone project. The author also aimed to address quality of care on a broader community level rather than just an individual patient level. The process completed in this DNP project allowed the author to excel as a leader and translate the literature into practice in an area where there is an identified gap of knowledge. Successful completion of the DNP project required the author assume leadership, confidence, and readiness to move forward into the Doctor of Nursing Practice role.

Five Criteria for Executing a Successful Doctor of Nursing Practice Final Project

The number of DNP programs in the United States has drastically increased in recent years, which has led to a great deal of variability in the requirements and expectations of doctoral work (Waldrop, Caruso, Fuchs, & Hypes, 2014). Therefore, the AACN's (2006) *Essentials of Doctoral Education in Advanced Nursing Practice* were created to guide the rigor of the DNP capstone project. Since the establishment of the

AACN *Essentials*, Waldrop et al. (2014) set forth five criteria that summarize the steps a DNP capstone project must fulfill. The five criteria are summarized with the acronym EC as PIE: E = Enhance; C = Culmination; P = Partnerships; I = Implements; E = Evaluates (Waldrop et al., 2014). Each of the essential components must be completed to "come together to form one complete 'pie' representing evidenced-based practice that is robust and innovative, culminating in a DNP final project that makes a difference" (Waldrop et al., 2014, p. 301). The EC as PIE acronym was used to evaluate this quality improvement project; a description of how each essential component was fulfilled is described as follows:

- E= Enhance health outcomes/practice outcomes. This project enhanced health and practice outcomes by introducing a concussion guideline and algorithm that ensures adherence to evidenced-based practices. The guideline and algorithm serve as a guide for providers caring for adolescents with a sports-related concussion.
- C = Culmination of practice inquiry. In this project, the author attained expert knowledge in concussion diagnosis and management in the adolescent population through the completion of a thorough literature review in the first phase of the project. As this essential component also delineates, this expert knowledge must be practical and usable within the clinical setting. The knowledge gained from the Needs Assessment Survey, Delphi surveys, and pre/post-tests allowed the author to determine the pragmatic use of the developed guideline. If the project continues as

recommended by the author, the algorithm steps are also able to be integrated into the electronic health record.

- P = Partnerships. Successful completion of this capstone project required partnering with various professionals for the completion of the Delphi survey and Needs Assessment Survey. Furthermore, the author partnered with the office manager of Sunrise Kids Clinic to ensure the delivery of the educational in-service.
- I = Implement/apply/translate evidence into practice. The author applied the evidence-based literature on sports-related concussions in adolescents into a specific clinical practice setting. The RE-AIM framework (Schwingel et al., 2017) assisted in this step. The RE-AIM framework allowed the author to determine the essential elements for practice change, feasibility, barriers, adaptations necessary, and the feasibility over time. Furthermore, the Needs Assessment Survey was conducted to determine the specific needs of the practice and an educational in-service was conducted at the facility.
- E= Evaluation of health care, practice, or policy outcomes. In this project, the author utilized a post-test to evaluate the intervention of the educational in-service. Providers at the clinic also ranked their likelihood to implement the proposed guideline. While the guideline was not physically implemented into practice with a pilot study during this project, the recommended evaluation methods were discussed above in this chapter. If the organization decides to move forward with implementation as advised

by the author, the necessary next steps to evaluate outcomes have been described.

Summary

Recommendations for the continuation, expansion, and evaluation of this DNP project were described in this final chapter. This quality improvement project, which resulted in the development of a concussion guideline and algorithm for sports-related concussions in adolescents, is an important public health topic. Use of the guideline and algorithm will ensure providers care for adolescents with sports-related concussions in a consistent, well-validated, evidenced-based manner.

This DNP project addressed the concern of providers who were caring for adolescents with concussions in an inconsistent, outdated, non-evidenced-based manner. To produce a guideline that was well supported by the literature and applicable to the clinical setting, many steps were undertaken: a Needs Assessment Survey, a thorough literature review, Delphi surveys, pre- and post-tests during an educational in-service, and an evaluation of the likelihood providers would use the presented guideline. The EC as PIE method described by Waldrop et al. (2014) was used to evaluate the scholarly qualities of this project. Since each of the five components was met, this DNP project met the necessary components for a DNP capstone project as required by the AACN (2006).

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APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL AND STATEMENT OF AGREEMENT

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

DATE:	August 31, 2017
TO:	Carlo Parker, PHD
FROM:	University of Northern Colorado (UNCO) IRB
PROJECT TITLE:	[1094149-2] Guideline for the diagnosis, evaluation, and management of sports-related concussions in adolescent athletes: translating evidenced-based recommendations into primary care practice
SUBMISSION TYPE:	Amendment/Modification
ACTION:	APPROVAL/VERIFICATION OF EXEMPT STATUS
DECISION DATE:	August 31, 2017
EXPIRATION DATE:	August 30, 2021

Thank you for your submission of Amendment/Modification materials for this project. The University of Northern Colorado (UNCO) IRB approves this project and verifies its status as EXEMPT according to federal IRB regulations.

Julie -

Thank for providing clearly highlighted and warranted modifications to your IRB protocols and materials.

These modifications are verified/approved exempt.

Best wishes with your research.

Sincerely,

Dr. Megan Stellino, UNC IRB Co-Chair

We will retain a copy of this correspondence within our records for a duration of 4 years.

If you have any questions, please contact Sherry May at 970-351-1910 or Sherry.May@unco.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within University of Northern Colorado (UNCO) IRB's records.

Statement of Agreement between Participant and Community Agency

Statement of Mutual Agreement

University of Northern Colorado Doctorate of Nursing Practice Capstone Project

The purpose of the "Statement of Mutual Agreement" is to describe the shared view between Sunrise Kids Care Clinic and Julie Greenwood, DNP Candidate from University of Northern Colorado, concerning his/her proposed capstone project.

Proposed Project Title: Guideline for the diagnosis, evaluation, and management of sports-related concussions in adolescent athletes: translating evidenced-based recommendations into primary care practice
Brief Description of Proposed Project: This project will consist of an educational in-service, with the aim of educating providers on the diagnosis, evaluation, and management of adolescents who present with a sports-related concussion.
Proposed On-site Activities: Educational in-service, along with a pre- and post- test to evaluate learning
Confidentiality of Patient Records: (If applicable) N/A

The designated Capstone Community/Agency member will agree to participate in the review and approval of the proposal and presentation of the final version of the project. He/she will attend (on campus or remotely) the meetings for both.

The DNP Capstone project will include a final report, an abstract, potential publication or oral presentation of the report. No personal identifiers will be included and all data will be reported in aggregate form. The author welcomes any comments or suggestions from the Agency, but reserves the right to publish findings and analysis according to professional standards and principles of academic freedom. For any work of a scholarly nature, the Author agrees to follow the Agency preferences in how it is to be named (or not) in the work.

_____ 6/28/17 _____ Signature of DNP Student Date

_____ 6/29/17 Signature of Agency Member Date

_____ 7/5/17 Signature of DNP Capstone Chair Date

APPENDIX B

EVALUATION TOOLS

Acute Concussion Evaluation (ACE)

ACUTE CONCUSSION EVALUATION (ACE)
PHYSICIAN/CLINICIAN OFFICE VERSION

Gerard Gioia, PhD[1] & Micky Collins, PhD[2]
[1]Children's National Medical Center
[2]University of Pittsburgh Medical Center

Patient Name:_____
DOB: _____ Age:_____
Date:_____ ID/MR#_____

A. Injury Characteristics Date/Time of Injury_____ Reporter: __Patient __Parent __Spouse __Other_____

1. Injury Description _____

1a. Is there evidence of a forcible blow to the head (direct or indirect)? __Yes __No __Unknown
1b. Is there evidence of intracranial injury or skull fracture? __Yes __No __Unknown
1c. Location of Impact: __Frontal __Lft Temporal __Rt Temporal __Lft Parietal __Rt Parietal __Occipital __Neck __Indirect Force
2. **Cause**: __MVC __Pedestrian-MVC __Fall __Assault __Sports (*specify*)_____ Other_____
3. **Amnesia Before (Retrograde)** Are there any events just BEFORE the injury that you/ person has no memory of (even brief)? __Yes __No Duration
4. **Amnesia After (Anterograde)** Are there any events just AFTER the injury that you/ person has no memory of (even brief)? __Yes __No Duration
5. **Loss of Consciousness**: Did you/ person lose consciousness? __Yes __No Duration
6. **EARLY SIGNS**: __Appears dazed or stunned __Is confused about events __Answers questions slowly __Repeats Questions __Forgetful (recent info)
7. **Seizures**: Were seizures observed? No__ Yes___ Detail_____

B. Symptom Check List* Since the injury, has the person experienced any of these symptoms any more than usual today or in the past day?
Indicate presence of each symptom (0=No, 1=Yes). ***Lovell & Collins, 1998 JHTR***

PHYSICAL (10)		COGNITIVE (4)		SLEEP (4)		
Headache	0 1	Feeling mentally foggy	0 1	Drowsiness	0 1	
Nausea	0 1	Feeling slowed down	0 1	Sleeping less than usual	0 1	N/A
Vomiting	0 1	Difficulty concentrating	0 1	Sleeping more than usual	0 1	N/A
Balance problems	0 1	Difficulty remembering	0 1	Trouble falling asleep	0 1	N/A
Dizziness	0 1	**COGNITIVE Total (0-4)** _____		**SLEEP Total (0-4)** _____		
Visual problems	0 1	**EMOTIONAL (4)**				
Fatigue	0 1	Irritability	0 1			
Sensitivity to light	0 1	Sadness	0 1			
Sensitivity to noise	0 1	More emotional	0 1			
Numbness/Tingling	0 1	Nervousness	0 1			
PHYSICAL Total (0-10) _____		**EMOTIONAL Total (0-4)** _____				
(Add Physical, Cognitive, Emotion, Sleep totals) Total Symptom Score (0-22) _____						

Exertion: Do these symptoms worsen with:
Physical Activity __Yes __No __N/A
Cognitive Activity __Yes __No __N/A

Overall Rating: How different is the person acting compared to his/her usual self? (circle)
Normal 0 1 2 3 4 5 6 Very Different

C. Risk Factors for Protracted Recovery *(check all that apply)*

Concussion History? Y____ N____	√	Headache History? Y____ N____	√	Developmental History	√	Psychiatric History
Previous # 1 2 3 4 5 6+		Prior treatment for headache		Learning disabilities		Anxiety
Longest symptom duration Days__ Weeks__ Months__ Years__		History of migraine headache __ Personal __ Family_____		Attention-Deficit/ Hyperactivity Disorder		Depression
						Sleep disorder
If multiple concussions, less force caused reinjury? Yes__ No__				Other developmental disorder_____		Other psychiatric disorder _____

List other comorbid medical disorders or medication usage (e.g., hypothyroid, seizures)_____

D. RED FLAGS for acute emergency management: Refer to the emergency department with sudden onset of any of the following:

* Headaches that worsen	* Looks very drowsy/ can't be awakened	* Can't recognize people or places	* Neck pain
* Seizures	* Repeated vomiting	* Increasing confusion or irritability	* Unusual behavioral change
* Focal neurologic signs	* Slurred speech	* Weakness or numbness in arms/legs	* Change in state of consciousness

E. Diagnosis (ICD): __Concussion w/o LOC 850.0 __Concussion w/ LOC 850.1 __Concussion (Unspecified) 850.9 __Other (854) _____
__No diagnosis

F. Follow-Up Action Plan **Complete *ACE Care Plan* and provide copy to patient/family.**
___ **No Follow-Up Needed**
___ **Physician/Clinician Office Monitoring**: Date of next follow-up _____
___ **Referral:**
___ Neuropsychological Testing
___ Physician: Neurosurgery____ Neurology____ Sports Medicine____ Physiatrist____ Psychiatrist____ Other_____
___ Emergency Department

ACE Completed by:_____

This form is part of the "Heads Up: Brain Injury in Your Practice" tool kit developed by the Centers for Disease Control and Prevention (CDC).

Source: Goia & Collins, 2006, p.1, Retrieved from Journal for Nurse Practitioners, 2013,9(6),381-386)

1) ORIENTATION:

Month: _____ 0 1
Date: _____ 0 1
Day of week: _____ 0 1
Year: _____ 0 1
Time (within 1 hr.): _____ 0 1

Orientation Total Score _____ / 5

2) IMMEDIATE MEMORY: (all 3 trials are completed regardless of score on trial 1 & 2; total score equals sum across all 3 trials)

List	Trial 1	Trial 2	Trial 3
Word 1	0 1	0 1	0 1
Word 2	0 1	0 1	0 1
Word 3	0 1	0 1	0 1
Word 4	0 1	0 1	0 1
Word 5	0 1	0 1	0 1
Total			

Immediate Memory Total Score ____ / 15

(Note: Subject is not informed of Delayed Recall testing of memory)

NEUROLOGICAL SCREENING:

Loss of Consciousness: (occurrence, duration)

Pre- & Post-traumatic Amnesia: (recollection of events pre- and post-injury)

Strength:

Sensation:

Coordination:

3) CONCENTRATION:

Digits Backward (If correct, go to next string length. If incorrect, read trial 2. Stop after incorrect on both trials)

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

Months in reverse order: (entire sequence correct for 1 point)
Dec-Nov-Oct-Sep-Aug-Jul
Jun-May-Apr-Mar-Feb-Jan _____ 0 1

Concentration Total Score _____ / 5

EXERTIONAL MANEUVERS
(when appropriate)
5 jumping jacks 5 push-ups
5 sit-ups 5 knee-bends

4) DELAYED RECALL

Word 1 0 1
Word 2 0 1
Word 3 0 1
Word 4 0 1
Word 5 0 1

Delayed Recall Total Score _____ / 5

Summary of Total Scores :

Orientation _____ / 5
Immediate Memory _____ / 15
Concentration _____ / 5
Delayed Recall _____ / 5

Overall Total Score _____ / 30

McCrea, Kelly & Randolph, 2000

(Source: McCrea, 2001, table 2, p. 2276, Retrieved from Graham et al., 2014, p. 311)

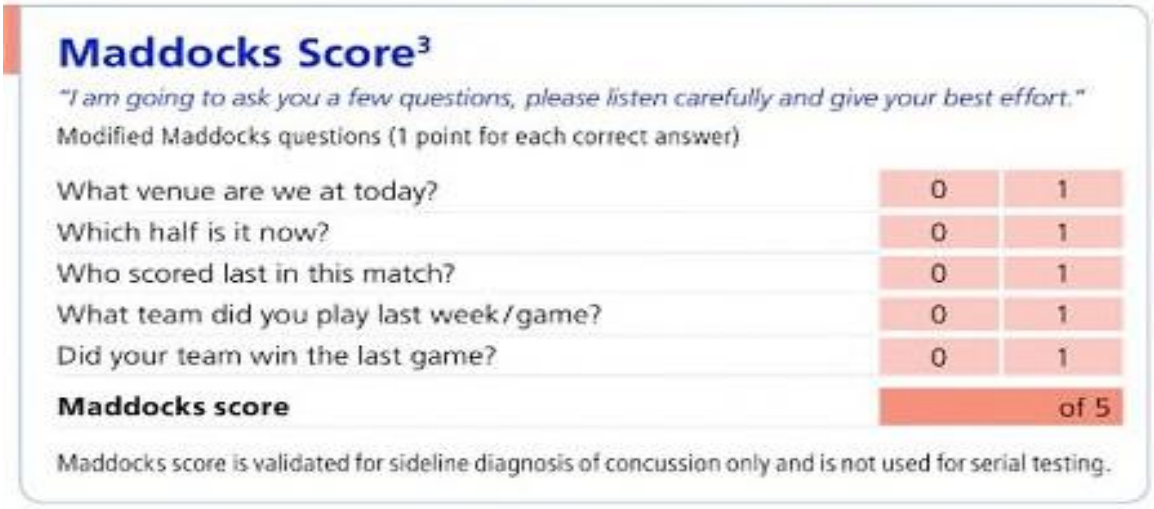
Glasgow Coma Scale (GCS)

Glasgow Coma Scale

Eye Opening	Points
Eyes open spontaneously	4
Eyes open to verbal command	3
Eyes open only with painful stimuli	2
No eye opening	1
Verbal Response	
Oriented and converses	5
Disorented and converses	4
Inappropriate words	3
Incomprehensible sounds	2
No verbal response	1
Motor Response	
Obeys verbal commands	6
Response to painful stimuli (UE)	
Localizes pain	5
Withdraws from pain	4
Flexor posturing	3
Extensor posturing	2
No motor response	1

Total score = eye opening + verbal + motor
GCS<5: 80% die or remain vegitative
GCS>11: 90% complete recovery
From Teasdale G, Jennett B: Acta Neurochirurg 34:45, 1976.

Maddocks Questions



Maddocks Score[3]

"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)

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 used for serial testing.

(Source: Retrieved from http://i.dailymail.co.uk/i/pix/2013/11/10/article-2497993-1954F43E00000578-23_634x331.jpg)

Balance Error Scoring System (BESS)

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.

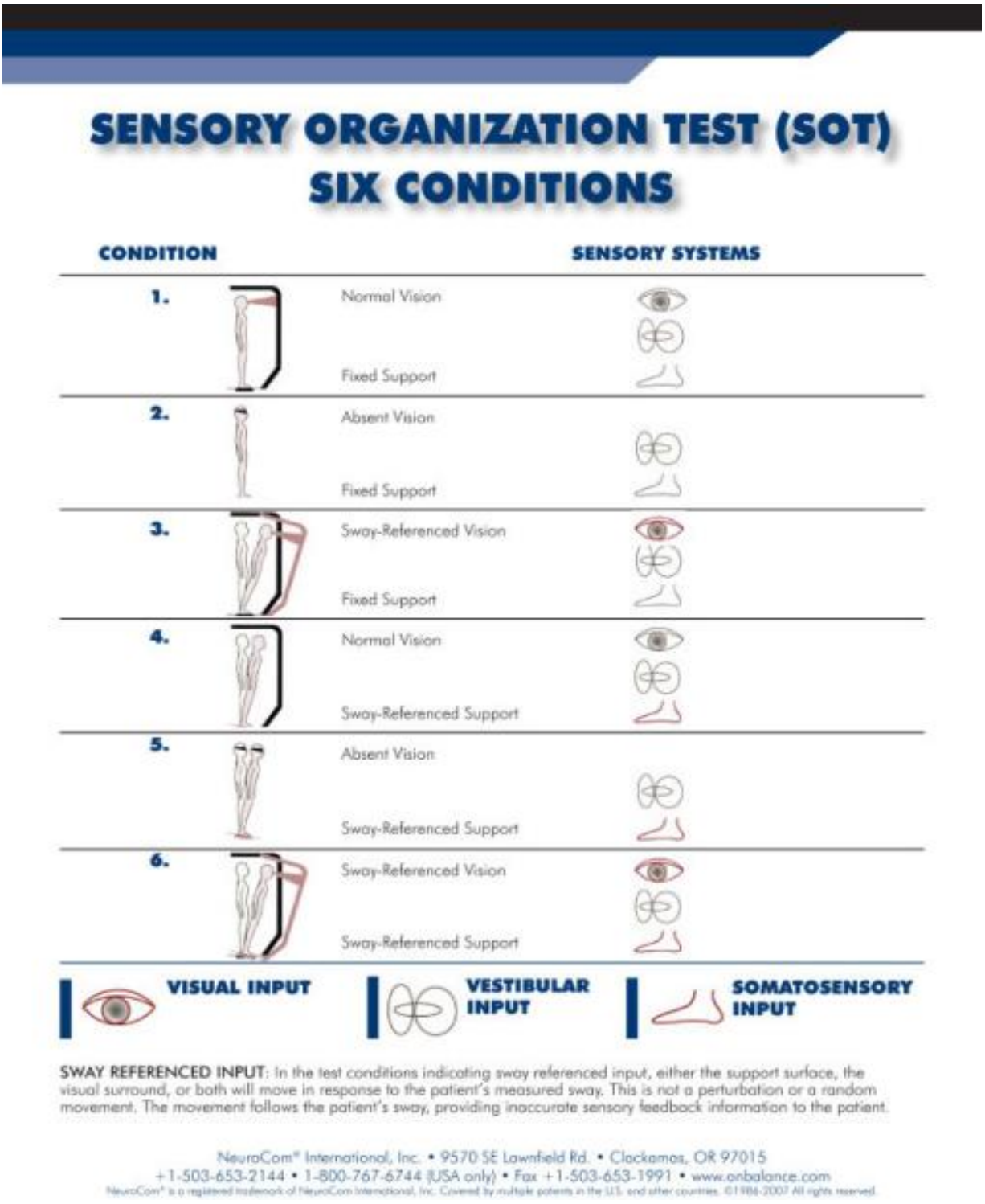
If a subject commits multiple errors simultaneously, only one error is recorded.

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.

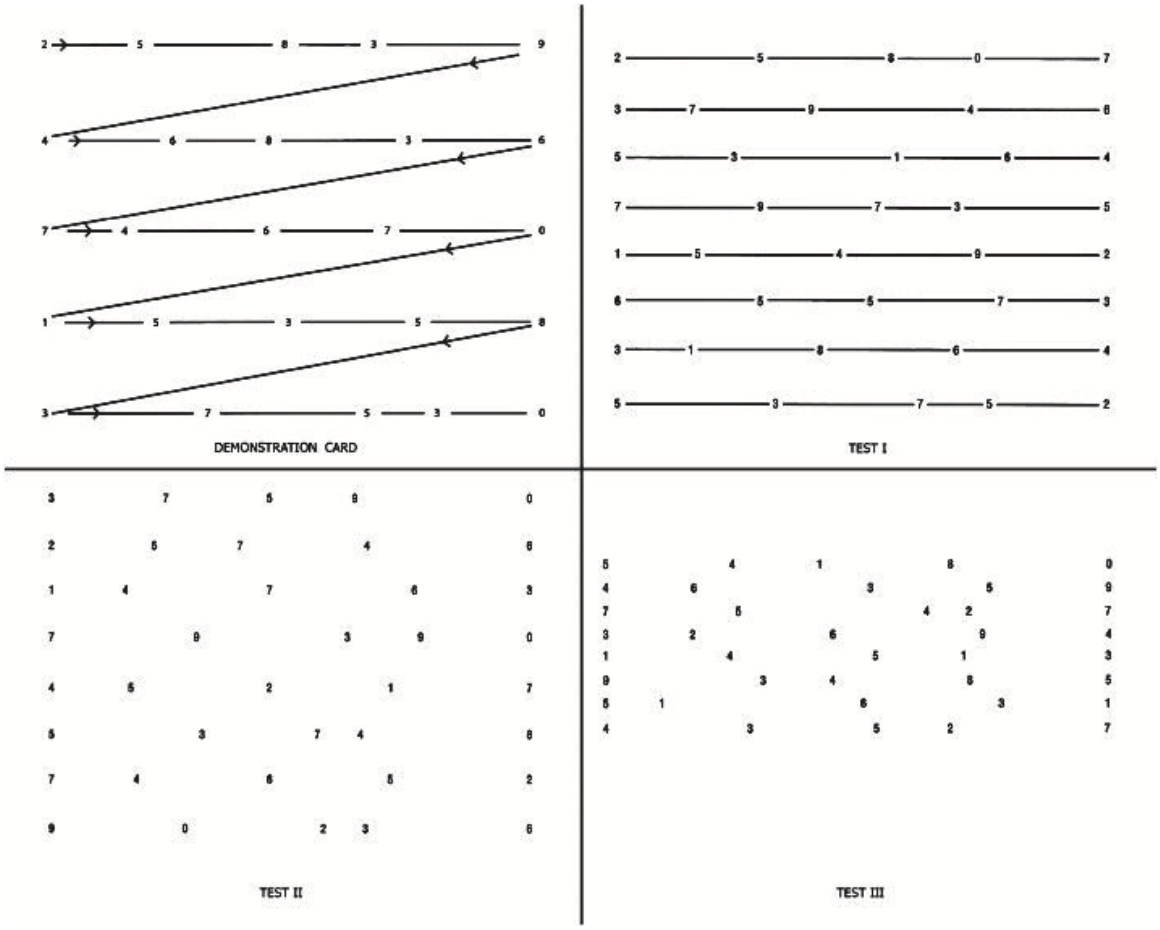
(Source: Retrieved from https://mathbio.colorado.edu/images/T3.jpg)

Sensory Organization Test (SOT)



(Source: Retrieved from https://openi.nlm.nih.gov/imgs/512/89/3239367/PMC3239367_ar3432-1.png)

King-Devick Test



Source: King-Devick, 2013, Retrieved from Graham et al., 2014, p. 313)

Graded Symptom Checklist (GSC)

Graded Symptom Checklist (GSC)

Symptom	Time of injury	2-3 Hours postinjury	24 Hours postinjury	48 Hours postinjury	72 Hours postinjury
Blurred vision					
Dizziness					
Drowsiness					
Excess sleep					
Easily distracted					
Fatigue					
Feel "in a fog"					
Feel "slowed down"					
Headache					
Inappropriate emotions					
Irritability					
Loss of consciousness					
Loss or orientation					
Memory problems					
Nausea					
Nervousness					
Personality change					
Poor balance/ coordination					
Poor concentration					
Ringing in ears					
Sadness					
Seeing stars					
Sensitivity to light					
Sensitivity to noise					
Sleep disturbance					
Vacant stare/glassy eyed					
Vomiting					

NOTE: The GSC should be used not only for the initial evaluation but for each subsequent follow-up assessment until all signs and symptoms have cleared at rest and during physical exertion. In lieu of simply checking each symptom present, the ATC can ask the athlete to grade or score the severity of the symptom on a scale of 0-6, where 0=not present, 1=mild, 3=moderate, and 6=most severe.

(Source: Guskiewicz et al., 2004, Appendix A, p. 296, Retrieved from Graham et al., 2014, figure C-5, p. 319)

Post Concussion Symptom Scale (PCSS)

Player's Name: _____ Team: _____ Position: _____

SYMPTOM	RATING None Mod. Severe	BASELINE Date:	TESTING 2 Date:	TESTING 3 Date:	TESTING 4 Date:	TESTING 5 Date:
Headache	0 1 2 3 4 5 6					
Nausea	0 1 2 3 4 5 6					
Vomiting	0 1 2 3 4 5 6					
Balance problems	0 1 2 3 4 5 6					
Dizziness	0 1 2 3 4 5 6					
Fatigue	0 1 2 3 4 5 6					
Trouble falling asleep	0 1 2 3 4 5 6					
Sleeping more than usual	0 1 2 3 4 5 6					
Sleeping less than usual	0 1 2 3 4 5 6					
Drowsiness	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					
Irritability	0 1 2 3 4 5 6					
Sadness	0 1 2 3 4 5 6					
Nervousness	0 1 2 3 4 5 6					
Feeling more emotional	0 1 2 3 4 5 6					
Numbness or tingling	0 1 2 3 4 5 6					
Feeling slowed down	0 1 2 3 4 5 6					
Feeling mentally "foggy"	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					
TOTAL SCORE						

FIGURE C-6 Post-concussion scale.
NOTE: More recent versions of this instrument include "visual problems" in the list of symptoms rated.
SOURCE: Lovell and Collins, 1998, Figure 1, p. 20.

APPENDIX C

DELPHI SURVEY ROUND ONE QUESTIONS

Delphi Survey One Questions:

1. Is there a tool that you recommend for evaluation and diagnosis of an adolescent athlete suspected of having endured a concussion? In a short appointment slot, what are the most important aspects to evaluate when a concussion is suspected?
2. What are the most significant risk-factors for prolonged recovery?
3. What do you recommend for amount of rest?
4. What do you recommend regarding aerobic activity?
5. At what point should a referral to physical therapy and/or vestibular therapy be considered?
6. How should symptoms be evaluated, and at what frequency?
7. How should returning to school and physical demands (including sports) be addressed? Do you recommend a graduated return-to-play protocol, and if so at what point in their recovery?
8. How often should these patients be followed up on?
9. Is there a part of the exam that could be performed by someone other than the provider, in order to maximize the provider's time and be more efficient?

APPENDIX D

DELPHI SURVEY ROUND TWO QUESTIONS

1. Do you agree that the following are the most important components of a concussion evaluation and diagnosis, and would therefore recommend the SCAT too?
    - Presence of red flags, a memory assessment using Maddocks questions, a Glasgow Coma Scale, Cervical spine assessment, background information, symptom evaluation/checklist, cognitive screening, immediate memory testing, concentration testing, a specific neurological screen including moving head up/down and side to side, balance testing, and delayed recall?
2. Do you agree that in a short appointment slot, the most important aspects to evaluate when a concussion is suspected are: Vestibular and oculomotor issues, headaches, and concussion symptoms?
3. The majority of the participants agreed that the following are the most significant risk factors for prolonged recovery: amnesia, prior concussion history, migraines or headaches, dizziness, attention and/or mood disorders, and/or premature returning to sport, do you agree?
4. The responses regarding the amount of rest varied in the first survey. However, would you agree with the following? Maximize rest the first few days (around 72 hours), then gradual increase activity as tolerated, individualized approach, no strict rest.
5. Regarding aerobic activity, do you agree with the following? Limit activity for at least the first week, depending on the severity of the symptoms, then begin light aerobic activity after the initial rest period, as long as there is not any significant vestibular dysfunction. May begin with 10-15 minutes per day and increase activity as tolerated. Symptom evaluation is very important, and cardio should only be done at home and never at school or sport until cleared.
6. The responses in the first round regarding a referral to physical therapy and/or vestibular therapy were mixed. Which of the following do you recommend?
    a. If after 10-14 days of persistent symptoms, especially dizziness, severe headache, lightheadedness, then refer to PT or OT
    b. If at 1-week post-injury the patient continues to have persistent symptoms (such as dizziness, severe headache, light-headedness), or in those individuals with neck pain, then refer to PT
    c. After 2-weeks post-injury, especially when vestibular/oculomotor symptoms refer to vestibular therapy
    d. As soon as possible in patients who complain of dizziness or visual problems refer to vestibular therapy. AS soon as possible in those with neck pain or persistent headache refer to PT
7. Do you agree with the following regarding symptom evaluation: Do not evaluate concussion symptoms daily, have the school nurse, athletic trainer, or parents evaluate symptoms scales multiple times per week with specific checklists? Follow up with patients in the clinic at least once a week, more often if symptoms are worse and less often as symptoms decrease.
8. Regarding returning to school, do you agree with the following? Have the adolescent return to school as soon as possible after the initial few days of rest (72 hours) once the acute symptoms have resolved. Do not keep the adolescent from attending school until they are completely free of symptoms; minimize time away

from school; ask the school to provide adjustments for recovery. Ideal is full days with accommodations.

9. Do you agree that the graduated return-to-play should not occur until the adolescent is fully functioning at school and completely symptom free?
10. The majority of respondents agreed that individuals should follow up in the clinic, and it should be an individualized approach based on symptoms, do you agree?
11. Do you agree that balance testing could be completed by support staff?
12. Do you agree that neurocognitive testing could be completed by support staff?
13. Do you agree that symptom checklists could be completed by the patient or the patient and their parent prior to seeing the provider?

APPENDIX E

NEEDS ASSESSMENT

Questionnaire for Needs Assessment

1. Could you tell me about how you diagnose an adolescent with a concussion?
2. How do you evaluate the signs, symptoms, and severity of an adolescent suspected of having a concussion?
3. What restrictions do you place on the concussed adolescent athlete?
4. How do you manage recovery? How about returning to school and/or sports/activities?

APPENDIX F

GUIDELINE FOR THE DIAGNOSIS AND MANAGEMENT OF SPORT-RELATED CONCUSSIONS IN ADOLESCENTS AND ALGORITHM

SUNRISE KIDS CARE CLINIC

TITLE: Guideline for the Diagnosis and Management of Sport-Related Concussions in Adolescents

Reviewed: October, 2017

Target patient population: All adolescents suspected of sports-related concussion, including both males and females

Rationale: The following proposed guideline will serve as a guide when diagnosing and managing adolescents suspected of having endured a sports-related concussion. It will allow for consistency in management and ensure all essential components are addressed.

Author: Julie May Greenwood, BSN, RN, DNP-S

I. OVERVIEW

It is extremely important to diagnose and manage a concussion in an adolescent appropriately. Diagnosis and management of a concussion can be very difficult for providers. Symptoms are often vague to discern, and practices are inconsistent. The literature has expanded tremendously in recent years and it can be extremely difficult to stay up to date with the most recent guidelines.

Adolescents are more susceptible to catastrophic injury after a concussion when compared to adults. They are at risk for prolonged symptoms and the detrimental consequence of second-impact syndrome. Not only this, but long term issues such as mood impairment, cognitive dysfunction, balance problems, concentration issues, and memory impairment may result if a concussion is not managed properly.

This guideline was created in an effort to ensure that all providers are practicing with consistent, validated, evidenced-based practices.

II. CONCUSSION TERMINOLOGY

***Definition of a concussion*, as defined by Consensus statement on concussion in sport: the 4th international Conference on Concussion in Sport, 2012**: "Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic and biomechanical injury constructs that may be utilized in defining the nature of a concussive head injury include:

1. Concussion may be caused either by a direct blow to the head, face, neck, or elsewhere on the body with an "impulsive" force transmitted to the head.
2. Concussion typically results in the rapid onset of short-lived impairment of neurologic function that resolves spontaneously. However, in some cases, symptoms and signs may evolve over a number of minutes to hours.

3. Concussion may result in neuropathologic changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies.
4. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness (LOC). Resolution of the clinical and cognitive symptoms typically follows a sequential course. However, it is important to note that in some cases symptoms may be prolonged" (McCrory et al., 2013, p. 555).

****NOTE: LOC is NOT defining characteristic**

III. MEDICAL EXAM IN THE OFFICE

1. Recognition of a concussion

- The evaluation of a concussion needs to include assessment of 4 domains, including: physical signs/symptoms, cognitive impairments, behavioral/emotional features, and sleep disturbances
  - If any 1 or more of the following signs/symptoms from any of the ***4 domains below*** are present, ***suspect a concussion***
  - Furthermore, the presence of oculomotor and/or vestibular issues should prompt the provider to suspect a concussion

physical (somatic) signs and symptoms	**Cognitive impairment**	**Behavioral (emotional) features**	**Sleep disturbances**
• headache • fuzzy/ blurry vision • vomiting (early) • dizziness • visual problems • fatigue • sensitivity to light • sensitivity to noise • numbness/tingling • dazed, stunned look • balance problems • amnesia	• feeling mentally 'foggy' • difficulty remembering • difficulty thinking clearly • feeling slowed down • difficulty concentrating • forgetfulness, unable to remember recent dialogues • confusion • repeating questions • slowed responses/slowed reaction time	• irritability • sadness • feeling more emotional • nervousness and/or anxiety	• drowsiness • difficulty falling asleep • sleeping more than normal • sleeping less than normally

2. **Determine if neuroimaging is necessary.**
   Typically, neuroimaging is not necessary for a concussion, except for in the following cases:

   ****Red Flags: send to ER for neuroimaging if presence of any of these red flags**

Severe brain injury suspected
LOC
Deteriorating mental status
Potential spinal injury
GCS < 15
Worsening or new neurologic signs

3. **Evaluation of a concussion: use SCAT 3 tool for history, symptom assessment, and physical exam- this section walks through each step of the exam in the office**

HISTORY OF PRESENT ILLNESS

- Use **SCAT 3 as a guide** for initial diagnosis of concussion:
  SCAT 3 for adolescents 13 years and older
  Child SCAT for younger (for ages 5-12)

- Gather **background information** on the incident, including how the injury happened, what the individual remembers, if they lost consciousness, what they remember leading up to and after the injury

- **Symptom evaluation/checklist**: use the SCAT's symptom evaluation section, which includes symptoms from each of the 4 domains listed above- rank as none (0), mild, moderate, severe (6) (0-6 scale)
  - *This section may be completed by the patient and/or parent prior to seeing the provider- support staff should provide this paperwork*
  - **Note risk factor for prolonged recovery: amnesia post-concussion, and presence of feeling mentally 'foggy'**

  **While the symptom checklist in the SCAT covers the vestibular and oculomotor systems, *make special note of dizziness, benign paroxysmal positional vertigo, cervicogenic vertigo, visual stability disturbances such as diplopia, blurred vision, poor visual concentration, headaches, amnesia*

REVIEW OF SYSTEMS: Obtain a full ROS

PAST MEDICAL HISTORY:

- Obtain a thorough past medical history (Use SCAT as a guide)
- Prior concussion history, including number of concussions, most recent, and any premature returning to sport with previous concussion
- History of migraines or headaches

- History or presence of attention disorders → ADD/ADHD
- Mental health history → mood disorders/emotional labiality /depression

*****NOTE risk factors for prolonged recovery after concussion***:**

History:

- **history of prior concussion**
- **history of prematurely returning to sport with prior concussion**
- **history of migraines**
- **history of headaches**
- **attention disorders- ADD/ADHD**
- **mood disorder**
- **emotional labiality**
- **mental health condition**
- **age: adolescents**

s/s after concussion:

- **amnesia post-concussion injury**
- **presence of mental 'fogginess'**

*Prolonged recovery: symptoms >10 days after injury

PAST SOCIAL HISTORY

- School, grade level
- Typical school performance
- Sports/activities
- Substance use
- Alcohol use
- Caffeine intake
- Migraines
- Life Stressors

OBJECTIVE/PHYSICAL EXAM

Focused Concussion exam must include these items **at a minimum** (in addition to typical head to toe evaluation):

- ***Cognitive assessment with SAC (Standardized Assessment of Concussion on the SCAT)***
  - Evaluates immediate memory and concentration

- ***General/appearance/abbreviated musculoskeletal:***
  - Careful inspection for head/**neck (especially cervical spine- on SCAT)**** injuries
  - Evaluate for musculoskeletal injuries

- ***Neuro exam (items to check):***
  - Examination of alertness, orientation
  - Assess muscular strength of upper and lower extremities
  - **Examination of Balance with the BESS (modified Balance Error Scoring System, on SCAT)****
    - **this portion may be completed by the medical assistant, as long as it is interpreted by the provider*
  - **Coordination Examination**: upper limb finger-to-nose task, on SCAT**
  - **Delayed recall (on SCAT)**
  - **Assessment of Cranial nerves:**
    - Examination of EOM of the eyes, presence of *nystagmus*
    - Facial symmetry
    - Assess for numbness, Tingling, Weakness
    - Examination of Gag/cough reflexes
    - Speech and language

    - **Vestibulo-ocular Motor Screening:**
      - Smooth pursuites
      - Horizontal and vertical saccades
      - Convergence
      - nystagmus
      - Vestibular-ocular reflex test (vertical and horizontal)
      - Visual Motion Sensitivity test

  **** indicates that this item is found in the SCAT3, use the SCAT 3 to guide these assessments:**

    - Neuropsych testing with ImPACT if software is available, not required, however this testing does help to guide diagnosis and evaluation throughout treatment – May be initiated by support staff, but must be interpreted by provider

- ***Ears/Nose:***
  - Ears: assess Tympanic membrane, also assess for CSF fluid leaking (emergency that requires imaging and transfer to ER)
  - Nose: Ensure there is no CSF leakage
  - Throat: palate elevation

- ***Cardiac:***
  - Auscultate heart sounds and rhythm
  - Evaluate pulse strength and perfusion

- ***Pulmonary:***
  - Auscultate lung sounds, evaluate breathing effort

IV. DIAGNOSIS

- *Differentials:*
  - Headache
  - Migraine
  - Skull Fracture
  - epidural/subdural hematoma
  - vertigo
  - stroke
  - seizure
  - intracranial hemorrhage
  - subarachnoid hemorrhage
  - **Concussion**

V. MANAGEMENT

A. **Initial management**

- **REST**
- **Maximize physical and cognitive rest for first few days after the concussion.** This acute rest phase should **last around 72 hours.**
  - No school during this time
  - No screen time- no texting, no video games, no TV
  - No work during this time
  - No driving
  - If individual had significant VOMS symptoms, then limit reading and writing during this time

B. **Recovery**

- **INCREASE ACTIVITY**
- After initial rest period gradually increase activity as tolerated **as long as NO symptoms worsen**
  - This does **NOT** include cardio activity yet
  - This should only be light activity, such as reading, writing, watching TV, texting as tolerated
    - If significant VOMS no driving
    - If visual or auditory sensitivity in crowds, consider wearing a baseball hat and sunglasses to decrease stimulation

- **Evaluation of symptoms:**
  - **EVALUATE FREQUENTLY, A FEW TIMES PER WEEK**
  - **Utilize specific symptom checklist (Post-concussion Symptom Scale)** a few times per week
  - Have the parents, school nurse, or athletic trainer perform symptom checklists

Player's Name: _____ Team: _____ Position: _____						
SYMPTOM	RATING None Mod. Severe	BASELINE Date:	TESTING 2 Date:	TESTING 3 Date:	TESTING 4 Date:	TESTING 5 Date:
Headache	0 1 2 3 4 5 6					
Nausea	0 1 2 3 4 5 6					
Vomiting	0 1 2 3 4 5 6					
Balance problems	0 1 2 3 4 5 6					
Dizziness	0 1 2 3 4 5 6					
Fatigue	0 1 2 3 4 5 6					
Trouble falling asleep	0 1 2 3 4 5 6					
Sleeping more than usual	0 1 2 3 4 5 6					
Sleeping less than usual	0 1 2 3 4 5 6					
Drowsiness	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					
Irritability	0 1 2 3 4 5 6					
Sadness	0 1 2 3 4 5 6					
Nervousness	0 1 2 3 4 5 6					
Feeling more emotional	0 1 2 3 4 5 6					
Numbness or tingling	0 1 2 3 4 5 6					
Feeling slowed down	0 1 2 3 4 5 6					
Feeling mentally "foggy"	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					
TOTAL SCORE						

C. **Follow up:**

- Support staff to **call** and follow up on symptoms every other day for the first week
- Provider to ***see patient once a week in the clinic***; some patients may require more frequently or others less frequently depending on symptoms
- After initial week, support staff will call once a week to follow up on symptoms

D. **Aerobic activity:**

- **AFTER ONE WEEK** of limited activity, as long as symptoms permit, begin aerobic activity with **10-15 minutes per day**
- **Max aerobic activity is up to 30 minutes per day/ 5 days a week.**
- Evaluate symptoms frequently after cardio
- No cardio if persistent symptoms, especially those with vestibular issues
- Activity should **only be done at home and NEVER at school or sport until cleared by provider**
- Perform **exercises that will not strain the body** (such as walking indoor and/or on treadmill or outdoors, stationary bike, light swimming as long as no significant VOMS symptoms, no weight lifting)

E. **Symptom Management**
- Preferably no medications, but if they must be used:
  - Headache: Anti-inflammatory medication for <3 days
  - Nausea: antiemetic during first 1-2 days after concussion
  - Sensitivity to light/noise: dim, therapeutic environment; also baseball cap, sunglasses, ear plugs when out
  - Sleep disturbances: manage without medication, but instead sleep hygiene
  - Aerobic activity as discussed above
  - Emotional labiality/depression: Anti-depressant and/or cognitive therapy may be considered if symptoms continue past 6-12 weeks (this is prolonged course at this time)
  - Balance dysfunction/vertigo: referral to physical therapy and/or vestibular therapy

- **When to refer for therapy:**
  - **Consider early, PREFERABLY refer to physical therapist with vestibular therapy training (if unable to then refer to general physical therapist)**
  - Consider referral to general physical therapy 1-week post-injury if the adolescent continues to have persistent symptoms (such as: severe headache, light-headedness, or neck pain).
  - Consider referral to vestibular therapist 1-2-weeks post injury if persistent vestibular/oculomotor symptoms (such as: nausea, vertigo, nystagmus, dizziness,
  - Refer when persistent symptoms, and allow the therapist to oversee physical activity for recovery

VI. RETURNING TO SCHOOL AND RETURNING TO SPORTS

1. **Returning to school**
   - ***After the initial rest period of 72 hours and the individual can tolerate light cognitive demands for 30-45 minutes without significant symptoms***
     - Return to school as symptoms improve, but do not wait until the adolescent is completely symptom-free
     - Progress back to school as tolerated, may begin with half days initially after 72-hours rest period and then increase to full days with adjustments
     - **Ideal is full days with adjustments→ may require more time for homework, testing, breaks during school, etc. Work with school to ensure adjustments for student**

2. **Returning to sports**
   - ***Completion of Graduated Return-To-Play protocol ONLY once the adolescent is FULLY functioning at school (without any adjustments), is tolerating aerobic activity, and is completely symptom free***

- Adolescent must NOT be taking any medications for symptoms
- Ideally, this progression should be supervised by an athletic trainer, general physical therapist, or vestibular therapist.
- **There must be a minimum of 24 hours between each stage.**
- **If symptoms worsen while progressing through the protocol, the adolescent must return to the previous stage and remain asymptomatic for at least 24 hours.**

Rehabilitation Stage	Functional Exercise at Each Stage of Rehabilitation	Objective(s) of Each Stage
1. No activity	Symptom-limited physical and cognitive rest	Recover
2. Light aerobic exercise	Walking, swimming, or stationary cycling, keeping intensity <70% of maximum permitted heart rate; no resistance training	Increase heart rate
3. Sport specific exercise	Skating drills in ice hockey, running drills in soccer; no head-impact activities	Add movement
4. Noncontact training drills	Progression to more complex training drills in football and ice hockey; may start progressive resistance training	Exercise, coordination, and cognitive load
5. Full-contact practice	After medical clearance, participation in normal training activity	Restore confidence and assessment of functional skills by coaching staff
6. Return to play	Normal game play	Normal activity

(McCroy et al., 2013, table 1)

- *NOTE: despite this return-to-play, the adolescent athlete will have already progressed through stages 1 and 2 by the time they complete this progression.

- It is therefore **encouraged that after light aerobic exercise at stage 2** for 30 minutes, 5 days per week, **increase activity to light to moderate for the next stage for a few days** before progressing to stage 3.
    - For example, instead of running drills for soccer, increase activity to running for 30 minutes)
    - See example for specific return to play protocol for football

VII. PRE-PARTICIPATION EVALUATION

- Perform at sports-physical clearance or yearly well-child check
- Evaluate history of concussions, mood, learning, attention, migraine disorders
- Discuss importance of recognizing signs and symptoms of a concussion
- Baseline neurocognitive testing with SCAT3 or ImPACT testing. Can be used for comparison if concussion experienced during sport

Example of a specific return-to-play for football
Return to Physical Activity Following Concussion Football

Stage	Activity	Football Specific Exercise	Objective of the Stage
1	No physical activity; Complete physical and cognitive rest	• No activity	• Recovery and elimination of symptoms
2	Light aerobic activity	• 10-15 min of walking at home or at field, or stationary bike	• Add light aerobic activity and monitor for symptom return
3	Moderate aerobic activity Light resistance training	• 20-30 min jogging w/helmet • Resistance training -body weight squats and push-ups 1 set of 10 reps each	• Increase aerobic activity and monitor for symptom return
4	Non-contact football-specific drills	• Moving in/out 3-point stance, bear crawls through tunnel, tires, step over bags (vertical and lateral), QB/center exchange, QB drop backs, passing, break downs and plant, jump cuts, backpedaling, match the hips, up/downs • *Start w/o helmet; progress to helmet and shoulder pads if symptom free	• Maximize aerobic activity • Accelerate to full speed with change of directions (cuts) • Introduce rotational head movements • Monitor for symptoms
5	Limited contact football drills	• Stage 4 workout in full pads • Hit/push pads then sled (focus on technique-head up, square up, stay low), step and hit, run and hit, leverage drill, punch drill	• Maximize aerobic activity • Add deceleration/rotational forces in controlled setting • Monitor for symptoms
6	Full contact practice (after medical clearance)	• Normal training activities	• Reassess for symptoms every 30 minutes throughout the practice • Monitor for symptoms
7	Return to play	• Normal game play	• Assess frequently • Monitor for symptoms • Consider one side of the ball only, no special teams play

(Retrieved from International Journal of Sports Physical Therapy, 2014)

SCAT 3

SCAT 3

BACKGROUND

Name: _____ Date: _____
Examiner: _____
Sport/team/school: _____ Date/time of injury: _____
Age: _____ Gender: ☐ M ☐ F
Years of education completed: _____
Dominant hand: ☐ right ☐ left ☐ neither
How many concussions do you think you have had in the past? _____
When was the most recent concussion? _____
How long was your recovery from the most recent concussion? _____
Have you ever been hospitalized or had medical imaging done for a head injury? ☐ Y ☐ N
Have you ever been diagnosed with headaches or migraines? ☐ Y ☐ N
Do you have a learning disability, dyslexia, ADD/ADHD? ☐ Y ☐ N
Have you ever been diagnosed with depression, anxiety or other psychiatric disorder? ☐ Y ☐ N
Has anyone in your family ever been diagnosed with any of these problems? ☐ Y ☐ N
Are you on any medications? If yes, please list: ☐ Y ☐ N

SCAT3 to be done in resting state. Best done 10 or more minutes post excercise.

SYMPTOM EVALUATION

3 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	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 (Maximum possible 132) _____

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

☐ self rated ☐ self rated and clinician monitored
☐ clinician interview ☐ self rated with parent input

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 | N/A

Scoring on the SCAT3 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. Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.

COGNITIVE & PHYSICAL EVALUATION

4 Cognitive assessment

Standardized Assessment of Concussion (SAC)[4]

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

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 total of 15

Concentration: Digits Backward

List	Trial 1		Alternative digit list		
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
Total of 4					

Concentration: Month in Reverse Order (1 pt. for entire sequence correct)

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0	1
Concentration score		of 5

5 Neck Examination:

Range of motion Tenderness Upper and lower limb sensation & strength
Findings: _____

6 Balance examination

Do one or both of the following tests.
Footwear (shoes, barefoot, braces, tape, etc.) _____

Modified Balance Error Scoring System (BESS) testing[5]
Which foot was tested (i.e. which is the **non-dominant** foot) ☐ Left ☐ Right
Testing surface (hard floor, field, etc.) _____

Condition

Double leg stance:	Errors
Single leg stance (non-dominant foot):	Errors
Tandem stance (non-dominant foot at back):	Errors

And/Or

Tandem gait[6,7]
Time (best of 4 trials): _____ seconds

7 Coordination examination

Upper limb coordination
Which arm was tested: ☐ Left ☐ Right
Coordination score of 1

8 SAC Delayed Recall[4]

Delayed recall score of 5

Child SCAT 3

SYMPTOM EVALUATION

3 Child report

Name: _____

	never	rarely	sometimes	often
I have trouble paying attention	0	1	2	3
I get distracted easily	0	1	2	3
I have a hard time concentrating	0	1	2	3
I have problems remembering what people tell me	0	1	2	3
I have problems following directions	0	1	2	3
I daydream too much	0	1	2	3
I get confused	0	1	2	3
I forget things	0	1	2	3
I have problems finishing things	0	1	2	3
I have trouble figuring things out	0	1	2	3
It's hard for me to learn new things	0	1	2	3
I have headaches	0	1	2	3
I feel dizzy	0	1	2	3
I feel like the room is spinning	0	1	2	3
I feel like I'm going to faint	0	1	2	3
Things are blurry when I look at them	0	1	2	3
I see double	0	1	2	3
I feel sick to my stomach	0	1	2	3
I get tired a lot	0	1	2	3
I get tired easily	0	1	2	3

Total number of symptoms (Maximum possible 20) _____

Symptom severity score (Maximum possible 20 x 3 = 60) _____

☐ self rated ☐ clinician interview ☐ self rated and clinician monitored

4 Parent report

The child	never	rarely	sometimes	often
has trouble sustaining attention	0	1	2	3
Is easily distracted	0	1	2	3
has difficulty concentrating	0	1	2	3
has problems remembering what he/she is told	0	1	2	3
has difficulty following directions	0	1	2	3
tends to daydream	0	1	2	3
gets confused	0	1	2	3
is forgetful	0	1	2	3
has difficulty completeing tasks	0	1	2	3
has poor problem solving skills	0	1	2	3
has problems learning	0	1	2	3
has headaches	0	1	2	3
feels dizzy	0	1	2	3
has a feeling that the room is spinning	0	1	2	3
feels faint	0	1	2	3
has blurred vision	0	1	2	3
has double vision	0	1	2	3
experiences nausea	0	1	2	3
gets tired a lot	0	1	2	3
gets tired easily	0	1	2	3

Total number of symptoms (Maximum possible 20) _____

Symptom severity score (Maximum possible 20 x 3 = 60) _____

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

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

☐ parent self rated ☐ clinician interview ☐ parent self rated and clinician monitored

Overall rating for parent/teacher/coach/carer to answer.
How different is the child acting compared to his/her usual self?
Please circle one response:

no different	very different	unsure	N/A

Name of person completing Parent-report: _____

Relationship to child of person completing Parent-report: _____

Scoring on the ChildSCAT3 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.

COGNITIVE & PHYSICAL EVALUATION

5 Cognitive assessment

Standardized Assessment of Concussion – Child Version (SAC-C)[4]

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
Orientation score		of 4

Immediate memory

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 total of 15

Concentration: Digits Backward

List	Trial 1	Alternative digit list		
6-2	0 1	5-2	4-1	4-9
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
Total of 5				

Concentration: Days in Reverse Order (1 pt. for entire sequence correct)

Sunday-Saturday-Friday-Thursday-Wednesday-Tuesday-Monday	0	1
Concentration score		of 6

6 Neck Examination:

Range of motion Tenderness Upper and lower limb sensation & strength

Findings: _____

7 Balance examination

Do one or both of the following tests.

Footwear (shoes, bare foot, braces, tape, etc.) _____

Modified Balance Error Scoring System (BESS) testing[5]

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

Testing surface (hard floor, field, etc.) _____

Condition

Double leg stance:	Errors
Tandem stance (non-dominant foot at back):	Errors

Tandem gait[6,7]

Time taken to complete (best of 4 trials): _____ seconds

If child attempted, but unable to complete tandem gait, mark here ☐

8 Coordination examination

Upper limb coordination

Which arm was tested: ☐ Left ☐ Right

Coordination score of 1

9 SAC Delayed Recall[4]

Delayed recall score of 5

Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.

INSTRUCTIONS

Words in *Italics* throughout the ChildSCAT3 are the instructions given to the child by the tester.

Sideline Assessment – child-Maddocks Score

To be completed on the sideline/in the playground, immediately following concussion. There is no requirement to repeat these questions at follow-up.

Symptom Scale[8]

In situations where the symptom scale is being completed after exercise, it should still be done in a resting state, at least 10 minutes post exercise.

On the day of injury

- the child is to complete the Child Report, according to how he/she feels now.

On all subsequent days

- the child is to complete the Child Report, according to how he/she feels today, **and**
- the parent/carer is to complete the Parent Report according to how the child has been over the previous 24 hours.

Standardized Assessment of Concussion – Child Version (SAC-C)[4]

Orientation

Ask each question on the score sheet. A correct answer for **each question scores 1 point.** If the child does not understand the question, gives an incorrect answer, or no answer, then the score for that question is 0 points.

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 child that delayed recall will be tested.

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, you would say 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.

Days in Reverse Order:

"Now tell me the days of the week in reverse order. Start with Sunday and go backward. So you'll say Sunday, Saturday … Go ahead"

1 pt. for entire sequence correct

Delayed recall

The delayed recall should be performed after completion of the Balance and Coordination Examination.

"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.**

Balance examination

These instructions are to be read by the person administering the childSCAT3, and each balance task **should be demonstrated to the child**. The child should then be asked to copy what the examiner demonstrated.

Modified Balance Error Scoring System (BESS) testing[5]

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[5]. A stopwatch or watch with a second hand is required for this 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 two different parts."

(a) Double leg stance:

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

(b) Tandem stance:

Instruct the child to stand heel-to-toe with the non-dominant foot in the back. Weight should be evenly distributed across both feet. Again, the child should try to maintain stability for 20 seconds with hands on hips and eyes closed. You should inform the child that you will be counting the number of times the child moves out of this position. If the child stumbles out of this position, instruct him/her to open the eyes and return to the start position and continue balancing. You should start timing when the child is set and the eyes are closed.

Balance testing – types of errors - Parts (a) and (b)

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 child. The examiner will begin counting errors only after the child has assumed the proper start position. **The modified BESS is calculated by adding one error point for each error during the two 20-second tests. The maximum total number of errors for any single condition is 10.** If a child commits multiple errors simultaneously, only one error is recorded but the child should quickly return to the testing position, and counting should resume once subject is set. Children who 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.

OPTION: For further assessment, the same 2 stances can be performed on a surface of medium density foam (e.g., approximately 50cm x 40cm x 6cm).

Tandem Gait[6,7]

Use a clock (with a second hand) or stopwatch to measure the time taken to complete this task. Instruction for the examiner – **Demonstrate the following to the child**:

The child is instructed to stand with their feet together behind a starting line (the test is best done with footwear removed). Then, they walk in a forward direction as quickly and as accurately as possible along a 38mm wide (sports tape), 3 meter line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they cross the end of the 3m line, they turn 180 degrees and return to the starting point using the same gait. ***A total of 4 trials are done and the best time is retained****. Children fail the test if they step off the line, have a separation between their heel and toe, or if they touch or grab the examiner or an object. In this case, the time is not recorded and the trial repeated, if appropriate.*

Explain to the child that you will time how long it takes them to walk to the end of the line and back.

Coordination examination

Upper limb coordination

Finger-to-nose (FTN) task:

The tester should **demonstrate it to the child**.

"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."

Scoring: 5 correct repetitions in < 4 seconds = 1
Note for testers: Children 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.**

References & Footnotes

1. This tool has been developed by a group of international experts at the 4th International Consensus meeting on Concussion in Sport held in Zurich, Switzerland in November 2012. The full details of the conference outcomes and the authors of the tool are published in The BJSM Injury Prevention and Health Protection, 2013, Volume 47, Issue 5. The outcome paper will also be simultaneously co-published in other leading biomedical journals with the copyright held by the Concussion in Sport Group, to allow unrestricted distribution, providing no alterations are made.

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3. Maddocks, DL; Dicker, GD; Saling, MM. The assessment of orientation following concussion in athletes. Clinical Journal of Sport Medicine. 1995; 5(1): 32 3.

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6. Schneiders, A.G., Sullivan, S.J., Gray, A., Hammond-Tooke, G.&McCrory, P. Normative values for 16-37 year old subjects for three clinical measures of motor performance used in the assessment of sports concussions. Journal of Science and Medicine in Sport. 2010; 13(2): 196–201.

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8. Ayr, L.K., Yeates, K.O., Taylor, H.G., &Brown, M. Dimensions of post-concussive symptoms in children with mild traumatic brain injuries. Journal of the Internat onal Neuropsychological Society. 2009; 15:19–30.

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2:_____ Measure 3:_____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

(Mucha A, Collins MW, Elbin RJ, Furman JM, Troutman-Enseki C, DeWolf RM, Marchetti G, Kontos AP. A brief vestibular and ocular motor screening (VOMS) assessment to evaluate preliminary concussion: Preliminary findings. Am J Sports Med; in press)

Instructions:

Interpretation: This test is designed for use with subjects ages 9-40. When used with patients outside this age range, interpretation may vary. Abnormal findings or provocation of symptoms with any test may indicate dysfunction – and should trigger a referral to the appropriate health care professional for more detailed assessment and management.

Equipment: Tape measure (cm); Metronome; Target w/ 14 point font print.
Baseline Symptoms – Record: Headache, Dizziness, Nausea & Fogginess on 0-10 scale prior to beginning screening

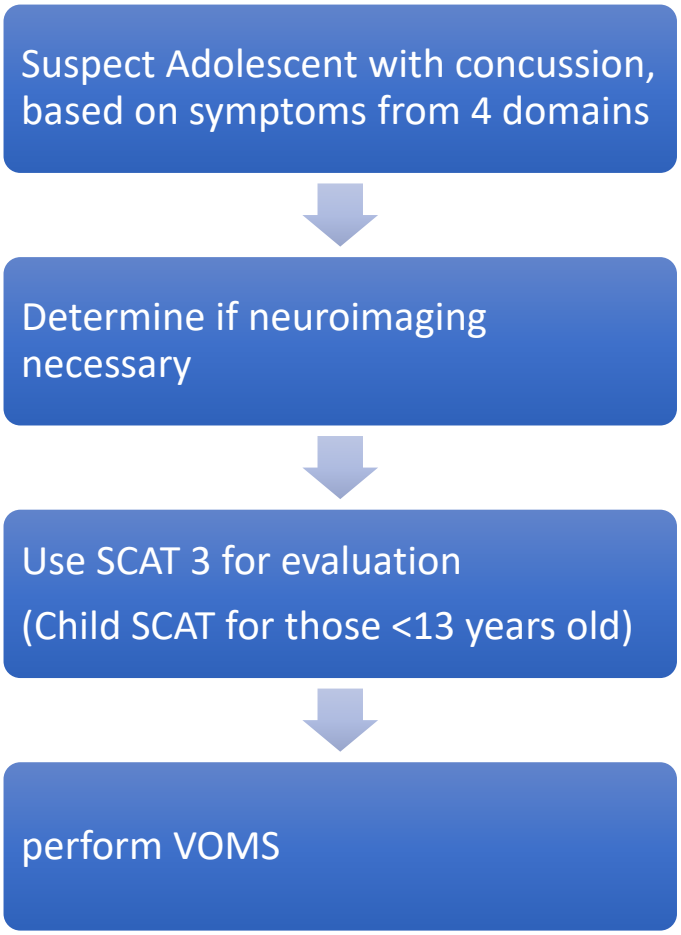
- Smooth Pursuits - Test the ability to follow a slowly moving target. The patient and the examiner are seated. The examiner holds a fingertip at a distance of 3 ft. from the patient. The patient is instructed to maintain focus on the target as the examiner moves the target smoothly in the horizontal direction 1.5 ft. to the right and 1.5 ft. to the left of midline. One repetition is complete when the target moves back and forth to the starting position, and 2 repetitions are performed. The target should be moved at a rate requiring approximately 2 seconds to go fully from left to right and 2 seconds to go fully from right to left. The test is repeated with the examiner moving the target smoothly and slowly in the vertical direction 1.5 ft. above and 1.5 ft. below midline for 2 complete repetitions up and down. Again, the target should be moved at a rate requiring approximately 2 seconds to move the eyes fully upward and 2 seconds to move fully downward. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 1)
- • Saccades – Test the ability of the eyes to move quickly between targets. The patient and the examiner are seated.

• Horizontal Saccades: The examiner holds two single points (fingertips) horizontally at a distance of 3 ft. from the patient, and 1.5 ft. to the right and 1.5 ft. to the left of midline so that the patient must gaze 30 degrees to left and 30 degrees to the right. Instruct the patient to move their eyes as quickly as possible from point to point. One repetition is complete when the eyes move back and forth to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 2)

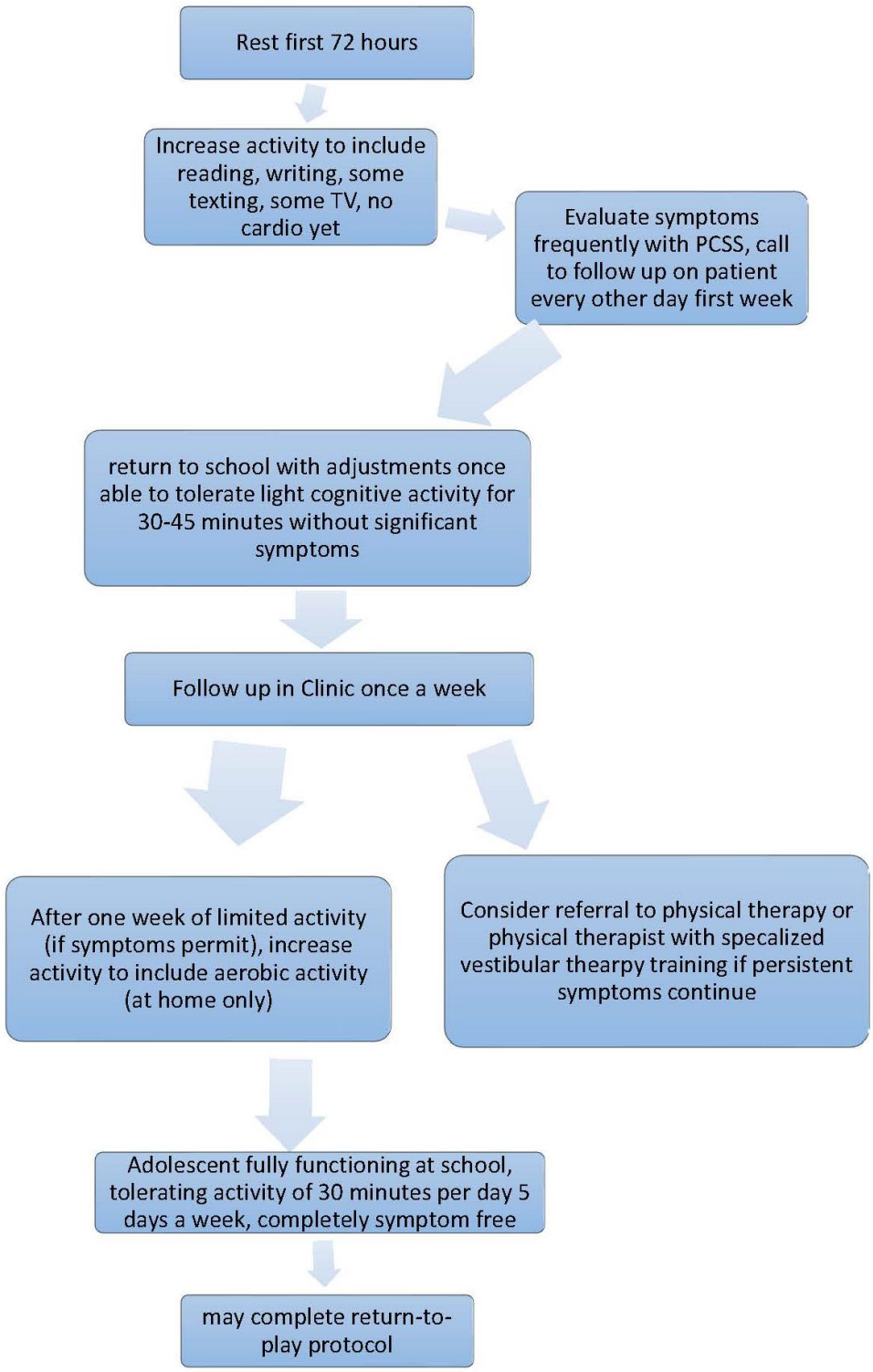
• Vertical Saccades: Repeat the test with 2 points held vertically at a distance of 3 ft. from the patient, and 1.5 feet above and 1.5 feet below midline so that the patient must gaze 30 degrees upward and 30 degrees downward. Instruct the patient to move their eyes as quickly as possible from point to point. One repetition is complete when the eyes move up and down to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 3)

- Convergence – Measure the ability to view a near target without double vision. The patient is seated and wearing corrective lenses (if needed). The examiner is seated front of the patient and observes their eye movement during this test. The patient focuses on a small target (approximately 14 point font size) at arm's length and slowly brings it toward the tip of their nose. The patient is instructed to stop moving the target when they see two distinct images or when the examiner observes an outward deviation of one eye. Blurring of the image is ignored. The distance in cm. between target and the tip of nose is measured and recorded. This is repeated a total of 3 times with measures recorded each time. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. Abnormal: Near Point of convergence ≥ 6 cm from the tip of the nose. (Figure 4)
-
- Vestibular-Ocular Reflex (VOR) Test – Assess the ability to stabilize vision as the head moves. The patient and the examiner are seated. The examiner holds a target of approximately 14 point font size in front of the patient in midline at a distance of 3 ft.
    - Horizontal VOR Test: The patient is asked to rotate their head horizontally while maintaining focus on the target. The head is moved at an amplitude of 20 degrees to each side and a metronome is used to ensure the speed of rotation is maintained at 180 beats/minute (one beat in each direction). One repetition is complete when the head moves back and forth to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea and Fogginess ratings 10 sec after the test is completed. (Figure 5)
    - Vertical VOR Test: The test is repeated with the patient moving their head vertically. The head is moved in an amplitude of 20 degrees up and 20 degrees down and a metronome is used to ensure the speed of movement is maintained at 180 beats/minute (one beat in each direction). One repetition is complete when the head moves up and down to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea and Fogginess ratings after the test. (Figure 6)
- Visual Motion Sensitivity (VMS) Test – Test visual motion sensitivity and the ability to inhibit vestibular-induced eye movements using vision. The patient stands with feet shoulder width apart, facing a busy area of the clinic. The examiner stands next to and slightly behind the patient, so that the patient is guarded but the movement can be performed freely. The patient holds arm outstretched and focuses on their thumb. Maintaining focus on their thumb, the patient rotates, together as a unit, their head, eyes and trunk at an amplitude of 80 degrees to the right and 80 degrees to the left. A metronome is used to ensure the speed of rotation is maintained at 50 beats/min (one beat in each direction). One repetition is complete when the trunk rotates back and forth to the starting position, and 5 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 7)

Suggested Algorithm for Evaluation of concussion



Suggested Algorithm for management of diagnosed concussion



APPENDIX G

CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH

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School of Nursing

CONSENT FORM FOR HUMAN PARTICPANTS IN RESEARCH

UNIVERSITY OF NORTHERN COLORADO

Project Title: Guideline for the Diagnosis, Evaluation, and Management of Sports-related Concussions in Adolescent Athletes: Translating Evidenced-based Recommendations into Primary Care Practice

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Purpose and Description: The primary purpose of this study is to translate the most updated, high quality evidenced-based literature into practice, in the form of a concussion guideline and algorithm for primary care providers caring for adolescent athletes suspected of having endured a sports-related concussion. The aim is to enhance the quality and consistency amongst primary care providers in the diagnosis, evaluation, and management of this patient population.

Participation in the research study would consist of:

Answering questions regarding current practices relating to caring for adolescent athletes with concussions and making recommendations for the development of the clinical practice guidelines for concussions. All participation is voluntary and participants may withdraw at any point form the study. Participation is likely to take approximately 10-20 minutes.

To assess current practice:

1- Could you tell me about how you diagnose an adolescent with a concussion?
2- How do you evaluate the signs, symptoms, and severity of an adolescent suspected of having a concussion?
3- What restrictions do you place on the concussed adolescent athlete?
4- How do you manage recovery? How about returning to school and/or sports/activities?

To develop the clinical practice guideline a second round of questions will be sent to obtain additional expert opinions regarding caring for adolescents with concussions. Participation in this survey will consist of the following questions:

1- Is there a tool that you recommend for evaluation and diagnosis of an adolescent athlete suspected of having endured a concussion? In a short appointment slot, what are the most important aspects to evaluate when a concussion is suspected?
2- What are the most significant risk-factors for prolonged recovery?
3- What do you recommend for amount of rest?
4- What do you recommend regarding aerobic activity?
5- At what point should a referral to physical therapy and/or vestibular therapy be considered?
6- How should symptoms be evaluated, and at what frequency?
7- How should returning to school and physical demands (including sports) be addressed? Do you recommend a graduated return-to-play protocol, and if so at what point in their recovery?

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8- How often should these patients be followed up on?
9- Is there a part of the exam that could be performed by someone other than the provider, in order to maximize the provider's time and be more efficient?

Answers to these questions will dictate the questions for the second round of the survey, in order to gain a 70% consensus agreement. The findings from the surveys will determine a newly developed concussion guideline that will be presented to primary care providers. The data will be collected with electronic surveys. You will be sent an electronic link by email to access the survey. Your responses will be kept confidential. While the researcher will be aware of the participants, you will not be aware of the other participants, and your answers will not include any identifying information. Instead of using personal identifiers, you will only be identified by numerical values, i.e. participant #1, #2, #3, etc. The amount of time spent on this survey may range from 15 minutes to 30 minutes.

To determine learning from the educational in-service and likelihood to implement the developed guideline and algorithm:

You, as the provider, will participate in an educational in-service where you will learn about concussions, and the newly developed guideline. Prior to the in-service, you will take a pre-test that assesses your previous knowledge. Following the in-service, you will participate in a post-test and rate your likelihood of utilizing the proposed guideline. Your confidentiality will be protected. We would be happy to share with you the results at the end of the study if you would like. Participation in the educational in-service, pre-test, and post-test is likely to take a total of 30-40 minutes.

We will take every precaution in order to protect your confidentiality. Only the researchers will know the name connected with the numerical value of each participant. Your name will not be used when reporting data. Furthermore, all data collected will be stored in a locked file cabinet at the UNC School of Nursing, which can only be accessed by the researchers. We do not anticipate any major risks to you from participation in this research study. Some participants may experience remorse or discomfort as they remember their experiences in caring for patients with a concussion.

There are no direct benefits to you from participation in this study. However, the researcher may gain knowledge about concussion diagnosis and management, and how it can be applied to the primary care practice setting. The results may offer the opportunity to improve concussion management and improve patient outcomes.

Participation is voluntary. You may decide not to participate in this study and if you begin participation you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Having read the above and having had an opportunity to ask any questions, please complete the questionnaire if you would like to participate in this research. By completing the questionnaire, you will give us permission for your participation. You may keep this form for future reference. If you have any concerns about your selection or treatment as a research participant, please contact Sherry May, IRB Administrator, Office of Sponsored Programs, Kepner Hall, University of Northern Colorado Greeley, CO 80639; 970-351-1910. _____

APPENDIX H

SPORT CONCUSSION ASSESSMENT TOOL 2, SPORT CONCUSSION ASSESSMENT TOOL 3, AND SPORT CONCUSSION ASSESSMENT TOOL 5

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)[6]. 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**

Clinic phone number

Patient's name

Date/time of injury

Date/time of medical review

Treating physician

Contact details or stamp

SCAT3™

Sport Concussion Assessment Tool – 3rd edition

For use by medical professionals only

Name: Date / Time of Injury: Date of Assessment: Examiner:

What is the SCAT3?[1]

The SCAT3 is a standardized tool for evaluating injured athletes for concussion and can be used in athletes aged from 13 years and older. It supersedes the original SCAT and the SCAT2 published in 2005 and 2009, respectively[2]. For younger persons, ages 12 and under, please use the Child SCAT3. The SCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion Recognition Tool[1]. Preseason baseline testing with the SCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the SCAT3 are provided on page 3. If you are not familiar with the SCAT3, please read through these instructions carefully. This tool may be freely copied in its current form for distribution to individuals, teams, groups and organizations. Any revision or any reproduction in a digital form requires approval by the Concussion in Sport Group.
NOTE: The diagnosis of a concussion is a clinical judgment, ideally made by a medical professional. The SCAT3 should not be used solely to make, or exclude, the diagnosis of concussion in the absence of clinical judgement. An athlete may have a concussion even if their SCAT3 is "normal".

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 signs and / or symptoms (some examples listed below) and most often does not involve loss of consciousness. Concussion should be suspected in the presence of any one or more of the following:

- Symptoms (e.g., headache), or
- Physical signs (e.g., unsteadiness), or
- Impaired brain function (e.g. confusion) or
- Abnormal behaviour (e.g., change in personality).

SIDELINE ASSESSMENT

Indications for Emergency Management

NOTE: A hit to the head can sometimes be associated with a more serious brain injury. Any of the following warrants consideration of activating emergency procedures and urgent transportation to the nearest hospital:

- Glasgow Coma score less than 15
- Deteriorating mental status
- Potential spinal injury
- Progressive, worsening symptoms or new neurologic signs

Potential signs of concussion?

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop participation, be evaluated by a medical professional and **should not be permitted to return to sport the same day** if a concussion is suspected.

Any loss of consciousness?	Y	N
"If so, how long?"		
Balance or motor incoordination (stumbles, slow / laboured movements, etc.)?	Y	N
Disorientation or confusion (inability to respond appropriately to questions)?	Y	N
Loss of memory:	Y	N
"If so, how long?"		
"Before or after the injury?"		
Blank or vacant look:	Y	N
Visible facial injury in combination with any of the above:	Y	N

1 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.

2 Maddocks Score[3]

"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)

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 used for serial testing.

Notes: Mechanism of injury **("Tell me what happened"?):**

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 until cleared to do so by a medical professional. No athlete diagnosed with concussion should be returned to sports participation on the day of injury.

BACKGROUND

Name: Date:

Examiner:

Sport / team / school: Date / time of injury:

Age: Gender: M F

Years of education completed:

Dominant hand: right left neither

How many concussions do you think you have had in the past?

When was the most recent concussion?

How long was your recovery from the most recent concussion?

Have you ever been hospitalized or had medical imaging done for a head injury? Y N

Have you ever been diagnosed with headaches or migraines? Y N

Do you have a learning disability, dyslexia, ADD / ADHD? Y N

Have you ever been diagnosed with depression, anxiety or other psychiatric disorder? Y N

Has anyone in your family ever been diagnosed with any of these problems? Y N

Are you on any medications? If yes, please list: Y N

SCAT3 to be done in resting state. Best done 10 or more minutes post exercise.

3 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	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 (Maximum possible 132)

Do the symptoms get worse with physical activity? Y N

Do the symptoms get worse with mental activity? Y N

self rated self rated and clinician monitored

clinician interview self rated with parent input

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* *N/A*

Scoring on the SCAT3 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. Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.

4 Cognitive assessment

Standardized Assessment of Concussion (SAC)[4]

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

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 total of 15

Concentration: Digits Backward

List	Trial 1		Alternative digit list		
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
Total					

Concentration: Month in Reverse Order (1 pt. for entire sequence correct)

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

Concentration score of 5

5 Neck examination

Range of motion Tenderness Upper and lower limb sensation & strength

Findings:

6 Balance examination

Do one or both of the following tests.
Footwear (shoes, barefoot, braces, tape, etc.)

Modified Balance Error Scoring System (BESS) testing[5]

Which foot was tested (i.e. which is the non-dominant foot) L R

Testing surface (hard floor, field, etc.)

Condition

Double leg stance: Errors

Single leg stance (non-dominant foot): Errors

Tandem stance (non-dominant foot at back): Errors

And / Or

Tandem gait[6,7]

Time (best of 4 trials):

7 Coordination examination

Upper limb coordination

Which arm was tested: L R

Coordination score of 1

8 SAC Delayed Recall[4]

Delayed recall score of 5

INSTRUCTIONS

Words in *Italics* throughout the SCAT3 are the instructions given to the athlete by the tester.

Symptom Scale

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

To be completed by the athlete. In situations where the symptom scale is being completed after exercise, it should still be done in a resting state, at least 10 minutes post exercise.
For total number of symptoms, maximum possible is 22.
For Symptom severity score, add all scores in table, maximum possible is 22 x 6 = 132.

SAC[4]

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.

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.

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

Delayed Recall

The delayed recall should be performed after completion of the Balance and Coordination Examination.

"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."

Score 1 pt. for each correct response

Balance Examination

Modified Balance Error Scoring System (BESS) testing[5]

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[6]. A stopwatch or watch with a second hand is required for this testing.

(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.

OPTION: For further assessment, the same 3 stances can be performed on a surface of medium density foam (e.g., approximately 50 cm x 40 cm x 6 cm).

Tandem Gait[6,7]

Participants are instructed to stand with their feet together behind a starting line (the test is best done with footwear removed). Then, they walk in a forward direction as quickly and as accurately as possible along a 38mm wide (sports tape), 3 meter line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they cross the end of the 3m line, they turn 180 degrees and return to the starting point using the same gait. A total of 4 trials are done and the best time is retained. Athletes should complete the test in 14 seconds. Athletes fail the test if they step off the line, have a separation between their heel and toe, or if they touch or grab the examiner or an object. In this case, the time is not recorded and the trial repeated, if appropriate.

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), pointing in front of you. 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, and then return to the starting position, as quickly and as accurately as possible."

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.

References & Footnotes

1. This tool has been developed by a group of international experts at the 4th International Consensus meeting on Concussion in Sport held in Zurich, Switzerland in November 2012. The full details of the conference outcomes and the authors of the tool are published in The BJSM Injury Prevention and Health Protection, 2013, Volume 47, Issue 5. The outcome paper will also be simultaneously co-published in other leading biomedical journals with the copyright held by the Concussion in Sport Group, to allow unrestricted distribution, providing no alterations are made.
2. McCrory P et al., Consensus Statement on Concussion in Sport – the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. British Journal of Sports Medicine 2009; 43: i76-89.
3. Maddocks, DL; Dicker, GD; Saling, MM . The assessment of orientation following concussion in athletes. Clinical Journal of Sport Medicine. 1995; 5(1): 32 – 3.
4. McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sport Medicine. 2001; 11: 176 – 181.
5. Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003; 2: 24 – 30.
6. Schneiders, A.G., Sullivan, S.J., Gray, A., Hammond-Tooke, G. & McCrory, P. Normative values for 16-37 year old subjects for three clinical measures of motor performance used in the assessment of sports concussions. Journal of Science and Medicine in Sport. 2010; 13(2): 196 – 201.
7. Schneiders, A.G., Sullivan, S.J., Kvarnstrom. J.K., Olsson, M., Yden. T. & Marshall, S.W. The effect of footwear and sports-surface on dynamic neurological screening in sport-related concussion. Journal of Science and Medicine in Sport. 2010; 13(4): 382 – 386.

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. The athlete should not be left alone and must go to a hospital at once if they:

- Have a headache that gets worse
- Are very drowsy or can't be awakened
- 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 their 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 be **medically cleared and then follow a stepwise supervised program**, with stages of progression.

For example:

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
No activity	Physical and cognitive rest	Recovery
Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity, 70 % maximum predicted heart rate. No resistance training	Increase heart rate
Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
Non-contact training drills	Progression to more complex training drills, eg passing drills in football and ice hockey. May start progressive resistance training	Exercise, coordination, and cognitive load
Full contact practice	Following medical clearance participate in normal training activities	Restore confidence and assess functional skills by coaching staff
Return to play	Normal game play	

There should be at least 24 hours (or longer) for each stage and if symptoms recur the athlete should rest until they resolve once again and then resume the program at the previous asymptomatic stage. Resistance training should only be added in the later stages.

If the athlete is symptomatic for more than 10 days, then consultation by a medical practitioner who is expert in the management of concussion, is recommended.

Medical clearance should be given before return to play.

Scoring Summary:

Test Domain	Score		
	Date:	Date:	Date:
Number of Symptoms of 22			
Symptom Severity Score of 132			
Orientation of 5			
Immediate Memory of 15			
Concentration of 5			
Delayed Recall of 5			
SAC Total			
BESS (total errors)			
Tandem Gait (seconds)			
Coordination of 1			

Notes:

CONCUSSION INJURY ADVICE

(To be given to the person monitoring the 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. Recovery time is variable across individuals and 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 contact your doctor or the nearest hospital emergency department immediately.

Other important points:

- Rest (physically and mentally), including training or playing sports until symptoms resolve and you are medically cleared
- No alcohol
- No prescription or non-prescription drugs without medical supervision. Specifically:
  - No sleeping tablets
  - Do not use aspirin, anti-inflammatory medication or sedating pain killers
- Do not drive until medically cleared
- Do not train or play sport until medically cleared

Clinic phone number

Patient's name

Date / time of injury

Date / time of medical review

Treating physician

Contact details or stamp

SCAT5©

SPORT CONCUSSION ASSESSMENT TOOL – 5TH EDITION

DEVELOPED BY THE CONCUSSION IN SPORT GROUP
FOR USE BY MEDICAL PROFESSIONALS ONLY

supported by

Patient details

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date of Injury: _____ Time: _____

WHAT IS THE SCAT5?

The SCAT5 is a standardized tool for evaluating concussions designed for use by physicians and licensed healthcare professionals[1]. The SCAT5 cannot be performed correctly in less than 10 minutes.

If you are not a physician or licensed healthcare professional, please use the Concussion Recognition Tool 5 (CRT5). The SCAT5 is to be used for evaluating athletes aged 13 years and older. For children aged 12 years or younger, please use the Child SCAT5.

Preseason SCAT5 baseline testing can be useful for interpreting post-injury test scores, but is not required for that purpose.Detailed instructions for use of the SCAT5 are provided on page 7. Please read through these instructions carefully before testing the athlete. Brief verbal instructions for each test are given in italics. The only equipment required for the tester is a watch or timer.

Recognise and Remove

A head impact by either a direct blow or indirect transmission of force can be associated with a serious and potentially fatal brain injury. If there are significant concerns, including any of the red flags listed in Box 1, then activation of emergency procedures and urgent transport to the nearest hospital should be arranged.

Key points

- Any athlete with suspected concussion should be REMOVED FROM PLAY, medically assessed and monitored for deterioration. No athlete diagnosed with concussion should be returned to play on the day of injury.
- If an athlete is suspected of having a concussion and medical personnel are not immediately available, the athlete should be referred to a medical facility for urgent assessment.
- Athletes with suspected concussion should not drink alcohol, use recreational drugs and should not drive a motor vehicle until cleared to do so by a medical professional.
- Concussion signs and symptoms evolve over time and it is important to consider repeat evaluation in the assessment of concussion.
- The diagnosis of a concussion is a clinical judgment, made by a medical professional. The SCAT5 should NOT be used by itself to make, or exclude, the diagnosis of concussion. An athlete may have a concussion even if their SCAT5 is "normal".

Remember:

- The basic principles of first aid (danger, response, airway, breathing, circulation) should be followed.
- Do not attempt to move the athlete (other than that required for airway management) unless trained to do so.
- Assessment for a spinal cord injury is a critical part of the initial on-field assessment.
- Do not remove a helmet or any other equipment unless trained to do so safely.

1

IMMEDIATE OR ON-FIELD ASSESSMENT

The following elements should be assessed for all athletes who are suspected of having a concussion prior to proceeding to the neurocognitive assessment and ideally should be done on-field after the first first aid / emergency care priorities are completed.

If any of the "Red Flags" or observable signs are noted after a direct or indirect blow to the head, the athlete should be immediately and safely removed from participation and evaluated by a physician or licensed healthcare professional.

Consideration of transportation to a medical facility should be at the discretion of the physician or licensed healthcare professional.

The GCS is important as a standard measure for all patients and can be done serially if necessary in the event of deterioration in conscious state. The Maddocks questions and cervical spine exam are critical steps of the immediate assessment; however, these do not need to be done serially.

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

STEP 1: RED FLAGS

RED FLAGS:

- Neck pain or tenderness
- Double vision
- Weakness or tingling/ burning in arms or legs
- Severe or increasing headache
- Seizure or convulsion
- Loss of consciousness
- Deteriorating conscious state
- Vomiting
- Increasingly restless, agitated or combative

STEP 2: OBSERVABLE SIGNS

Witnessed ☐ Observed on Video ☐

Lying motionless on the playing surface	Y	N
Balance / gait difficulties / motor incoordination: stumbling, slow / laboured movements	Y	N
Disorientation or confusion, or an inability to respond appropriately to questions	Y	N
Blank or vacant look	Y	N
Facial injury after head trauma	Y	N

STEP 3: MEMORY ASSESSMENT MADDOCKS QUESTIONS[2]

"I am going to ask you a few questions, please listen carefully and give your best effort. First, tell me what happened?"

_____

_____

Mark Y for correct answer / N for incorrect

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

Note: Appropriate sport-specific questions may be substituted.

STEP 4: EXAMINATION GLASGOW COMA SCALE (GCS)[3]

Time of assessment			
Date of assessment			
Best eye response (E)			
No eye opening	1	1	1
Eye opening in response to pain	2	2	2
Eye opening to speech	3	3	3
Eyes opening spontaneously	4	4	4
Best verbal response (V)			
No verbal response	1	1	1
Incomprehensible sounds	2	2	2
Inappropriate words	3	3	3
Confused	4	4	4
Oriented	5	5	5
Best motor response (M)			
No motor response	1	1	1
Extension to pain	2	2	2
Abnormal flexion to pain	3	3	3
Flexion / Withdrawal to pain	4	4	4
Localizes to pain	5	5	5
Obeys commands	6	6	6
Glasgow Coma score (E + V + M)			

CERVICAL SPINE ASSESSMENT

Does the athlete report that their neck is pain free at rest?	Y	N
If there is NO neck pain at rest, does the athlete have a full range of ACTIVE pain free movement?	Y	N
Is the limb strength and sensation normal?	Y	N

In a patient who is not lucid or fully conscious, a cervical spine injury should be assumed until proven otherwise.

Davis GA, *et al. Br J Sports Med* 2017;**0**:1–8. doi:10.1136/bjsports-2017-097506SCAT5

OFFICE OR OFF-FIELD ASSESSMENT

Please note that the neurocognitive assessment should be done in a distraction-free environment with the athlete in a resting state.

STEP 1: ATHLETE BACKGROUND

Sport / team / school: _____

Date / time of injury: _____

Years of education completed: _____

Age: _____

Gender: M / F / Other

Dominant hand: left / neither / right

How many diagnosed concussions has the athlete had in the past?: _____

When was the most recent concussion?: _____

How long was the recovery (time to being cleared to play) from the most recent concussion?: _____ (days)

Has the athlete ever been:

Hospitalized for a head injury?	Yes	No
Diagnosed / treated for headache disorder or migraines?	Yes	No
Diagnosed with a learning disability / dyslexia?	Yes	No
Diagnosed with ADD / ADHD?	Yes	No
Diagnosed with depression, anxiety or other psychiatric disorder?	Yes	No

Current medications? If yes, please list:

_____

_____

_____

_____

_____

_____

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

2

STEP 2: SYMPTOM EVALUATION

The athlete should be given the symptom form and asked to read this instruction paragraph out loud then complete the symptom scale. For the baseline assessment, the athlete should rate his/her symptoms based on how he/she typically feels and for the post injury assessment the athlete should rate their symptoms at this point in time.

Please Check: ☐ **Baseline** ☐ **Post-Injury**

Please hand the form to the athlete

	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
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
Trouble falling asleep (if applicable)	0	1	2	3	4	5	6
Total number of symptoms:							of 22
Symptom severity score:							of 132
Do your symptoms get worse with physical activity?						Y	N
Do your symptoms get worse with mental activity?						Y	N
If 100% is feeling perfectly normal, what percent of normal do you feel?							

If not 100%, why?

_____

_____

_____

Please hand form back to examiner

3

STEP 3: COGNITIVE SCREENING

Standardised Assessment of Concussion (SAC)[4]

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

ORIENTATION

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

The Immediate Memory component can be completed using the traditional 5-word per trial list or optionally using 10-words per trial to minimise any ceiling effect. All 3 trials must be administered irrespective of the number correct on the first trial. Administer at the rate of one word per second.

Please choose EITHER the 5 or 10 word list groups and circle the specific word list chosen for this test.

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. For 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.

List	Alternate 5 word lists					Score (of 5) Trial 1	Trial 2	Trial 3
A	Finger	Penny	Blanket	Lemon	Insect			
B	Candle	Paper	Sugar	Sandwich	Wagon			
C	Baby	Monkey	Perfume	Sunset	Iron			
D	Elbow	Apple	Carpet	Saddle	Bubble			
E	Jacket	Arrow	Pepper	Cotton	Movie			
F	Dollar	Honey	Mirror	Saddle	Anchor			
					Immediate Memory Score			of 15
					Time that last trial was completed			

List	Alternate 10 word lists					Score (of 10) Trial 1	Trial 2	Trial 3
G	Finger Candle	Penny Paper	Blanket Sugar	Lemon Sandwich	Insect Wagon			
H	Baby Elbow	Monkey Apple	Perfume Carpet	Sunset Saddle	Iron Bubble			
I	Jacket Dollar	Arrow Honey	Pepper Mirror	Cotton Saddle	Movie Anchor			
					Immediate Memory Score			of 30
					Time that last trial was completed			

CONCENTRATION

DIGITS BACKWARDS

Please circle the Digit list chosen (A, B, C, D, E, F). Administer at the rate of one digit per second reading DOWN the selected column.

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

Concentration Number Lists (circle one)

List A	List B	List C			
4-9-3	5-2-6	1-4-2	Y	N	0
6-2-9	4-1-5	6-5-8	Y	N	1
3-8-1-4	1-7-9-5	6-8-3-1	Y	N	0
3-2-7-9	4-9-6-8	3-4-8-1	Y	N	1
6-2-9-7-1	4-8-5-2-7	4-9-1-5-3	Y	N	0
1-5-2-8-6	6-1-8-4-3	6-8-2-5-1	Y	N	1
7-1-8-4-6-2	8-3-1-9-6-4	3-7-6-5-1-9	Y	N	0
5-3-9-1-4-8	7-2-4-8-5-6	9-2-6-5-1-4	Y	N	1
List D	**List E**	**List F**			
7-8-2	3-8-2	2-7-1	Y	N	0
9-2-6	5-1-8	4-7-9	Y	N	1
4-1-8-3	2-7-9-3	1-6-8-3	Y	N	0
9-7-2-3	2-1-6-9	3-9-2-4	Y	N	1
1-7-9-2-6	4-1-8-6-9	2-4-7-5-8	Y	N	0
4-1-7-5-2	9-4-1-7-5	8-3-9-6-4	Y	N	1
2-6-4-8-1-7	6-9-7-3-8-2	5-8-6-2-4-9	Y	N	0
8-4-1-9-3-5	4-2-7-9-3-8	3-1-7-8-2-6	Y	N	1
		Digits Score:			of 4

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.

Dec - Nov - Oct - Sept - Aug - Jul - Jun - May - Apr - Mar - Feb - Jan	0 1
Months Score	of 1
Concentration Total Score (Digits + Months)	of 5

4

STEP 4: NEUROLOGICAL SCREEN

See the instruction sheet (page 7) for details of test administration and scoring of the tests.

Can the patient read aloud (e.g. symptom check-list) and follow instructions without difficulty?	Y	N
Does the patient have a full range of pain-free PASSIVE cervical spine movement?	Y	N
Without moving their head or neck, can the patient look side-to-side and up-and-down without double vision?	Y	N
Can the patient perform the finger nose coordination test normally?	Y	N
Can the patient perform tandem gait normally?	Y	N

BALANCE EXAMINATION

Modified Balance Error Scoring System (mBESS) testing[5]

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

Testing surface (hard floor, field, etc.) _____

Footwear (shoes, barefoot, braces, tape, etc.) _____

Condition	Errors
Double leg stance	of 10
Single leg stance (non-dominant foot)	of 10
Tandem stance (non-dominant foot at the back)	of 10
Total Errors	of 30

Name: _____

DOB: _____

Address: _____

ID number: _____

Examiner: _____

Date: _____

5

STEP 5: DELAYED RECALL:

The delayed recall should be performed after 5 minutes have elapsed since the end of the Immediate Recall section. Score 1 pt. for each correct response.

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.

Time Started _____

Please record each word correctly recalled. Total score equals number of words recalled.

_____

_____

_____

Total number of words recalled accurately: _____ of 5 or _____ of 10

6

STEP 6: DECISION

	Date & time of assessment:		
Domain			
Symptom number (of 22)			
Symptom severity score (of 132)			
Orientation (of 5)			
Immediate memory	of 15 of 30	of 15 of 30	of 15 of 30
Concentration (of 5)			
Neuro exam	Normal Abnormal	Normal Abnormal	Normal Abnormal
Balance errors (of 30)			
Delayed Recall	of 5 of 10	of 5 of 10	of 5 of 10

Date and time of injury: _____

If the athlete is known to you prior to their injury, are they different from their usual self?
☐ **Yes** ☐ **No** ☐ **Unsure** ☐ **Not Applicable**
(If different, describe why in the clinical notes section)

Concussion Diagnosed?
☐ **Yes** ☐ **No** ☐ **Unsure** ☐ **Not Applicable**

If re-testing, has the athlete improved?
☐ **Yes** ☐ **No** ☐ **Unsure** ☐ **Not Applicable**

I am a physician or licensed healthcare professional and I have personally administered or supervised the administration of this SCAT5.

Signature: _____

Name: _____

Title: _____

Registration number (if applicable): _____

Date: _____

SCORING ON THE SCAT5 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.

Davis GA, *et al. Br J Sports Med* 2017;**0**:1–8. doi:10.1136/bjsports-2017-097506SCAT5

CLINICAL NOTES:

Name: _____
DOB: _____
Address: _____
ID number: _____
Examiner: _____
Date: _____

CONCUSSION INJURY ADVICE

(To be given to the person monitoring the 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. Recovery time is variable across individuals and 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, worsening headache, double vision or excessive drowsiness, please telephone your doctor or the nearest hospital emergency department immediately.

Other important points:

Initial rest: Limit physical activity to routine daily activities (avoid exercise, training, sports) and limit activities such as school, work, and screen time to a level that does not worsen symptoms.

1) Avoid alcohol

2) Avoid prescription or non-prescription drugs without medical supervision. Specifically:

   a) Avoid sleeping tablets

   b) Do not use aspirin, anti-inflammatory medication or stronger pain medications such as narcotics

3) Do not drive until cleared by a healthcare professional.

4) Return to play/sport requires clearance by a healthcare professional.

Clinic phone number: _____

Patient's name: _____

Date / time of injury: _____

Date / time of medical review: _____

Healthcare Provider: _____

Contact details or stamp

INSTRUCTIONS

Words in *Italics* throughout the SCAT5 are the instructions given to the athlete by the clinician

Symptom Scale

The time frame for symptoms should be based on the type of test being administered. At baseline it is advantageous to assess how an athlete "typically" feels whereas during the acute/post-acute stage it is best to ask how the athlete feels at the time of testing.

The symptom scale should be completed by the athlete, not by the examiner. In situations where the symptom scale is being completed after exercise, it should be done in a resting state, generally by approximating his/her resting heart rate.

For total number of symptoms, maximum possible is 22 except immediately post injury, if sleep item is omitted, which then creates a maximum of 21.

For Symptom severity score, add all scores in table, maximum possible is 22 x 6 = 132, except immediately post injury if sleep item is omitted, which then creates a maximum of 21x6=126.

Immediate Memory

The Immediate Memory component can be completed using the traditional 5-word per trial list or, optionally, using 10-words per trial. The literature suggests that the Immediate Memory has a notable ceiling effect when a 5-word list is used. In settings where this ceiling is prominent, the examiner may wish to make the task more difficult by incorporating two 5–word groups for a total of 10 words per trial. In this case, the maximum score per trial is 10 with a total trial maximum of 30.

Choose one of the word lists (either 5 or 10). Then perform 3 trials of immediate memory using this list.

Complete all 3 trials regardless of score on previous trials.

"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." The words must be read at a rate of one word per second.

Trials 2 & 3 MUST be completed regardless of score on trial 1 & 2.

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."

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.

Concentration

Digits backward

Choose one column of digits from lists A, B, C, D, E or F and administer those digits as follows:

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

Begin with first 3 digit string.

If correct, circle "Y" for correct and go to next string length. If incorrect, circle "N" for the first string length and read trial 2 in the same string length. One point possible for each string length. Stop after incorrect on both trials (2 N's) in a string length. The digits should be read at the rate of one per second.

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

Delayed Recall

The delayed recall should be performed after 5 minutes have elapsed since the end of the Immediate Recall section.

"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."

Score 1 pt. for each correct response

Modified Balance Error Scoring System (mBESS)[5] testing

This balance testing is based on a modified version of the Balance Error Scoring System (BESS)[5]. A timing device is required for this testing.

Each of 20-second trial/stance is scored by counting the number of errors. The examiner will begin counting errors only after the athlete 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 number of errors for any single condition is 10. If the 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 the athlete is set. Athletes 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.

OPTION: For further assessment, the same 3 stances can be performed on a surface of medium density foam (e.g., approximately 50cm x 40cm x 6cm).

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

"I am now going to test your balance. Please take your shoes off (if applicable), 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."

Tandem Gait

Participants are instructed to stand with their feet together behind a starting line (the test is best done with footwear removed). Then, they walk in a forward direction as quickly and as accurately as possible along a 38mm wide (sports tape), 3 metre line with an alternate foot heel-to-toe gait ensuring that they approximate their heel and toe on each step. Once they cross the end of the 3m line, they turn 180 degrees and return to the starting point using the same gait. Athletes fail the test if they step off the line, have a separation between their heel and toe, or if they touch or grab the examiner or an object.

Finger to Nose

"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), pointing in front of you. 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, and then return to the starting position, as quickly and as accurately as possible."

References

1. McCrory et al. Consensus Statement On Concussion In Sport – The 5th International Conference On Concussion In Sport Held In Berlin, October 2016. British Journal of Sports Medicine 2017 (available at www.bjsm.bmj.com)
2. Maddocks, DL; Dicker, GD; Saling, MM. The assessment of orientation following concussion in athletes. Clinical Journal of Sport Medicine 1995; 5: 32-33
3. Jennett, B., Bond, M. Assessment of outcome after severe brain damage: a practical scale. Lancet 1975; i: 480-484
4. McCrea M. Standardized mental status testing of acute concussion. Clinical Journal of Sport Medicine. 2001; 11: 176-181
5. Guskiewicz KM. Assessment of postural stability following sport-related concussion. Current Sports Medicine Reports. 2003; 2: 24-30

CONCUSSION INFORMATION

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

Signs to watch for

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

- Worsening headache
- Drowsiness or inability to be awakened
- Inability to recognize people or places
- Repeated vomiting
- Unusual behaviour or confusion or irritable
- Seizures (arms and legs jerk uncontrollably)
- Weakness or numbness in arms or legs
- Unsteadiness on their feet.
- Slurred speech

Consult your physician or licensed healthcare professional after a suspected concussion. Remember, it is better to be safe.

Rest & Rehabilitation

After a concussion, the athlete should have physical rest and relative cognitive rest for a few days to allow their symptoms to improve. In most cases, after no more than a few days of rest, the athlete should gradually increase their daily activity level as long as their symptoms do not worsen. Once the athlete is able to complete their usual daily activities without concussion-related symptoms, the second step of the return to play/sport progression can be started. The athlete should not return to play/sport until their concussion-related symptoms have resolved and the athlete has successfully returned to full school/learning activities.

When returning to play/sport, the athlete should follow a stepwise, **medically managed exercise progression, with increasing amounts of exercise.** For example:

Graduated Return to Sport Strategy

Exercise step	Functional exercise at each step	Goal of each step
1. Symptom-limited activity	Daily activities that do not provoke symptoms.	Gradual reintroduction of work/school activities.
2. Light aerobic exercise	Walking or stationary cycling at slow to medium pace. No resistance training.	Increase heart rate.
3. Sport-specific exercise	Running or skating drills. No head impact activities.	Add movement.
4. Non-contact training drills	Harder training drills, e.g., passing drills. May start progressive resistance training.	Exercise, coordination, and increased thinking.
5. Full contact practice	Following medical clearance, participate in normal training activities.	Restore confidence and assess functional skills by coaching staff.
6. Return to play/sport	Normal game play.	

In this example, it would be typical to have 24 hours (or longer) for each step of the progression. If any symptoms worsen while exercising, the athlete should go back to the previous step. Resistance training should be added only in the later stages (Stage 3 or 4 at the earliest).

Written clearance should be provided by a healthcare professional before return to play/sport as directed by local laws and regulations.

Graduated Return to School Strategy

Concussion may affect the ability to learn at school. The athlete may need to miss a few days of school after a concussion. When going back to school, some athletes may need to go back gradually and may need to have some changes made to their schedule so that concussion symptoms do not get worse. If a particular activity makes symptoms worse, then the athlete should stop that activity and rest until symptoms get better. To make sure that the athlete can get back to school without problems, it is important that the healthcare provider, parents, caregivers and teachers talk to each other so that everyone knows what the plan is for the athlete to go back to school.

Note: If mental activity does not cause any symptoms, the athlete may be able to skip step 2 and return to school part-time before doing school activities at home first.

Mental Activity	Activity at each step	Goal of each step
1. Daily activities that do not give the athlete symptoms	Typical activities that the athlete does during the day as long as they do not increase symptoms (e.g. reading, texting, screen time). Start with 5-15 minutes at a time and gradually build up.	Gradual return to typical activities.
2. School activities	Homework, reading or other cognitive activities outside of the classroom.	Increase tolerance to cognitive work.
3. Return to school part-time	Gradual introduction of school-work. May need to start with a partial school day or with increased breaks during the day.	Increase academic activities.
4. Return to school full-time	Gradually progress school activities until a full day can be tolerated.	Return to full academic activities and catch up on missed work.

If the athlete continues to have symptoms with mental activity, some other accomodations that can help with return to school may include:

- Starting school later, only going for half days, or going only to certain classes
- More time to finish assignments/tests
- Quiet room to finish assignments/tests
- Not going to noisy areas like the cafeteria, assembly halls, sporting events, music class, shop class, etc.
- Taking lots of breaks during class, homework, tests
- No more than one exam/day
- Shorter assignments
- Repetition/memory cues
- Use of a student helper/tutor
- Reassurance from teachers that the child will be supported while getting better

The athlete should not go back to sports until they are back to school/learning, without symptoms getting significantly worse and no longer needing any changes to their schedule.

Sport concussion assessment tool - 5th edition

Br J Sports Med published online April 26, 2017

APPENDIX I

VESTIBULAR-OCULAR MOTOR SCREENING TOOL

Vestibular/Ocular-Motor Screening (VOMS) for Concussion

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2:_____ Measure 3:_____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

(Mucha A, Collins MW, Elbin RJ, Furman JM, Troutman-Enseki C, DeWolf RM, Marchetti G, Kontos AP. A brief vestibular and ocular motor screening (VOMS) assessment to evaluate preliminary concussion: Preliminary findings. Am J Sports Med; in press)

Instructions:

Interpretation: This test is designed for use with subjects ages 9-40. When used with patients outside this age range, interpretation may vary. Abnormal findings or provocation of symptoms with any test may indicate dysfunction – and should trigger a referral to the appropriate health care professional for more detailed assessment and management.

Equipment: Tape measure (cm); Metronome; Target w/ 14 point font print.
Baseline Symptoms – Record: Headache, Dizziness, Nausea & Fogginess on 0-10 scale prior to beginning screening

- Smooth Pursuits - Test the ability to follow a slowly moving target. The patient and the examiner are seated. The examiner holds a fingertip at a distance of 3 ft. from the patient. The patient is instructed to maintain focus on the target as the examiner moves the target smoothly in the horizontal direction 1.5 ft. to the right and 1.5 ft. to the left of midline. One repetition is complete when the target moves back and forth to the starting position, and 2 repetitions are performed. The target should be moved at a rate requiring approximately 2 seconds to go fully from left to right and 2 seconds to go fully from right to left. The test is repeated with the examiner moving the target smoothly and slowly in the vertical direction 1.5 ft. above and 1.5 ft. below midline for 2 complete repetitions up and down. Again, the target should be moved at a rate requiring approximately 2 seconds to move the eyes fully upward and 2 seconds to move fully downward. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 1)
- • Saccades – Test the ability of the eyes to move quickly between targets. The patient and the examiner are seated.

• Horizontal Saccades: The examiner holds two single points (fingertips) horizontally at a distance of 3 ft. from the patient, and 1.5 ft. to the right and 1.5 ft. to the left of midline so that the patient must gaze 30 degrees to left and 30 degrees to the right. Instruct the patient to move their eyes as quickly as possible from point to point. One repetition is complete when the eyes move back

and forth to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 2)

• Vertical Saccades: Repeat the test with 2 points held vertically at a distance of 3 ft. from the patient, and 1.5 feet above and 1.5 feet below midline so that the patient must gaze 30 degrees upward and 30 degrees downward. Instruct the patient to move their eyes as quickly as possible from point to point. One repetition is complete when the eyes move up and down to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. (Figure 3)

- Convergence – Measure the ability to view a near target without double vision. The patient is seated and wearing corrective lenses (if needed). The examiner is seated front of the patient and observes their eye movement during this test. The patient focuses on a small target (approximately 14 point font size) at arm's length and slowly brings it toward the tip of their nose. The patient is instructed to stop moving the target when they see two distinct images or when the examiner observes an outward deviation of one eye. Blurring of the image is ignored. The distance in cm. between target and the tip of nose is measured and recorded. This is repeated a total of 3 times with measures recorded each time. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test. Abnormal: Near Point of convergence ≥ 6 cm from the tip of the nose. (Figure 4)
- Vestibular-Ocular Reflex (VOR) Test – Assess the ability to stabilize vision as the head moves. The patient and the examiner are seated. The examiner holds a target of approximately 14 point font size in front of the patient in midline at a distance of 3 ft.
    - Horizontal VOR Test: The patient is asked to rotate their head horizontally while maintaining focus on the target. The head is moved at an amplitude of 20 degrees to each side and a metronome is used to ensure the speed of rotation is maintained at 180 beats/minute (one beat in each direction). One repetition is complete when the head moves back and forth to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea and Fogginess ratings 10 sec after the test is completed. (Figure 5)
    - Vertical VOR Test: The test is repeated with the patient moving their head vertically. The head is moved in an amplitude of 20 degrees up and 20 degrees down and a metronome is used to ensure the speed of movement is maintained at 180 beats/minute (one beat in each direction). One repetition is complete when the head moves up and down to the starting position, and 10 repetitions are performed. Record: Headache, Dizziness, Nausea and Fogginess ratings after the test. (Figure 6)
- Visual Motion Sensitivity (VMS) Test – Test visual motion sensitivity and the ability to inhibit vestibular-induced eye movements using vision. The patient stands with feet shoulder width apart, facing a busy area of the clinic. The examiner stands next to and slightly behind the patient, so that the patient is guarded but the movement can be performed freely. The patient holds arm outstretched and focuses on their thumb. Maintaining focus on their thumb, the patient rotates, together as a unit, their head, eyes and trunk at an amplitude of 80 degrees to the right and 80 degrees to the left. A metronome is used to ensure the speed of rotation is maintained at 50 beats/min (one beat in each direction). One repetition is complete when the trunk rotates back and forth to the starting position, and 5 repetitions are performed. Record: Headache, Dizziness, Nausea & Fogginess ratings after the test.

APPENDIX J

POWERPOINT PRESENTATION TO SUNRISE KIDS CARE CLINIC

Sports-Related Concussions in Adolescents

Presented by Julie M. Greenwood
DNP Candidate
University of Northern Colorado

So Why This Presentation?

- Sports-related concussions in adolescent athletes are a significant health concern
- Confusion in practice: Evidence has shown that many providers are still practicing with outdated information that is not evidenced-based
- The literature has vastly changed, and keeping up with it can be difficult
- Detrimental consequences of concussions can include prolonged recovery and also second-impact syndrome
- Presentation of a guideline created in an effort to ensure each provider is practicing with consistent, evidenced based practices

Presentation Objectives

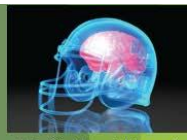
- 1. Review pathophysiology of concussions
- 2. Discuss the significance of concussions in adolescents
- 3. Present developed guideline aimed at improving consistency in practice and adherence to the latest evidenced-based practices
- 4. Discuss symptom management, return-to-play and return-to-learn

Concussion

- Concussion definition: "A clinical syndrome involving a disturbance in brain function that is generally time-limited and results from biomechanical forces, such as a bump, blow, or jolt to the ***head or body***" (Giza et al., 2013; Harmon et al., 2013; McCrory et al., 2013).

Butistaleroy.com

What Happens During a Concussion?

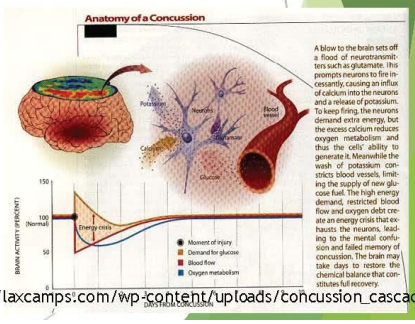


http://elitenutritionandperformance.com/concussions-athletes/

- Primary cause of concussions is: the velocity of the initial external force the brain experiences at the moment of the impact, followed by subsequent kinematic responses to the head
- The initial impact causes the brain to experience linear and rotational forces.
  - Rotational forces generate a shearing force
- The injury causes:
  - permeability of the plasma membrane, a
  - **neurometabolic cascade** and mismatch,
  - neurotransmitter release,
  - an increase in brain glucose uptake,
  - alteration in receptors and intracellular signaling,
  - changes in neuron responses,
  - and various oxidative injuries to the brain
    - (Graham et al., 2014; King et al., 2014; Meaney & Smith, 2011).

What Happens During a Concussion? (cont.)

- Neurometabolic cascade: ionic, metabolic, and pathophysiological events
- Mitochondrial Dysfunction
- Cerebral blood flow decreases
- Inflammatory response
- Increased susceptibility to serous injury if another injury occurs before symptom resolution from primary injury
- Ventricular system



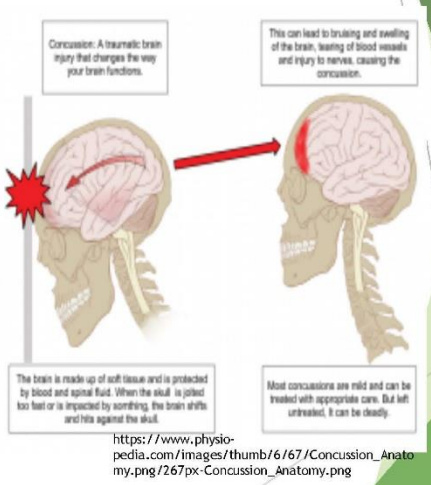
http://laxcamps.com/wp-content/uploads/concussion_cascade.jpg

Why Focus on Adolescents?

- Adolescent brain more susceptible to catastrophic injury after a concussion
- Lower auto regulation of blood flow and higher blood velocities (Grady et al., 2010)
  - Animal studies have demonstrated that the developing brain may be more susceptible to the "pathologic release of excitatory amino acid neurotransmitters (glutamine and aspartate) following trauma than adult brains" (Grady, 2010, p. 159)
- Believed that neurological maturation influences recovery time, and adolescents have been proven to take longer to heal from a concussion when compared to adults
  - Study showed more than half of students took longer than 1 week to heal, 10% took longer than 3 weeks, and others took longer than 6 months (Grady, 2010)
- Concussions damage the developing grey and the white matter
- Second-impact syndrome

Detrimental Consequence – Second Impact Syndrome

- Subsequent impact before complete symptom resolution can result in second impact syndrome
- Reported almost exclusively in teens, when subsequent impact to the head before symptom resolution of the first injury (Rivera et al., 2015)
- **Second-impact syndrome:** results in devastating consequences, including:
  - Collapse
  - Permanent neurological damage
  - Respiratory failure
  - Loss of consciousness
  - **Death**
- **Mortality up to 50%** (Reddy et al., 2008, p. 263)



https://www.physio-pedia.com/images/thumb/6/67/Concussion_Anatomy.png/267px-Concussion_Anatomy.png

Second Impact Syndrome- Jake Snakenberg Youth Sports Act

http://denver.cbslocal.com/tag/jake-snakenberg/

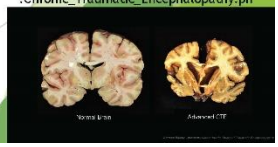
- In response to a high school football player who likely experienced second-impact syndrome
- Jake, who was freshman football player at Grandview High School in Aurora, CO, passed away after a typical hit during the game
- He had likely experienced a concussion the week prior, from which he did not recover
- He collapsed on the field and never regained consciousness
- The act Requires coaches to be educated on concussions, remove student athlete from play, and be cleared by a healthcare professional before returning to play (BIAC.org, 2017).
- Despite legislations, healthcare professionals are not required to receive training on concussions

Long-Term Effects of Concussions

http://www.raiznerlaw.com/blog/what-is-cte-and-how-can-it-be-diagnosed/

- Cumulative and permanent
- **Depression, mild cognitive impairment, prolonged recovery from subsequent concussions, electrophysiological changes, and chronic traumatic encephalopathy (CTE)**
- Post-traumatic headaches are extremely common
- **Risk of epilepsy doubles in the first five years after concussion**
- **Post-traumatic vertigo**
- Cranial nerve injuries
- **History of a concussion is associated a 2-5.8 times higher risk of sustaining another (Harmon et al., 2013)**
- Past concussion correlated with prolonged recovery time

https://en.wikipedia.org/wiki/Chronic_traumatic_encephalopathy#/media/File:Chronic_Traumatic_Encephalopathy.pn



Incidence of Concussions in Adolescents

- 3.8 million concussions occur during competitive sports each year (with approximately 50% of them going unreported)(Harmon et al., 2013)
- 1 in 10 high school sports injuries is a concussion (Rivera et al., 2015)
- Athletes between 10-19 years of age are at high risk
- Concussions are 2nd to road trauma in the US as the most common cause of brain injury in individuals between ages 15-24 yrs old (King et al., 2014)
- Colorado ranks 9th in nation in fatalities due to TBI and 13th in nation for hospitalizations due to TBI (Brain Injury Alliance Colorado, 2017)
- Cost:
  - In 2010, the cost of TBI in the U.S. was estimated to be $76.5 billion (CDC) (concussion is included in this figure)

Confusions in Practice and the Literature

- 3 studies evaluated and noted to have similarities and differences:
  - Zurich Consensus/4th International Concussion in Sports Group
  - CDC
  - American Academy of Neurology

Comparison of Concussion Guidelines

Zurich Consensus	CDC	AAN
Symptoms: 4 domains: somatic (headache), cognitive (feeling foggy), behavioral, and sleep disturbance (West & Marion, 2014)	**Symptoms:** physical (somatic), cognitive, emotional (affective), and sleep (Graham et al., 2014).	**Symptoms:** Symptoms discussed as risk factors for severe/prolonged impairments: headache, fatigue/fogginess, & dizziness (West & Marion, 2014).
Diagnostic/Evaluation tools: SCAT3 or SAC (for sideline and evaluation of progress)	**Diagnostic/Evaluation tools:** SAC, SCAT3, BESS, King-Devick Test, and/or Clinical Reaction Time (for screening) Endorse multiple tools Evaluation of progress: CSI and/or ACE each visit	**Diagnostic/Evaluation tools:** PCS, GSC, SAC, computerized and/or paper Neuropsychological testing, SOT, BESS. (Combination recommended)
Management: **Rest:** first 24-48 hrs Graduated Return-to-school protocol Graduated Return-to-play protocol → Must remain asymptomatic at each step for 24 hrs	**Management:** **Rest,** do not begin aggressive management until 2-4 weeks after injury Graduated Return-to-play protocol Gradually return to school, does not specify	**Management:** Returning to play determined by evaluating recovery w/ system checklists, neurocognitive testing, and balance testing (Giza et al., 2013). Progressive return to physical activity may be beneficial, but does not support specific recommendations (Giza et al., 2013). **Does not endorse absolute rest** Cognitive restructuring
Neuropsychological testing: to aid in return to play decisions	**Neuropsychological testing:** for diagnosis and evaluation of symptoms, but does not endorse	**Neuropsychological testing:** for diagnosis, when neuropsychologist can evaluate

How Primary Care Providers Can Help Adolescent Athletes- Concussion Guideline

- Understand concussions
- Recognize the signs and symptoms
- Utilize appropriate tools and evaluation techniques
- Manage appropriately
- Follow up appropriately
- Utilize referrals appropriately when needed
- Work together with school, family, and athletic team
- Pre-participation evaluation

Recognition of Concussion Signs and Symptoms

physical (somatic) signs and symptoms	Cognitive impairment	Behavioral (emotional) features	Sleep disturbances
• headache • fuzzy/ blurry vision • vomiting (early) • dizziness • visual problems • fatigue • sensitivity to light • sensitivity to noise • numbness/tingling • dazed, stunned look • balance problems • amnesia	• feeling mentally 'foggy' • difficulty remembering • difficulty thinking clearly • feeling slowed down • difficulty concentrating • forgetfulness, unable to remember recent dialogues • confusion • repeating questions • slowed responses/slowed reaction time	• irritability • sadness • feeling more emotional • nervousness and/or anxiety	• drowsiness • difficulty falling asleep • sleeping more than normal • sleeping less than normally

Recognition of Emergent Signs and Symptoms

****Red Flags: send to ER for neuroimaging if these red flags are present**

- Severe brain injury suspected
- Loss of consciousness
- Deteriorating mental status
- Potential spinal injury
- Increased confusion, vomiting, unequal pupils
- Glasgow Coma Scale < 15
- Worsening or new neurological signs

Evaluation of a Concussion
SCAT 3

- Use of multiple tools together increases the sensitivity and specificity for concussions (Graham et al., 2014)
- SCAT 3 components: background information, symptom evaluation, Cognitive assessment with Standardized assessment of Concussion (SAC), Neck Examination, Balance examination (mBESS), coordination examination, delayed recall (Graham et al., 2014; Rivera et al., 2015).
  - **Reliability is 54% to 94%, sensitivity is 83% to 96%, and specificity is 81% to 91%** (King et al., 2014; Sprouse et al., 2016).
- *Note: SCAT 5 was published in April, 2017, but normative data is limited since it is so new

Evaluation of a concussion
Evaluation and Diagnosis

- Use SCAT3 as a guide for diagnosis (SCAT 3 for adolescents >13 years old, child SCAT for 5-12 years old
- Gather background information of the incident including mechanism of action, what the individual remembers, if there was loss of consciousness
- Symptom evaluation/checklist
  - Use the SCAT3's symptom evaluation section which includes symptoms from each of the 4 domains
  - This section may be completed by the patient and/or parent prior to seeing the provider
- Note signs/symptoms for prolonged recovery: amnesia post-concussion and presence of feeling mentally 'foggy'
- Make special note of vestibular and oculomotor s/s: such as dizziness, benign paroxysmal positional vertigo, cervicogenic vertigo, visual stability disturbances such as diplopia, blurred vision, poor visual concentration, headaches, amnesia

Evaluation of a Concussion
Past Medical History

- Obtain thorough past medical history
- ****NOTE risk factors for prolonged history after concussion****
  - History of prior concussion
  - History of prematurely returning to sport with prior concussion
  - History of migraines
  - History of headaches
  - History of or presence of attention disorders - ADD/ADHD
  - History of or presence of mental health conditions - emotional labiality, depression, bipolar
  - Age: adolescents

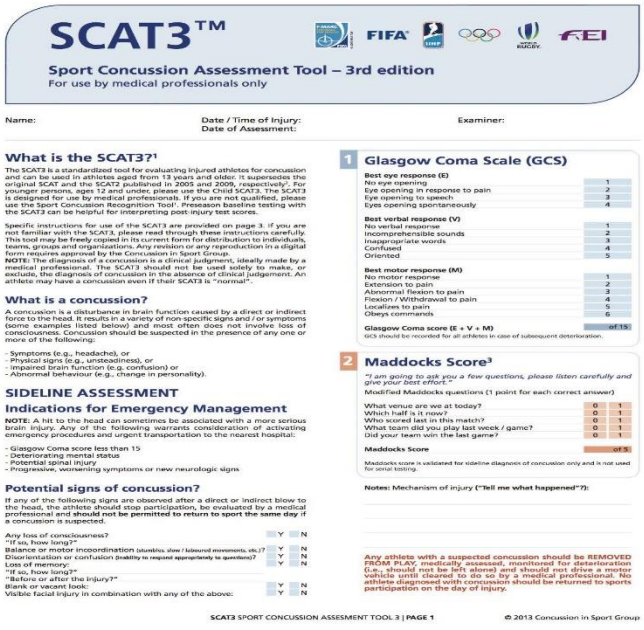
Evaluation of a Concussion
Past Social History

- School, grade level
- Typical school performance
- Sports/activities
- Substance use
- Alcohol use
- Caffeine intake
- Migraines
- Life stressors

Evaluation of a Concussion
Physical Exam (cont.)

- **Neuro Exam**
  - Examination of alertness, orientation
  - Assess muscular strength of upper and lower extremities
  - **Examination of Balance with the BESS (modified Balance Error Scoring System on SCAT)**
  - **Coordination: upper limb, finger-to-nose task, on SCAT**
  - **Delayed recall (on SCAT)**
  - **Assessment of Cranial Nerves**
    - EOM of eyes, assess for nystagmus
    - Facial symmetry
    - Assess numbness, tingling, weakness
    - Examination of cough/gag
    - Speech/language
- Vestibulo-ocular motor screening (VOMS):
  - Smooth pursuits
  - Horizontal and vertical saccades
  - Convergence
  - nystagmus
  - Vestibular-ocular reflex test (vertical and horizontal)
  - Visual Motion Sensitivity test
- Neuropsych testing:
  - With ImPACT if software is available, but not required
  - However testing does help guide diagnosis and evaluation throughout treatment
  - May be initiated by support staff, as long as interpreted by provider

SCAT 3



SCAT3™

Sport Concussion Assessment Tool – 3rd edition

For use by medical professionals only

Name: Date / Time of Injury: Date of Assessment: Examiner:

What is the SCAT3?[1]

The SCAT3 is a standardized tool for evaluating injured athletes for concussion and can be used in athletes aged from 13 years and older. It supersedes the original SCAT and the SCAT2 published in 2005 and 2009, respectively[2]. For younger persons, ages 12 and under, please use the Child SCAT3. The SCAT3 is designed for use by medical professionals. If you are not qualified, please use the Sport Concussion Recognition Tool[1]. Preseason baseline testing with the SCAT3 can be helpful for interpreting post-injury test scores.

Specific instructions for use of the SCAT3 are provided on page 3. If you are not familiar with the SCAT3, please read through these instructions carefully. This tool may be freely copied in its current form for distribution to individuals, teams, groups and organizations. Any revision or any reproduction in a digital form requires approval by the Concussion in Sport Group.

NOTE: The diagnosis of a concussion is a clinical judgment, ideally made by a medical professional. The SCAT3 should not be used solely to make, or exclude, the diagnosis of concussion in the absence of clinical judgement. An athlete may have a concussion even if their SCAT3 is "normal".

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 signs and / or symptoms (some examples listed below) and most often does not involve loss of consciousness. Concussion should be suspected in the presence of any one or more of the following:

- Symptoms (e.g., headache), or
- Physical signs (e.g., unsteadiness), or
- Impaired brain function (e.g. confusion) or
- Abnormal behaviour (e.g., change in personality).

SIDELINE ASSESSMENT

Indications for Emergency Management

NOTE: A hit to the head can sometimes be associated with a more serious brain injury. Any of the following warrants consideration of activating emergency procedures and urgent transportation to the nearest hospital:

- Glasgow Coma score less than 15
- Deteriorating mental status
- Potential spinal injury
- Progressive, worsening symptoms or new neurologic signs

Potential signs of concussion?

If any of the following signs are observed after a direct or indirect blow to the head, the athlete should stop participation, be evaluated by a medical professional and **should not be permitted to return to sport the same day** if a concussion is suspected.

Any loss of consciousness?	Y	N
"If so, how long?"		
Balance or motor incoordination (stumbles, slow / laboured movements, etc.)?	Y	N
Disorientation or confusion (inability to respond appropriately to questions)?	Y	N
Loss of memory:	Y	N
"If so, how long?"		
"Before or after the injury?"		
Blank or vacant look:	Y	N
Visible facial injury in combination with any of the above:	Y	N

1 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.

2 Maddocks Score[3]

"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)

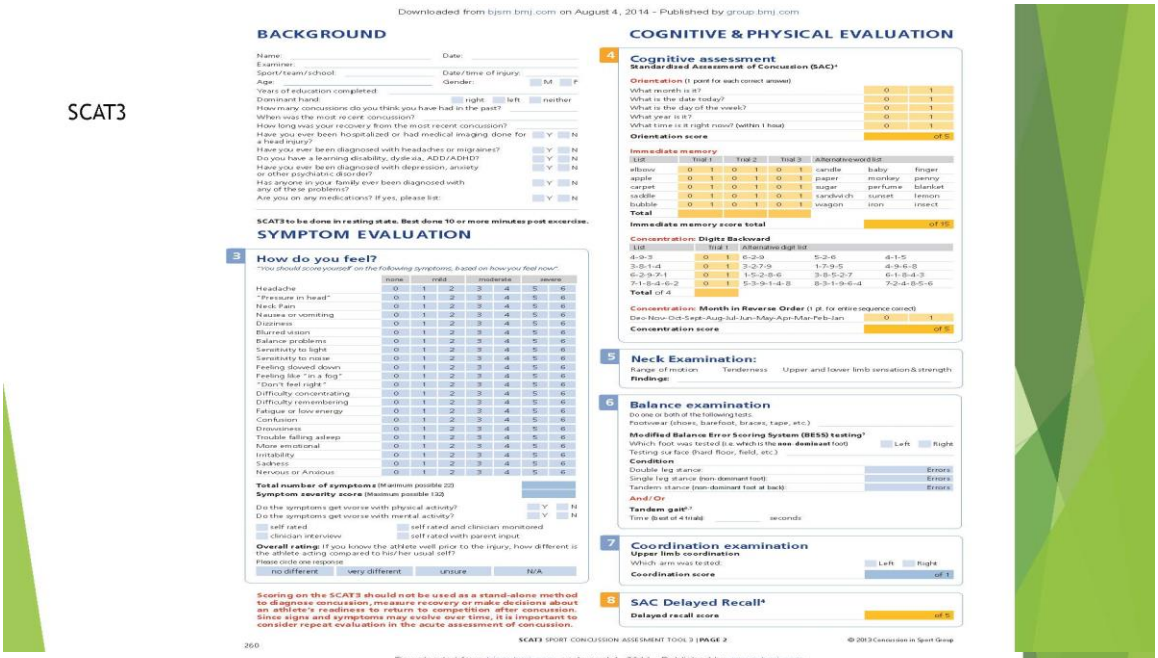
What venue are we at today?	0	1
Which half is it now?	0	1
Who scored last in this match?	0	1
What team did you play last week / game?	0	1
Did your team win the last game?	0	1
Maddocks Score		of 5

Maddocks score is validated for sideline diagnosis of concussion only and is not used for serial testing.

Notes: Mechanism of injury ("Tell me what happened"?):

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 until cleared to do so by a medical professional. No athlete diagnosed with concussion should be returned to sports participation on the day of injury.

SCAT3



BACKGROUND

Name: Date:
Examiner:
Sport/team/school: Date/time of injury:
Age: Gender: M F
Years of education completed:
Dominant hand: right left neither
How many concussions do you think you have had in the past?
When was the most recent concussion?
How long was your recovery from the most recent concussion?
Have you ever been hospitalized or had medical imaging done for a head injury? Y N
Have you ever been diagnosed with headaches or migraines? Y N
Do you have a learning disability, dyslexia, ADD/ADHD? Y N
Have you ever been diagnosed with depression, anxiety or other psychiatric disorder? Y N
Has anyone in your family ever been diagnosed with any of these problems? Y N
Are you on any medications? If yes, please list: Y N

SCAT3 to be done in resting state. Best done 10 or more minutes post exercise.

SYMPTOM EVALUATION

3 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 dowed 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	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 (Maximum possible 132)

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

self rated self rated and clinician monitored
clinician interview self rated with parent input

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	N/A

Scoring on the SCAT3 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. Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.

COGNITIVE & PHYSICAL EVALUATION

4 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

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 total of 15

Concentration: Digits Backward

List	Trial 1	Alternative digit list		
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
Total of 4				

Concentration: Month in Reverse Order (1 pt. for entire sequence correct)
Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan 0 1
Concentration score of 5

5 Neck Examination:

Range of motion Tenderness Upper and lower limb sensation & strength
Findings:

6 Balance examination

Do one or both of the following tests:
Footwear (shoes, bare foot, braces, tape, etc.)
Modified Balance Error Scoring System (BESS) testing*
Which foot was tested (i.e. which is the **non dominant** foot) Left Right
Testing surface (hard floor, field, etc.)
Condition
Double leg stance Errors
Single leg stance (non-dominant foot) Errors
Tandem stance (non-dominant foot at back) Errors

And/Or
Tandem gait*
Time (best of 4 trials) seconds

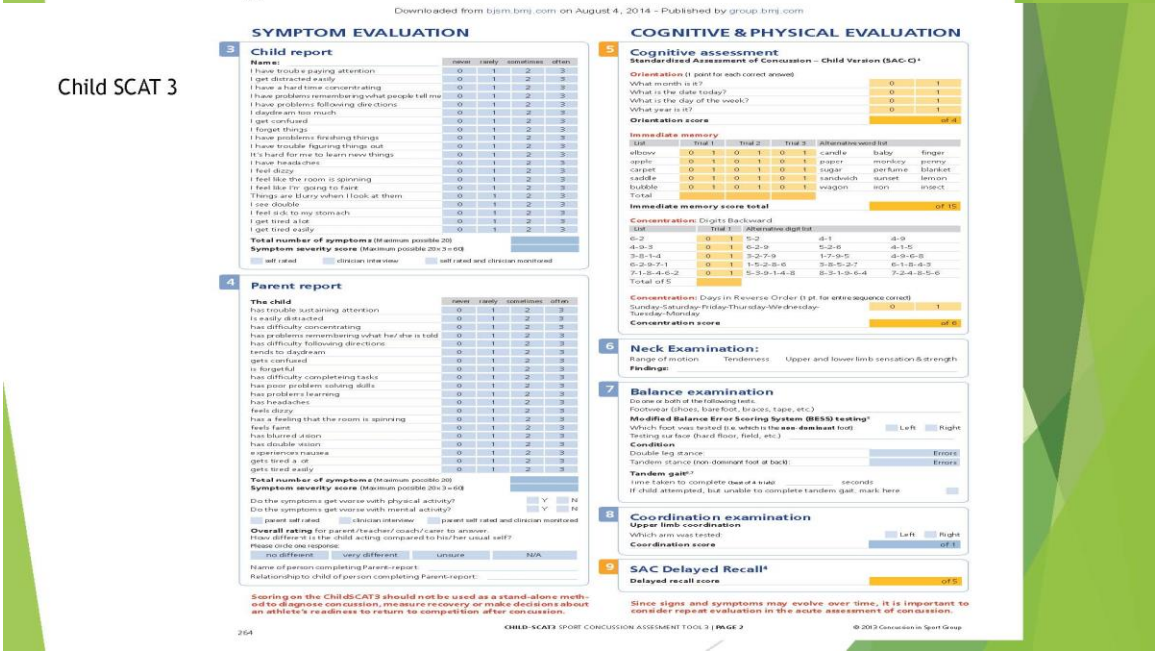
7 Coordination examination

Upper limb coordination
Which arm was tested: Left Right
Coordination score of 1

8 SAC Delayed Recall*

Delayed recall score of 5

Child SCAT 3



SYMPTOM EVALUATION

3 Child report

Name:

	never	rarely	sometimes	often
I have trouble paying attention	0	1	2	3
I get distracted easily	0	1	2	3
I have a hard time concentrating	0	1	2	3
I have problems remembering what people tell me	0	1	2	3
I have problems following directions	0	1	2	3
I daydream too much	0	1	2	3
I get confused	0	1	2	3
I forget things	0	1	2	3
I have problems finishing things	0	1	2	3
I have trouble figuring things out	0	1	2	3
It's hard for me to learn new things	0	1	2	3
I have headaches	0	1	2	3
I feel dizzy	0	1	2	3
I feel like the room is spinning	0	1	2	3
I feel like I'm going to faint	0	1	2	3
Things are blurry when I look at them	0	1	2	3
I see double	0	1	2	3
I feel sick to my stomach	0	1	2	3
I get tired a lot	0	1	2	3
I get tired easily	0	1	2	3

Total number of symptoms (Maximum possible 28)
Symptom severity score (Maximum possible 25 x 3 = 60)

self rated clinician interview self rated and clinician monitored

4 Parent report

The child	never	rarely	sometimes	often
has trouble sustaining attention	0	1	2	3
is easily distracted	0	1	2	3
has difficulty concentrating	0	1	2	3
has problems remembering what he/she is told	0	1	2	3
has difficulty following directions	0	1	2	3
tends to daydream	0	1	2	3
gets confused	0	1	2	3
is forgetful	0	1	2	3
has difficulty completing tasks	0	1	2	3
has poor problem solving skills	0	1	2	3
has problems learning	0	1	2	3
has headaches	0	1	2	3
feels dizzy	0	1	2	3
has a feeling that the room is spinning	0	1	2	3
feels faint	0	1	2	3
has blurred vision	0	1	2	3
has double vision	0	1	2	3
experiences nausea	0	1	2	3
gets tired a lot	0	1	2	3
gets tired easily	0	1	2	3

Total number of symptoms (Maximum possible 28)
Symptom severity score (Maximum possible 25 x 3 = 60)

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

parent self rated clinician interview parent self rated and clinician monitored

Overall rating for parent/teacher/coach/carer to answer
How different is the child acting compared to his/her usual self?
Please circle one response

no different	very different	unsure	N/A

Name of person completing Parent report:
Relationship to child of person completing Parent report:

Scoring on the ChildSCAT3 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.

COGNITIVE & PHYSICAL EVALUATION

5 Cognitive assessment

Standardized Assessment of Concussion – Child Version (SAC-C)*

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
Orientation score		of 4

Immediate memory

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 total of 15

Concentration: Digits Backward

List	Trial 1	Alternative digit list		
6-2	0 1	5-2	4-1	4-9
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
Total of 5				

Concentration: Days in Reverse Order (1 pt. for entire sequence correct)
Sunday-Saturday-Friday-Thursday-Wednesday-Tuesday-Monday 0 1
Concentration score of 6

6 Neck Examination:

Range of motion Tenderness Upper and lower limb sensation & strength
Findings:

7 Balance examination

Do one or both of the following tests:
Footwear (shoes, bare foot, braces, tape, etc.)
Modified Balance Error Scoring System (BESS) testing*
Which foot was tested (i.e. which is the **non-dominant** foot) Left Right
Testing surface (hard floor, field, etc.)
Condition
Double leg stance Errors
Tandem stance (non-dominant foot at back) Errors

Tandem gait*
Time taken to complete (**best of 4 trials**) seconds
If child attempted, but unable to complete tandem gait, mark here

8 Coordination examination

Upper limb coordination
Which arm was tested: Left Right
Coordination score of 1

9 SAC Delayed Recall*

Delayed recall score of 5

Since signs and symptoms may evolve over time, it is important to consider repeat evaluation in the acute assessment of concussion.

VOMS

- Smooth Pursuits
- Saccades
- Convergence
- Vestibular-Ocular Reflex (VOR) Test
- Visual Motion Sensitivity (VMS) Test

- https://youtube/PJLv5zdmEns

Vestibulo-ocular motor screening (VOMS)

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS: Smooth Pursuits	N/A					
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2: _____ Measure 3: _____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

https://www.impacttest.com/pdf/VOMSExam.pdf

(Mucha A, Collins MW, Elbin RJ, Furman JM, Troutman-Enseki C, DeWolf RM, Marchetti G, Kontos AP. A brief vestibular and ocular motor screening(VOMS) assessment to evaluate preliminary concussion: Preliminary findings. Am J Sports Med; in press).

Management of Sports-Related Concussion in Adolescents

- 1. **Initial management: REST**
  - Maximize physical and cognitive rest for first few days (around 72 hours)
    - No school, No screen time- no texting, no video games, no TV, No work, No driving
    - If individual has significant VOMS symptoms, then limit reading and writing during this time
- 2. **Next, recovery: INCREASE ACTIVITY** (as long as symptoms do not worsen)
  - No cardio yet
  - Light activity only such as reading, writing, watching TV, texting as tolerated
  - If significant VOMS no driving
  - If there is visual or auditory sensitivity in crowds, consider use of baseball cap and sunglasses to decrease stimulation

Management of Sports-Related Concussions in Adolescents

- 3. **Aerobic Activity:** increase activity to include aerobic activity **AFTER ONE week of limited activity**, as long as symptoms permit
  - Begin with 10-15 minutes/day; Max: up to 30 minutes per day/ 5 days a week
  - Evaluate symptoms frequently
  - No cardio if persistent symptoms, especially individuals with vestibular issues
  - Activity may ONLY be done at HOME and NEVER at school or sport until cleared by provider
  - Exercises that will not strain body: ie walking, stationary bike, light swimming as long as no significant VOMS symptoms, no weight lifting
- **Evaluate symptoms frequently:**
  - A few times per week, but not every day
  - Utilize specific checklist (post-concussion symptom scale)
  - Have parents, school nurse, or athletic trainer perform symptom checklists
- Follow up in the clinic once a week

Management of Sports-Related Concussion in Adolescents

Player's Name: _____ Team: _____ Position: _____

SYMPTOM	RATING None Mod. Severe	BASELINE Date:	TESTING 2 Date:	TESTING 3 Date:	TESTING 4 Date:	TESTING 5 Date:
Headache	0 1 2 3 4 5 6					
Nausea	0 1 2 3 4 5 6					
Vomiting	0 1 2 3 4 5 6					
Balance problems	0 1 2 3 4 5 6					
Dizziness	0 1 2 3 4 5 6					
Fatigue	0 1 2 3 4 5 6					
Trouble falling asleep	0 1 2 3 4 5 6					
Sleeping more than usual	0 1 2 3 4 5 6					
Sleeping less than usual	0 1 2 3 4 5 6					
Drowsiness	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					
Irritability	0 1 2 3 4 5 6					
Sadness	0 1 2 3 4 5 6					
Nervousness	0 1 2 3 4 5 6					
Feeling more emotional	0 1 2 3 4 5 6					
Numbness or tingling	0 1 2 3 4 5 6					
Feeling slowed down	0 1 2 3 4 5 6					
Feeling mentally "foggy"	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					
TOTAL SCORE						

Management of Sports-Related Concussions in Adolescents

- Symptom management:
  - Headache: Anti-inflammatory medication for <3 days
  - Nausea: antiemetic during first 1-2 days after concussion
  - Sensitivity to light/noise: dim, therapeutic environment; also baseball cap, sunglasses, ear plugs when out
  - Sleep disturbances: manage without medication, but instead sleep hygiene
  - Aerobic activity as discussed above
  - Emotional labiality/depression: Anti-depressant and/or cognitive therapy may be considered if symptoms continue past 6-12 weeks (this is prolonged course at this time)
  - Balance dysfunction/vertigo: referral to physical therapy and/or vestibular therapy

When to Refer for Therapy

- **Consider early**
- **PREFERABLY refer to physical therapist with vestibular therapy training (if unable to then refer to general physical therapist)**
- Consider referral to general physical therapy 1-week post-injury if the adolescent continues to have persistent symptoms (such as: severe headache, light-headedness, or neck pain)
- Consider referral to vestibular therapist 1-2-weeks post injury if persistent vestibular/oculomotor symptoms (such as: nausea, vertigo, nystagmus, dizziness
- Refer when persistent symptoms, and allow the therapist to oversee physical activity for recovery

Returning to School

- After initial 72 hour rest period, and once the adolescent can tolerate light cognitive demands for 30-45 minutes without significant symptoms
  - Return to school as symptoms improve, don't wait until completely symptom-free
  - Progress back as tolerated, may begin with half days initially and then increase to full days with adjustments
  - Ideally: the adolescent should be back to school with adjustments
    - May require more time for homework, testing, school work.
    - Work with school to provide adjustments for the student

Returning to Sports

- Athlete must complete Graduated Return to Play protocol ONLY once:
  - 1. completely FULLY functioning at school (without any adjustments),
  - 2. tolerating aerobic activity, and
  - 3. COMPLETELY SYMPTOM FREE

Graduated Return to Play Protocol

***Must be a MINIMUM of 24 HOURS BETWEEN EACH STAGE**
If symptoms worsen while progressing through protocol, adolescent must return to previous stage and remain asymptomatic for at least 24 hours

Rehabilitation Stage	Functional Exercise at Each Stage of Rehabilitation	Objective(s) of Each Stage
1. No activity	Symptom-limited physical and cognitive rest	Recover
2. Light aerobic exercise	Walking, swimming, or stationary cycling, keeping intensity <70% of maximum permitted heart rate; no resistance training	Increase heart rate
3. Sport specific exercise	Skating drills in ice hockey, running drills in soccer; no head-impact activities	Add movement
4. Noncontact training drills	Progression to more complex training drills in football and ice hockey; may start progressive resistance training	Exercise, coordination, and cognitive load
5. Full-contact practice	After medical clearance, participation in normal training activity	Restore confidence and assessment of functional skills by coaching staff
6. Return to play	Normal game play	Normal activity

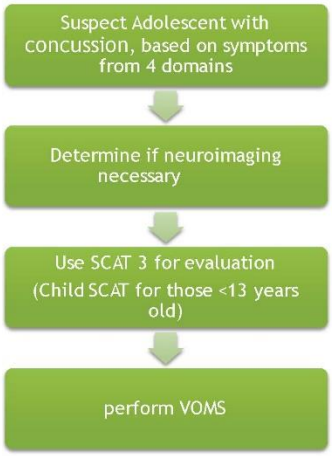
Example of a Specific Return-to-Play for Football

Stage	Activity	Football Specific Exercise	Objective of the Stage
1	No physical activity; Complete physical and cognitive rest	• No activity	• Recovery and elimination of symptoms
2	Light aerobic activity	10-15 min of walking at home or at field, or stationary bike	• Add light aerobic activity and monitor for symptom return
3	Moderate aerobic activity Light resistance training	• 20-30 min jogging w/helmet • Resistance training -body weight squats and push-ups 1 set of 10 reps each	• Increase aerobic activity and monitor for symptom return
4	Non-contact football-specific drills	Moving in/out 3-point stance, bear crawls through tunnel, tires, step over bags (vertical and lateral), QB/center exchange, QB drop backs, passing, break downs and plant, jump cuts, backpedaling, match the hips, up/downs *Start w/o helmet; progress to helmet and shoulder pads if symptom free	• Maximize aerobic activity • Accelerate to full speed with change of directions (cuts) • Introduce rotational head movements • Monitor for symptoms
5	Limited contact football drills	• Stage 4 workout in full pads • Hit/push pads then sled (focus on technique-head up, square up, stay low), step and hit, run and hit, leverage drill, punch drill	• Maximize aerobic activity • Add deceleration/rotational forces in controlled setting • Monitor for symptoms
6	Full contact practice (after medical clearance)	• Normal training activities	• Reassess for symptoms every 30 minutes throughout the practice • Monitor for symptoms
7	Return to play	Normal game play	Assess frequently Monitor for symptoms Consider one side of the ball only, no special teams play

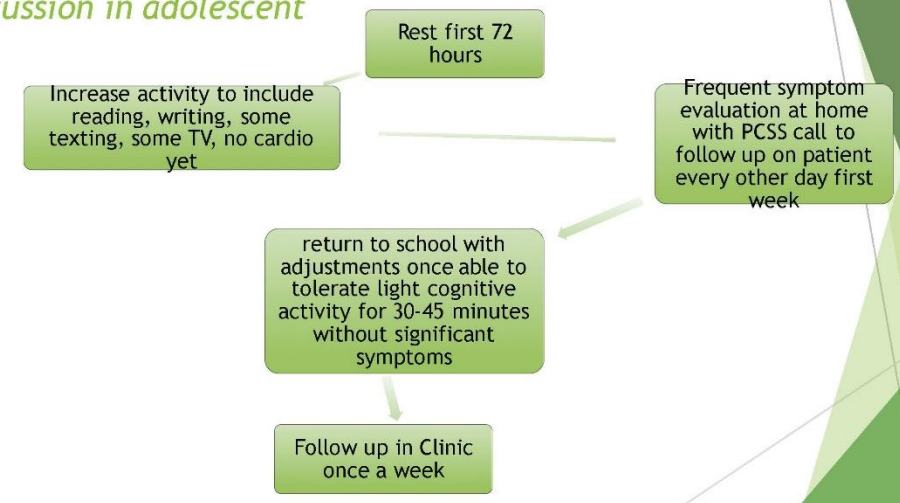
Pre-participation evaluation

- Perform at sports-physical clearance or yearly well-child check
- Evaluate history of concussions, mood, learning, attention, migraine disorders
- Discuss importance of recognizing signs and symptoms of a concussion
- Baseline neurocognitive testing with SCAT3 or ImPACT testing. Can be used for comparison if concussion experienced during sport

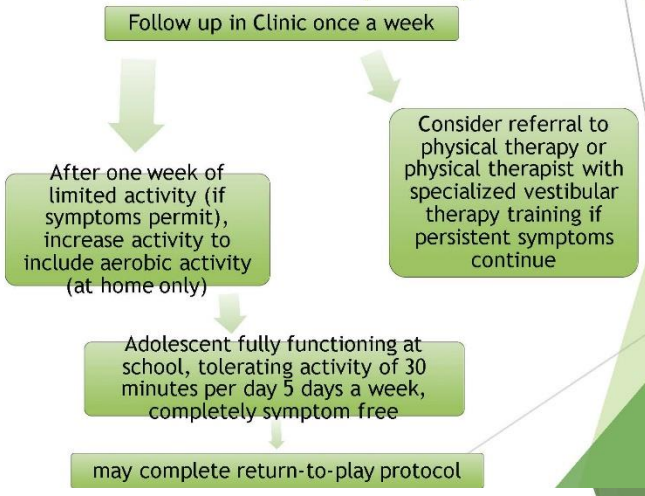
Summiting it all up:
Suggested Algorithm for Evaluation of Concussion in Adolescent



Summing it all up:
Suggested Algorithm for management of diagnosed concussion in adolescent



Summing it all up:
Suggested Algorithm for management of diagnosed concussion in adolescent (cont.)



Questions??

Thank you!

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APPENDIX K

PRE- AND POST-TEST QUESTIONS

1. A concussion can only occur with a direct blow to the head: True/ False
2. Concussion signs and symptoms are rather easy to distinguish: True/False
3. What are the 4 domains of concussion signs and symptoms?

   _____ _____ _____ _____

4. The most common symptom after a concussion is: (a) headache (b) confusion (c) amnesia (d) irritability
5. Frequent use of specific concussion checklists for individuals suspected of having endured a concussion is important: True/ False
6. A risk factor for prolonged recovery after a concussion is (circle all that apply): (a) Sedentary lifestyle (b) History of ADD/ADHD (c) History of alcohol use (d) Age: adolescents
7. Adolescents should not attend school until they are symptom free: True/False
8. If an individual is experiencing symptoms 1-2 weeks after the injury, you should order an MRI or CT of the head: True/False
9. Individuals may complete the graduated-return-to-play even if they are still taking medications for minor lingering symptoms: True/False