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A Clinician's Guide to Concussion Management

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A Clinician's Guide to Concussion Management

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Dedication

I want to dedicate this to my parents Charles and Maria. They have always supported me my whole life without question. I know I would not be who I am today without them. I hope to be as great a therapist as my dad and as strong-willed as my mom. I also want to dedicate this to my amazing support system of Amber, Heather, Isela, Josh, Monica, and Monique. Although distance separates us, I do not know how I could have completed this journey without your constant love and support. You are all amazing, intelligent, and beautiful people.

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Abstract

A Clinician's Guide to Concussion Management

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Sports participation in the United States involves athletes of all ages. One sports-related injury is a concussion, a force-induced head trauma characterized by cognitive and physical symptoms that interfere with cognitive functioning. Speech-language pathologists (SLPs) lack the resources to assess and treat concussed athletes with cognitive-linguistic deficits. My goal is to provide SLPs with a handbook incorporating the latest research to evaluate and treat concussed athletes. During an evaluation, SLPs are part of an interdisciplinary team while treatment focuses on memory, attention, self-monitoring, and word retrieval. Also, this manual will include information on 2014's Concussion in Sports Group (CISG) consensus statement, return to play guidelines and concussion education.

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Introduction

Sports participation spans the lifetime, ranging from child leagues to professional adult athletes. Brain injuries are a consequence of sports participation and may produce lasting cognitive deficits. Research on concussions in sports has increased dramatically. For example, a search of a University of Texas database using the search phrase "concussions in sports" yielded 1,288 peer-reviewed journal articles in 2016; the same search phrase found only 628 peer-reviewed journal articles in 2006.

Speech-language pathologists serve children and adults with concussions and more severe forms of brain injury that result from sports injuries. The purpose of this report is to provide a handbook for speech-language pathologists about the characteristics, diagnosis, and treatment of brain injuries related to sports participation.

Traumatic Brain Injury vs. concussion

Traumatic brain injury (TBI) is either a close-head or penetrating head injury. A closed head injury is when the brain moves within the skull during a hit. A penetrating head injury occurs when an object penetrates past the skull damaging the brain (LaPointe, 2011). Sports-induced concussions are typically closed-head injuries. Changes in brain function are usually short term resulting in an array of symptoms from memory problems to loss of consciousness. Traumatic brain injuries are classified into three broad categories: mild, moderate or severe (LaPointe, 2011). Sports-induced concussions categorize as a subtype of a mild injury.

Terms used in concussion research are "concussion" and "mild traumatic brain injury" (mTBI). A less frequent term is "acquired brain injury"(Medley & Powell, 2010). In European studies, the Latin term "commotio cerebri" is employed (McCrory, , Meeuwisse, Aubry, Cantu, Dvorak, Echemendia, Engebretsen, Johnston, Kutcher, Raftery, Sills, Benson, Davis, Ellenbogen, Guskiewicz, Herring, Iverson, Jordan, Kissick, McCrea, McIntosh, Maddocks, Makdissi, Purcell, Putukian, Schneider, Tator & Turner, 2012). Journal articles and research published from 2012-2017 interchangeably use "concussion" and "mTBI" while some authors define mTBI and concussions as different entities. The International Conference on Concussion in Sport discusses sports concussion management and issues, including the differentiation between concussion and mTBI (McCrory et al., 2013). A concussion is a separate category from both TBI and mTBI. Compared to other mTBIs, sports concussions occur at lower velocities. For example, the speed of a tackle occurs at a lower velocity than an mTBI caused by a motorcycle accident. Despite lower speeds, the brain still moves against the skull with enough force to cause clinical symptoms (McCrory et al., 2013). For the purpose of this handbook, the term "concussion" will be used to remain consistent with the consensus statement from the International Conference on Concussion in Sport.

CONCUSSION DEMOGRAPHICS

Research, news articles, lawsuits, and the feature film Concussion (Producers Scott, Facio, Wolthoff, Shuman, & Cantillon & Director Landesman, 2015) have increased media attention about football-related concussions. As a result, the general public has become more aware of the serious risks associated with football. The association between football and concussions has merit, as football is the sport most at risk for experiencing head injuries. According to national football associations ranging from the high school to collegiate level, football has the highest sports participation rate with an estimated 1,800,000 participants during the 2009 football season (Danshavar, Nowinski, McKee, & Cantu, 2011). However, football is just one sport at risk for concussions. In fact, all athletes of any sport, at any level, are at risk for a concussion including athletes at the intramural level and children's sports leagues. (Lo & Sirmon-Taylor, 2014). Concussions accounted for 5% of total injuries across all NCAA sports (See Figure 1). Football, ice hockey, and lacrosse accounted for the greatest number of concussions.

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Table 2
Frequency and rates of concussion in NCAA from 1988 to 1989 through 2003 to 2004

	Percentage of All Injuries (%)	Injury Rate per 1000 Athletic Exposures	95% Confidence Interval
Men's baseball	2.5	0.07	0.06, 0.08
Men's basketball	3.2	0.16	0.14, 0.17
Women's basketball	4.7	0.22	0.20, 0.17
Women's field hockey	3.9	0.18	0.15, 0.21
Men's football	6.0	0.37	0.36, 0.38
Women's gymnastics	2.3	0.16	0.12, 0.20
Men's ice hockey	7.9	0.41	0.37, 0.44
Women's ice hockey[a]	18.3	0.91	0.71, 1.11
Men's lacrosse	5.6	0.25	0.23, 0.29
Women's lacrosse	6.3	0.25	0.22, 0.28
Men's soccer	3.9	0.28	0.25, 0.30
Women's soccer	5.3	0.41	0.38, 0.44
Women's softball	4.3	0.14	0.12, 0.16
Women's volleyball	2.0	0.09	0.07, 0.10
Men's wrestling	3.3	0.25	0.22, 0.27
Men's spring football	5.6	0.54	0.50, 0.58
Total concussions	5.0	0.28	0.27, 0.28

[a] Data collection for women's ice hockey began in 2000 to 2001.
Data from Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. J Athl Train 2007;42(2):311–9.

Figure 1: Frequency and Rates of Concussion in NCAA (Daneshvar et al., 2011, p. 4)

Concussions are caused by force contact against a player, the ground or sporting equipment (Guskiewicz et al., 2003). Certain activities associate with a higher concussion risk such as tackling in football. A table of activities associated with concussions is provided below.

Sport	**Activity Associated with Concussions**
American Football	Tackling/being tackled
Baseball/Softball	Contact by ball Hit by a pitch
Basketball*	Ball handling Dribbling Defending Chasing loose balls Rebounding Collision with playing surface
Cheerleading	Toe-touch jumps Splits Human pyramids Lifts Tumbling runs Catches Tosses
Gymnastics	Headstands
Ice/Field Hockey	Body checking
Lacrosse*	Contact with stick
Soccer*	Heading the ball Contact with another person Goalie duties
Skiing/Snowboarding	Collision with trees Collision with other people
Volleyball*	(No specific activity listed)
Wrestling	Takedowns Contact with another person Contact with ground
Soccer*	Tackling/being tackled
*Increased concussion risk during game than practice Adapted from (Daneshvar et al., 2011)	

Figure 2: Activities Associated with Concussions By Sport (Daneshvar et al., 2011)

Sports are categorized into two groups: high-impact sports and low-impact sports (Salvatore & Fjordbak, 2011). High impact sports include football, baseball, softball, basketball, cheerleading, gymnastics, ice/field hockey, lacrosse, soccer, skiing, snowboarding, volleyball, and wrestling (Daneshvar et al., 2011; Salvatore & Fjordbak, 2011). Players involved in high-impact sports make frequent contact with each other during a game. Therefore, high-impact sports associate with a greater risk of concussion as compared to low impact sports. The risk of athletes receiving repeat concussions is also higher in high-impact sports (Daneshvar et al., 2011). Most concussions occur during practice except basketball, lacrosse, soccer, volleyball, and soccer where concussions more likely occur during the game. (Daneshvar et al.,, 2011)

Low impact sports include golf, fencing, rowing, swimming and diving, track and field (Kerr, Register-Mihalik, Kroshus, Baugh & Marshall, 2016; Salvatore & Fjordbak, 2011). In low impact sports, players are not expected to tackle or come into hard contact with opponents. The probability of concussion remains in low impact sports due to less contact with other opponents and equipment.

Approximately 60 million youth and adolescents participate in organized sports annually (Seichepine, Stamm, Daneshvar, Riley, Baugh, Gavett, Tripodis, Martin, Chaisson, McKee, Cantu, Nowinski, & Stern, 2013). Journal articles cite differences in concussion rates. For example one source estimated 6-3.8 million sports-related TBIs occurring yearly in the United States (Knollman, Constantinidou, & Hutchinson, 2014). Other investigators estimated 300,000 athletes sustained concussions yearly. (Diaz, 2014; Kontos, Collins, & Russo, 2004; Moser, Iverson, Echemendia, Lovell, Schatz, Webbe, Ruff, & Barth, 2007; Salvatore & Fjordbak, 2011, 2011; Sohlberg & Ledbetter, 2016; Seichepine et al., 2013). Concussions are not reported due to different diagnosis protocols. Intramural-level, as well as children sports leagues, are not included in statistics. Regardless of occurrence, accurate diagnosis of concussions based on clinical symptoms is critical for immediate treatment.

CHARACTERISTICS AND SYMPTOMS

Concussion symptoms include a combination of thinking difficulty, concentrating, or remembering, headache, nausea, dizziness, imbalance, drowsiness, disorientation, slow reaction time, memory loss, difficulty with balance and coordination, and emotional liability (Slobounov & Sebastianelli, 2014, p.v). The Concussion Symptom Inventory (Randolph, Millis, Barr, McCrea, Guskiewicz, Hammeke, & Kelly, 2008) also includes fatigue and light sensitivity. Wiese-Bjornstal, White, Russell, & Smith (2015) divided concussion-related symptoms into three categories: cognitive symptoms, affective symptoms and behavioral symptoms.

Cognitive Symptoms	**Affective Symptoms**	**Behavioral Symptoms**
● Slowed thinking or response speed ● Mental fogginess ● Poor concentration ● Easily distracted ● Trouble learning ● Memory problems ● Disorganization ● Problem-solving difficulties Kirkwood, Yeates, and Wilson. (2006).	● Fatigue ● Irritability ● Jumpiness ● Anxiety ● Sadness ● Mood swings ● Emotional lability Vargas, Rabinowtz Meyer, and Arnett (2015)	● Sleep-wake disturbances ● Poor social functioning ● Communication difficulties ● Aggression Wiese-Bjornstal et al., (2015)

Figure 3: Cognitive, Affective and Behavioral Symptoms of a Concussion (Kirkwood, Yeates, and Wilson, 2006; Vargas, Rabinowtz Meyer, & Arnett, 2015, Wiese-Bjornstal et al., 2015)

Each concussion profile varies in presentation due to individual traits and symptom profile. Personal characteristics refer to pre-injury and post-injury factors at the time of assessment. Pre-injury factors include personality traits. For example, an athlete who demonstrates poor concentration ability before a concussion is considered to have attention deficits as a pre-injury factor post injury factors include location and severity of the head injury. If a concussion occurs, the cognitive symptoms of poor concentration and quick distractibility are not attributed to the concussion injury but to the person's individual traits. Likewise, the post-injury factor of the exact location where a concussion occurs in the brain will result in different symptoms. While certain psychological, cognitive, affective, and behavioral symptoms are expected, each concussion profile is unique resulting in various recovery times and varying symptom inventories (Knollman et al., 2014). Different time frames of emerging symptoms also occur as some concussed athletes will experience deficits for only a short period while others may experience deficits for longer periods. For example, recovery begins between 2-14 days with an expected full recovery in one month (Moser et al., 2007). Due to the variability of recovery time, frequent symptom monitoring is required. Each concussion must be treated individually and without comparison to other athletes. The only comparison is the athlete's symptom inventory before and after a concussion.

Considering the variety of concussion profiles, the number of symptoms a player needs to exhibit to be diagnosed has been a topic of debate. The Concussion in Sports Group (CISG) states that one identified symptom is enough to signal a possible concussion.

Concussions have shorter recovery rates and positive long-term prognosis compared to other TBI injuries (Rabinowitz, Li, & Levin, 2014). In fact, 90% of concussions recover without any intervention saving an athlete time and health-related expenses (Salvatore & Fjordbak 2011). However, the cognitive, affective and behavioral symptoms athletes experience can interfere with cognitively demanding school or work related tasks.

Loss of Consciousness Update

A 2014 consensus statement from the CISG indicated that a player does not need to lose consciousness for a concussion diagnosis (Sohlberg & Ledbetter, 2016). Before 2014, players experienced head injuries without losing consciousness and returned to play without further evaluation. Athletics trainers and team physicians believed that a concussion only occurred if a player "blacked out." Athletes returned to play despite presenting with other symptoms such as fogginess or headaches. Immediate return to play puts the athlete at risk for repeat concussions. Concussions occur without a loss of consciousness (LOC) 90% of the time. (Moser et al.,2007). As a result, more concussions are reported as a loss of consciousness is no longer a diagnosis requirement. What seems like a rise in concussion diagnoses is a detection bias. Positive effects of clarifying the LOC diagnosis criteria include more concussion evaluations immediately following a head injury, reduced probability of repetitive concussions, and early intervention.

Gender and Return to Play Guidelines

Factors such as gender and age play a role in determining an athlete's safety in returning to full active, athletic activity. A player's gender did not predict neuropsychological performance on testing (Cancelliere, Hincapié, Keightley, Godbolt, Côté, Kristman, Stainacke, Carroll, Hung, Borg, Nygren-de Boussard, Coronado, Donovan, & Cassidy, 2014). There were no significant differences in scores between the sexes. Each concussion profile presented with different deficit profiles. There were no patterns observed that females tended to suffer deficits in one domain compared to another in neuropsychological testing. However, two other trends about gender are noted.

Females are more likely to report more severe symptoms and take approximately six days longer to return to play (Stone, Lee, Garrison, Blueitt, & Creed, 2017). The increased presence of symptoms can be attributed to differences in reporting styles between the genders (Cancelliere et al., 2014). A common observation in patient care shows that women on average tend to report symptoms and visit the doctor more often than men. The difference is reporting rates observed in both high school and college athletes. Not only do women report more symptoms, but found females also report more severe and persistent concussive symptoms (Thomas, Apps, Hoffmann, McCrea, & Hammeke, 2015). The observation women experience more severe and persistent symptoms is due to either increased motivation to report their symptoms or due to differences in physical/biological stature. Women tend to have smaller head to ball ratios and weaker necks (Gessel, Fields, Collins, Dick, & Comstock, 2007). Concerning the nature of contact sports, the force applied during a concussion would result in more severe symptoms due to women's weaker necks. The population size of athletic sports will not be a representative 50/50 male-female ratio for every single sport. Women in athletics may or may not have the same protective equipment.

Age and Return to Play Guidelines

A common misconception is that child athletes recover faster than adult athletes (Duff & Stuck, 2015). However, research shows younger athletes take longer to recover from concussions than adults. (Boden, Tacchetti, Cantu, Knowles, & Frederick, 2007;

Cancelliere et al., 2014; Covassin, Moran, & Wilhelm, 2013; Daneshvar et al, 2011). This observation contrasts with the Kennard principle, which dictates that the younger a person is, the faster the brain will recover due to the brain's plasticity (Kirkwood et al., 2006). The Kennard principle suggests young age results in better recovery because the brain is continuously developing and forming new connections. In moderate to severe traumatic brain injuries, a younger age indicates a better prognosis. In concussions, younger players took an average of 21 days to return to baseline functioning and experienced more prolonged memory dysfunction (Cancelliere et al., 2014). When working with young student athletes, an extended amount of time is required to return to baseline functioning. The interdisciplinary team needs to take extra precaution when recommending a full return to play. Younger athletes are still developing their athletic abilities. Younger athletes have poor body control and poor technique (Boden et al., 2007). They are developing their gross motor skills and coordination required for sports. A poorly executed tackle can result in concussions. Regarding cognitive skills, the human brain does not stop developing until age 25. Therefore, the blood vessels tear more easily, and skulls are thinner resulting in less protection between the brain and the skull in young athletes (Boden et al., 2007). The brain is more vulnerable to injury as it continues to develop. Due to the physical differences of the brain, second impact syndrome, brain swelling, and inflammation are more likely to occur (Kirkwood et al., 2006). Children and younger players are more vulnerable to long-term cognitive deficits compared to older athletes.

LONG TERM IMPLICATIONS

Executive Functioning Deficits

Concussion damage occurs anywhere in the brain. Depending on the sport, the frontal lobes are most at risk for damage. In football, the act of tackling, and being tackled are the leading causes of concussion. (Daneshvar et al., 2011) Executive functioning localize in the frontal lobes (Goldstein, Naglieri, Princiotta, & Otero, 2013). Executive functioning is a general term including planning, working memory, attention, inhibition, self-monitoring, self-regulation, and initiation (Goldstein et al., 2013). Executive functioning deficits are ongoing and subtle. Deficits are not always apparent at the time of injury. Concussed athletes with severe post-concussion symptoms report "difficulty remembering, concentrating, following directions, word retrieval issues, or difficulty in participating in conversations with peers" (Vidal, Goodman, Colin, Leddy & Grady, 2012, p. 5). Athletes return to daily activities and notice something feels "off" or certain tasks are suddenly more difficult to complete. However, not every concussed athlete will experience the same pattern of executive functioning deficits. Concussion symptoms persisting for 8-12 weeks require intervention (Vidal et al., 2012).

Secondary Impact Syndrome

An athlete needs to be immediately taken out of the game to recover when a concussion occurs. Prevention of repeated concussions will lead to the reduced probability of severe health repercussions. Secondary Impact Syndrome (SIS) is when a young athlete dies or has a severe disability as a result of too much brain swelling. (Moser et al., 2007) While a rare condition, a second head impact before the brain has healed triggers the brain to swell. Symptoms include "a headache, disorientation, nausea, vomiting, dizziness, fatigue" (Quintana, 2016, p. 648). Child athletes are most at risk for

SIS. Since SIS symptoms resemble concussion symptoms, a young athlete needs to be taken out of play immediately and thoroughly evaluated. Due to the possibility of death, immediate hospitalization is required if serious concussion symptoms are apparent.

Dementia Pugilistica

A controversial and unconfirmed serious long-term effect of repeated concussions is Chronic Traumatic Encephalopathy (CTE). A variant of CTE is Dementia Pugilistica. Dementia Pugilistica is associated with boxers and American football players. CTE diagnosed in older athletes who have suffered repeated concussions and is the topic of the movie Concussion. CTE is commonly referred to as “punch drunk” (Kontos et al., 2004). Similar to other variants of dementia, CTE is not detected in traditional neuroimaging, but diagnosed upon death, or post-mortem. The incidence of CTE in athletes is unknown (McNamee, Partridge & Anderson, 2015). Research data on CTE is growing, and there is an apparent correlation between repetitive concussions and CTE but no direct link.

Assessment

The main reason for evaluation in the acute stage is to determine when a player is safe to return to play. Assessment in the critical phase of a concussion is sideline testing. The athletic trainer initiates screenings to determine if a player is safe to return to full athletic play or needs further evaluation. Depending on the setting, a team physician and neuropsychologist may also be present. In the NFL, an average team has 29 total game day medical staff. In contrast, a middle school football team may only have the coach available to determine whether or not a possible concussion occurred.

INTERDISCIPLINARY TEAM

Assessment requires an interdisciplinary approach. Concussion management members include the athletic trainer, team physician, neuropsychologist, physical therapist, and a speech-language pathologist. Athletic trainers and doctors diagnose a concussion (Gessel et al.,, 2007). Athletic trainers are also involved in concussion management from initial evaluation until return to play. Athletic trainers develop relationships with the players and are most familiar with an athlete's baseline personality and baseline function (Knollman, et al., 2014; Williams, Welch, Parsons, & McLeod, 2015). They provide unbiased information when assessing a player before and after a concussive injury.

Physicians diagnose concussions and prescribe medications for acute physical symptoms such as headaches. They also have the responsibility of determining when players can participate in practice and games or require continued rest. Physical therapists assess and treat physical deficits associated with concussions such as balance problems (Diaz, 2014). Neuropsychologists initiate full cognitive batteries to assess language and cognitive deficits. Speech-language pathologists also assess language and cognitive deficits but the types of assessment tools are different (Wertheimer, Roebuck, Constantinidou, Tursktra, & Pavol, 2008). Each member of the interdisciplinary team contributes to an athlete's overall profile by assessing different areas. Collaboration between health care professionals on a concussion management team promotes optimal patient care.

Speech Language Pathologist

The scope of practice in speech-language pathology includes treating individuals with acquired cognitive-communication disorders such as concussion. SLPs play a role in the evaluation of long-term cognitive deficits associated with concussions (Knollman et al., 2014; Salvatore & Fjordbak, 2011). Cognitive deficits assessed are orientation, anterograde amnesia, retrograde amnesia, concentration and word list memory (Salvatore & Fjordbak, 2011).

An evaluation administered by the speech-language pathologist focuses on the athlete's ability to understand and use language (receptive and expressive language skills) as well as cognitive deficits on communication skills (Vidal et al., 2012). An evaluation of cognitive and communication skills are administered when concussion symptoms persist for 8-12 weeks (Vidal et al., 2012). Interventions target the domains of working memory and executive functioning (Vidal et al., 2012). SLPs arrange accommodations to meet the interests of the concussed student-athlete population. Aside from assessment, postconcussion symptoms management, and involvement in an interdisciplinary team, responsibilities will depend on the SLPs work setting of the hospital or school.

When a concussion is severe enough, hospitalization is required. Due to the nature of the hospital setting, subtle cognitive deficits may not be identified. Rest is the first step in concussion treatment. Due to the recommendation of rest, cognitive tests are not initiated during the time a concussed athlete is in the hospital. Patients may also be discharged before any comprehensive testing is completed. A patient's speech and language skills may appear to be within normal limits as hospitals employ short language and cognitive screeners.

In the elementary to the high school setting, school-based SLPs are not informed when students have a concussion (Duff & Stuck, 2015). Concussed students are not usually referred to a school SLP caseload for any persistent cognitive symptoms. In the middle school, and high school setting, a sports team may or may not have an athletic trainer with extensive knowledge in concussions. The coach may be the only person available to diagnose a concussion and make the return to play decisions. For an SLP in the school setting, sports teams and parents educated about concussion symptoms and the risks associated with high-contact sports are more likely to report concussions and seek treatment.

In the collegiate setting, SLP programs consist of a university speech clinic and research labs. SLPs interested in research contribute to knowledge about concussions by publishing articles related to sports-induced concussions. University SLP clinics have the opportunity to be involved with student athletes. For example, Miami University and the University of Texas at El Paso (UTEP) have concussion management clinics where SLPs manage concussion cases. SLPs coordinate baseline testing and post-concussion testing as well as treat concussed athletes and arrange accommodations for their university classes (Knollman et al., 2014). The concussion management program manages athletes from both the varsity and intramural level. Concussion management clinics also treat post-concussion syndrome.

Background and case history

Comprehensive evaluations gather as much background information about the patient as possible. Therapists need to determine an athlete's symptom profile. According to the CISG, only one symptom alerts a possible concussion (McCrory et al., 2013) and concussion profiles vary from individual to individual. Three important pieces of information are age, gender, and history of concussions. The number of previous head injuries the individual has experienced. Repetitive concussive injuries are associated with longer recovery times and more severe symptoms

Athletic trainers and parents are valuable sources of information regarding an athlete's prior functioning. Athletes may not be aware the symptoms they are experiencing are concussion related or provide false information regarding symptoms to continue sports participation.

Baseline Data

Sports programs are encouraged to conduct baseline data measures during the preseason, or before competitive games begin. Concussion management clinics offer baseline-measuring services. A frequently employed measure is the ImPACT program. While not the only pre-season baseline test available, ImPACT is the most used. (Covassin et al., 2013; Erdal, 2012; Kirkwood et al., 2006; Kontos et al., 2004; Knollman et al., 2014; Salvatore & Fjordbak, 2011, 2011; Schmidt, Register-Mihalik, Mihalik, Kerr, & Guskiewicz, 2012). ImPACT is a computer-based program beneficial to sports programs with scores of student-athletes. ImPACT takes demographic data about the athlete's sport, medical, and concussion history (Majerske, Mihalik, Ren, Collins, Reddy, Lovell, & Wagner, 2008). Seven neurocognitive tests assess cognitive skills most compromised by concussions including attention, memory, processing speed and reaction time (Majerske et al., 2008). The five composite scores include Verbal Memory, Visual

Memory, Visuomotor Processing Speed, Reaction Time, and Impulse Control (Majerske et al., 2008). Baseline ImPACT scores compare to future ImPACT testing administered after a concussion. Any differences in scores determine the extent of damage. ImPACT also includes the Post-Concussion Symptom Scale for symptom monitoring (Lovell et al., 2006; Majerske et al., 2008).

Baseline data is not always reliable because it does not detect athletes with mild deficits and athletes attempt to distort their scores (Erdal, 2012; Iverson & Schatz 2015). One motivation to perform badly on the ImPACT is to return to play sooner if an athlete does experience a concussion in the future. (Erdal, 2012). Strategies to purposely skew ImPACT results include “getting every fourth answer wrong, alternating between yes and no answers, and doing well on letter memory or counting subtests but not both” (Erdal, 2012, p. 476-477). However, only 11% of the Erdal (2012) participants were successful in performing poorly on purpose.

Baseline data is not comprehensive nor meant to be a thorough assessment of all cognitive functions. Consider the number of athletes on a single team and the administration time of neuropsychological testing. Baseline data focuses on the domains of memory, attention, the speed of mental processing, and reaction time. However, neuropsychological testing is useful when there is no baseline data available (Echemendia, Bruce, Bailey, Sanders, Arnett & Vargas, 2012). Both baseline and standard neuropsychological methods identified the same impairments for most post-concussion outcomes (Schmidt et al., 2012).

Baseline data obtained in sports programs occur during the preseason. Baseline data needs to be fast yet reliable and valid. The purpose of baseline data is to have a reference point of cognitive function pre-injury. Athlete’s post-injury cognitive performance is compared to their pre-injury cognitive performance to help determine when they can return to play. However, return to play decisions should never be solely based on baseline data (Schmidt et al., 2012).

CONCUSSION SYMPTOM INVENTORY

Post-concussion symptoms are self-reported by the athlete. The nature of self-reporting is subjective (Wiese-Bjornstal et al., 2015). Motivation to not accurately report symptoms can be influenced by external pressures such as coaches or teammates, or internal pressure such as the athlete's personal motivation to continue playing. Kerr et al. (2016) surveyed former athletes on their motivations in non-disclosure, or failure to report a concussion in their athletic careers. Retired athletes no longer presented with the same external or internal pressures as current athletes and are, therefore, more likely to accurately report past concussions and reasons why they failed to report any suspected concussions. The top four reasons for not reporting a concussion were: internal motivation to stay in the game for personal, or team benefit, lack of concussion symptoms and severity of symptoms (Kerr et al., 2016). Therefore, self-reported assessments are considered subjective and only one part of a comprehensive evaluation.

NEUROIMAGING

While self-reports are subjective measures, neuroimaging is an objective tool. In moderate and severe cases of TBI, the extent of damage is captured in standard neuroimaging tools. Computerized tomography (CT) and magnetic resonance imaging (MRI) are used to detect where damage has occurred in the brain. According to Duff & Stuck (2015), 30% of SLPs believe that concussions are apparent on CT and MRI imaging. However, CTs and MRIs do not detect the damage concussions cause. Athletes report symptoms interfering with their daily lives despite normal CT and MRI imaging. As technology in neuroimaging continues to grow, DTI (diffusion tensor imaging (DTI) and fMRI (functional magnetic resonance imaging) may help to capture the injuries caused by concussions. DTIs show white matter changes and fMRIs show which areas of the brain are activated (Ting et al., 2016). DTI imaging shows variations in the brain despite athletes report no longer experiencing concussion symptoms (Lancaster, Olson, McCrea, Nelson, LaRoche, & Muftuler, 2016). fMRI imaging shows a difference in brain functioning two months after injury even though athletes perform normally on cognitive tasks (Dettwiler, Murugavel, Putukian, Cubon, Furtado and Osherson, 2014). DTI and fMRI imaging can detect changes in the brain despite self-reports of symptom relief and successful cognitive task completion. New imaging tools suggest that concussions continue to alter the brain and may explain persistent concussion symptoms.

The limits of DTI and fMRI neuroimaging are the fact they are in the research stages and are not widely available. The cost-benefit of a DTI and fMRI scan are too high for standardized clinical use (Hancock, Bernal, Medina, & Medina, 2014). Aside from monetary costs and lack of access to the imaging tools, most concussions recover within one month. DTI or fMRI imaging is not a recommended for every case of suspected concussions.

A physician or clinician makes informed clinical judgments for each individual case. Symptoms requiring neuroimaging include “an LOC greater than a few seconds, prolonged impairment of conscious state, mental status deterioration, the dramatic worsening of a headache, focal neurologic deficit, seizure activity, persistence or worsening of post-concussion symptoms over time.” Kirkwood et al., (2006, p. 1363.) When there is an extended amount of time of LOC or impaired conscious state, there is a possibility of a more severe concussion. Any deterioration of symptoms signals a more serious concussion. Instead of recovering from a concussion, symptoms worsen. Focal neurologic deficits refer to symptoms that can affect the whole body such as weakness or uneven gait. Athletes experiencing any one symptom need referral for neuroimaging. Concussions require constant and close monitoring of symptoms until an athlete returns to play.

Treatment

Treatment focuses on decreasing cognitive symptoms. During therapy, concussed athletes experience high cognitive exertion (Crawford & Sirmon-Taylor, 2014). To reduce the risk of over-exertion and longer recovery time, SLPs need to observe behaviors such as frustration and agitation. As the brain recovers, cognitive load is gradually added. Concussed athletes require strategies to integrate back into school or work fully. The need for intervention is demonstrated by increasing the difficulty to complete tasks at school or work. Including patients' wants as well as needs increases motivation during therapy (Medley & Powell, 2010) Just as concussive profiles vary from individual to individual, goals are tailored to each patient.

RETURN TO PLAY GUIDELINES

Concussion management begins by following a stepwise, or gradual, return to play protocol (Salvatore & Fjordbak, 2011). The return to play protocol prevents further head injuries and post-concussion syndrome (PCS). No set timeline is recommended as the progression through the rehabilitation stages depends on symptom presentation. Therefore, constant monitoring of symptoms is recommended to allow a player to advance to the next level. The return to play protocol in Figure 4 is as follows: no activity, light return, sport- specific return, non-contact drills, full contact drills, and game play.

Table 1
Graduated return to play protocol

Rehabilitation stage	Functional exercise at each stage of rehabilitation	Objective of each stage
1. No activity	Symptom limited physical and cognitive rest	Recovery
2. Light aerobic exercise	Walking, swimming or stationary cycling keeping intensity <70% maximum permitted heart rate No resistance training	Increase HR
3. Sport-specific exercise	Skating drills in ice hockey, running drills in soccer. No head impact activities	Add movement
4. 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
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	Normal game play	

Figure 4: Return to Play Guidelines (McCroy et al., 2001)

Stepwise refers to the gradual return to play. Another important consideration is once a concussion is diagnosed, an athlete must not return to play that same day (McNamee et al., 2015). This includes if a concussion occurred during practice. Repetitive concussions need to be avoided, and a player must not engage in any activity that potentially could limit recovery or exacerbate cognitive deficits.

Rest

The first intervention for post-concussive treatment is rest to allow the brain to recover spontaneously and minimize further damage (Williams et al., (2015). Any activity involving cognitive demands needs to be limited. The two most important cognitive activities are school and work. Concussed athletes need to be allowed time off from school and work to allow the brain to rest. Other cognitive demanding tasks include recreational activities such as playing video games, listening to music, and reading.

Physicians recommend a 1-2 day rest period. As demonstrated in a randomized trial, strict rest for five days resulted in more symptoms reported than a 1-2 day rest period (Thomas et al., 2015). In the same study, 50% of strict rest patients took three more days to recover (Thomas et al., 2015). Rest is the important first step in concussion management and brain recovery; however, too much rest results in longer recovery time.

THERAPY TARGETING EXECUTIVE FUNCTION DEFICITS

Executive functioning goals target memory, attention, self-monitoring, and word retrieval (Goldstein et al., 2013).

Memory

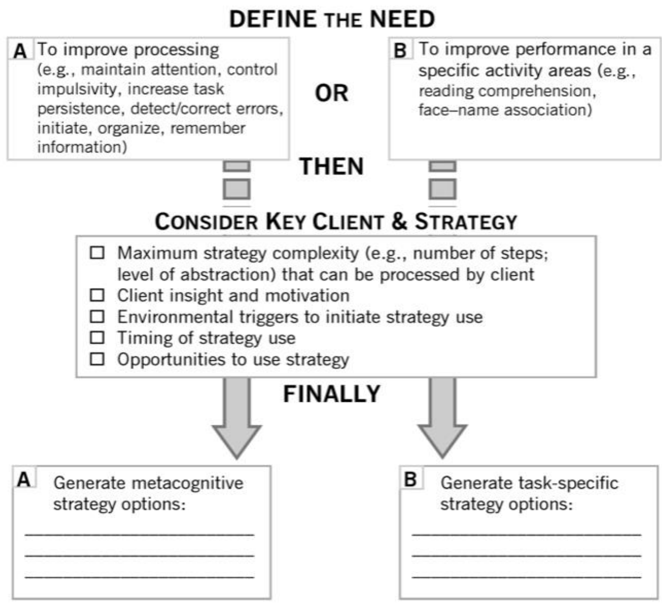
Types of memories include recall, prospective, and retrospective (Solhberg, 2011). In conjunction with therapy, external cognitive aids further facilitate the completion of tasks. SLPs determine which aids to use depending on age, prior use, and concussion severity (Sohlberg, 2011). Tools range from low-tech to high-tech including post-it notes, checklists, and smartphones. Most patients do not receive enough training on how to use external aids resulting in discontinued use (Crawford & Sirmon-Taylor, 2014). During therapy, SLPS train the patient on how to use each tool and cue the patient to use their external cognitive aid.

Attention

A common complaint is attention difficulties at school or work. Different types of attention include alternating, selective, sustained, and divided (Sohlberg, 2011). Therapy gradually increase attention levels to participate in daily activities. One treatment approach is the computer-based therapy tool: direct attention training (DAT). Researchers found children with mTBI and concussions who received DAT improved attention levels in school and during social interactions (Lee, Harn, Sohlberg, & Wade, 2012). Since DAT is a computer-based program, SLPs recommend using as part of a home program.

Self-monitoring

Self-monitoring skills help the patient monitor and adjust their progress in therapy. Metacognition is defined as cognition about cognition or knowing about knowing. It is a high-level cognitive skill associated with self-monitoring abilities. Metacognition requires a combination of executive functioning skills such as the capacity to plan, organize and evaluate progress toward a task. Metacognitive strategies are task specific or general strategies to use across different functions (Crawford & Sirmon-Taylor, 2014). After therapy, patients generalized self-monitoring skills across tasks. Figure 5 shows a step-by-step guide on goal selection while considering the individual's needs.



8. Training the Use of Metacognitive Strategies

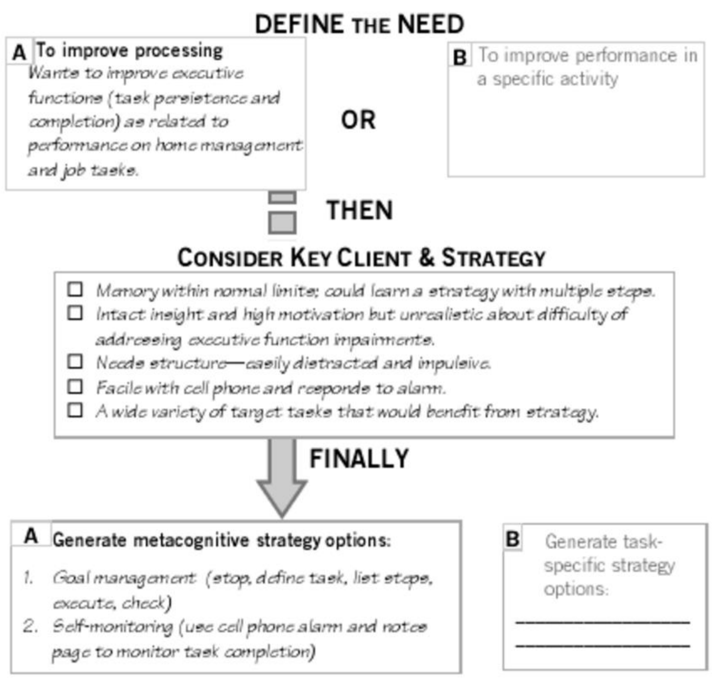


Figure 5: Examples of a Metacognitive Strategy Selection Process (Sohlberg, 2011, p. 198-199)

Word Retrieval Therapy

When the brain is injured, cognitive skills slow. One way speed-processing deficits are measured is by assessing word retrieval ability. The ability to produce a word is a complicated process. The speed a person can formulate a word demonstrates working memory skills. Compared to healthy subjects, concussed athletes produced fewer words and took longer to start naming words (Crawford, Knight, & Brent, 2006). Athletes with mild cognitive deficits also expressed word retrieval difficulties. Therapy focuses on training five high-frequency words and five low-frequency words while using a cueing hierarchy (Linebaugh, Shisler, & Lehner, 2005). Researchers found participants improved in overall word retrieval skills.

Persistent Cognitive Symptom Management

Symptoms lasting more than 90 days are considered "persistent" (Sohlberg & Ledbetter, 2016). Persistent symptoms have a negative impact on an athlete's daily life. Most long-term deficits are noticed months after a concussion and the athlete reports difficulty in school or work. As of 2017, there are no evidence-based guidelines for the management of persistent cognitive symptoms following concussions (Sohlberg & Ledbetter, 2016). Since no protocol for persistent symptoms is developed, intervention needs to be tailored to each athlete's needs. Sohlberg & Ledbetter (2016) used a combination of four treatment approaches for 24 cases at the University of Oregon. Some athletes received one approach or a combination of methods depending on their needs and 83% of athletes met their goals. Results from a retrospective case review suggested that just as an individual's concussion profile varies, intervention also varies.

Interventions included attention training, metacognitive strategy training, high-tech external cognitive aids, and education (Sohlberg & Ledbetter, 2016).

Approach	Description	Functional goal domain[a]	Outcomes summary[b]
Direct attention training (n = 13)	Computerized drills targeting different attention domains (e.g., sustained, selective, suppression, working memory) combined with strategy training	Improve attention during lecture (n = 4) Improve attention during homework sessions (n = 2) Increase reading with comprehension (n = 3) Increase homework completion (n = 1) Increase study efficiency (n = 1)	Improved class test/probe scores (n = 4) Passed written driving test (n = 1) Decreased number of missing assignments (n = 2) Decreased time needed to review lecture notes (n = 1) Improved grades (n = 2) Increased sustained attention for lecture/homework (n = 2) No change in homework completion (n = 1) Improvement on standardized attention test[c] (n = 5) No improvement on standardized attention test (n = 1)
Metacognitive strategy instruction (n = 9)	Instruction in use of strategies to facilitate self-regulation of states of mind, academic tasks, and study skills	Learn to use Cornell notetaking strategy (n = 1) Make study agenda (n = 1) Learn to use reading comprehension strategy (n = 2) Self-monitoring of social behavior (n = 2) Learn to use conversation marking strategy (n = 1) Learn to use internal memory strategies (n = 1)	Increased use of notetaking strategies in class (n = 2) Increased study efficiency (n = 1) Improved reading comprehension (n = 2) Increased social initiation (n = 2) Increased retention of conversation (n = 1) Improved school performance (n = 1)
Training assistive technology for cognition (n = 5)	Direct instruction in use of external cognitive aids	Learn to use smart pen for notetaking (n = 2) Learn to use homework-tracking app (n = 2) Learn to use e-reader (n = 1) Learn to use Google calendar (1)	Completed all missing assignments (n = 1) Improved homework completion (n = 1) Improved grades (n = 2) Improved class performance (n = 1)
Psychoeducational support (n = 24)	Provision of concussion education; facilitation of symptom monitoring and goal setting	Engage in symptom monitoring (n = 6) Concussion education (n = 3) Goal setting (n = 24)	Increased school attendance (n = 5) Decrease reported in symptom severity (n = 2) Decreased dizziness (n = 1) Completed graduation requirements (n = 1) Increase in perceived social support (n = 3) Addition of new recreational activities (n = 1)

Note. Some clients received more than one treatment.
[a]Clients self-selected functional goals through clinician-facilitated goal setting process; some self-selected goals in more than one domain.
[b]Summarized outcomes represent specific outcomes for commonly self-selected functional goals. [c]Demonstrated measurable improvement on at least one subtest of a standardized attention test.

Figure 6: Persistent Concussion Management (Sohlberg & Ledbetter, 2016, p.142)

CONCUSSION AWARENESS AND EDUCATION

SLPs are involved in concussion education regardless of work setting (school or hospital). Athletes, parents, and any person involved with concussion management need to be aware of the symptoms of a concussion and the importance of reporting concussions. Education is the first step in removing any stigma associated with concussions. Lessening the stigma results in an increase in reporting suspected concussions and receiving an intervention. Kerr et al., (2016) found 70% of former athletes did not report concussions. Athletes were not motivated to report symptoms or did not realize they were experiencing concussion symptoms. Education informs athletes about the serious consequences of untreated concussions.

Concussion education also occurs in treatment by educating athletes on what executive functioning deficits and memory deficits to expect after a concussion. In fact, awareness of deficits has led to a better overall quality of life. What is pertinent in concussion education, is for the athletes and parents to be aware of the symptoms, what to do when there are symptoms, and the importance of reporting them to medical personnel. Concussion education leads to early intervention and reduced risk of experiencing any long-term effects. “Heads up” is the free online concussion training program by The Center for Disease Control and Prevention (CDC). Researchers found “Heads Up” changed coaches attitudes towards concussion and the importance of early concussion management (Sarmiento, Mitchko, Klein, & Wong, 2010). Changing coaches attitudes to take concussions more seriously influence their athlete’s attitudes towards concussion as well.

Education varies on the setting. An SLP in the acute hospital setting has a limited amount of time to evaluate each patient’s speech and language skills. SLPs usually administer screenings over a complete speech-language cognitive assessment. In fact, cognitive screenings may be the only cognitive assessments administered in the acute hospital setting. The first step in concussion protocol is rest, and cognitive testing can exacerbate any cognitive deficits. Patients are discharged because their speech and language skills appear to be within normal limits. Patients are not showing any overt speech and language deficits compared to moderate or severe traumatic brain injured patients. As a patient is hospitalized, SLPs can educate the family by reviewing a concussion handout with recommendations (Crawford & Sirmon-Taylor, 2014).

Concussion education also occurs in the school setting. Concussion education leads to an increase in students reporting concussion and receiving treatment (Register-Mihlik, Linnan, Marshall, Valovich McLeod, Mueller, & Guskiewicz, 2013). The number of reported concussions is skewed. One reason is the underreporting of concussions. Athletes will be encouraged to report symptoms if they are educated about the risks. School-aged athletes learn the importance of reporting every suspected concussion and more likely to follow recommendations as professional athletes. In middle school and high school settings, there may or may not be an athletic trainer or team physician to immediately assess potential concussions.

Concussion education also includes prevention. The most important thing to remember is that despite advancements in helmets and safety equipment, there will always be a chance of a concussion (Lo Sirmon-Taylor, 2014). However, increased knowledge and awareness leads to proactive measures when a concussion does occur.

ACCOMMODATIONS

Speech-language pathologists are qualified to make accommodations for concussed athletes. Accommodations are made for either the school or workplace setting. Accommodations are either informal or formal (Kirkwood et al., 2006). Informal accommodations need to be implemented for a few days to weeks. Informal accommodations allow the student-athlete to follow the return to play protocol while slowly adding cognitive load. Formal accommodations (504 plans and Individualized Education Plans) are for student athletes with persistent concussion symptoms interfering with learning. Accommodations in the school setting include preferential seating, part-time attendance, reduced assignments, reduced schedule of classes, noise and light sensitivity, extended test-taking time, and frequent breaks. (Crawford & Sirmon-Taylor, 2014). Most concussions only require short-term informal recommendations to prevent cognitive overload.

Conclusion

Implementation science, or the time length required for theory to become common clinical practice takes one to two decades (Burke & Gitlin, 2012). At that rate, information from research articles published in 2017, will not be common clinical practice until the year 2037. As of 2017, there is only preliminary evidence supporting treatment for persistent cognitive symptoms.

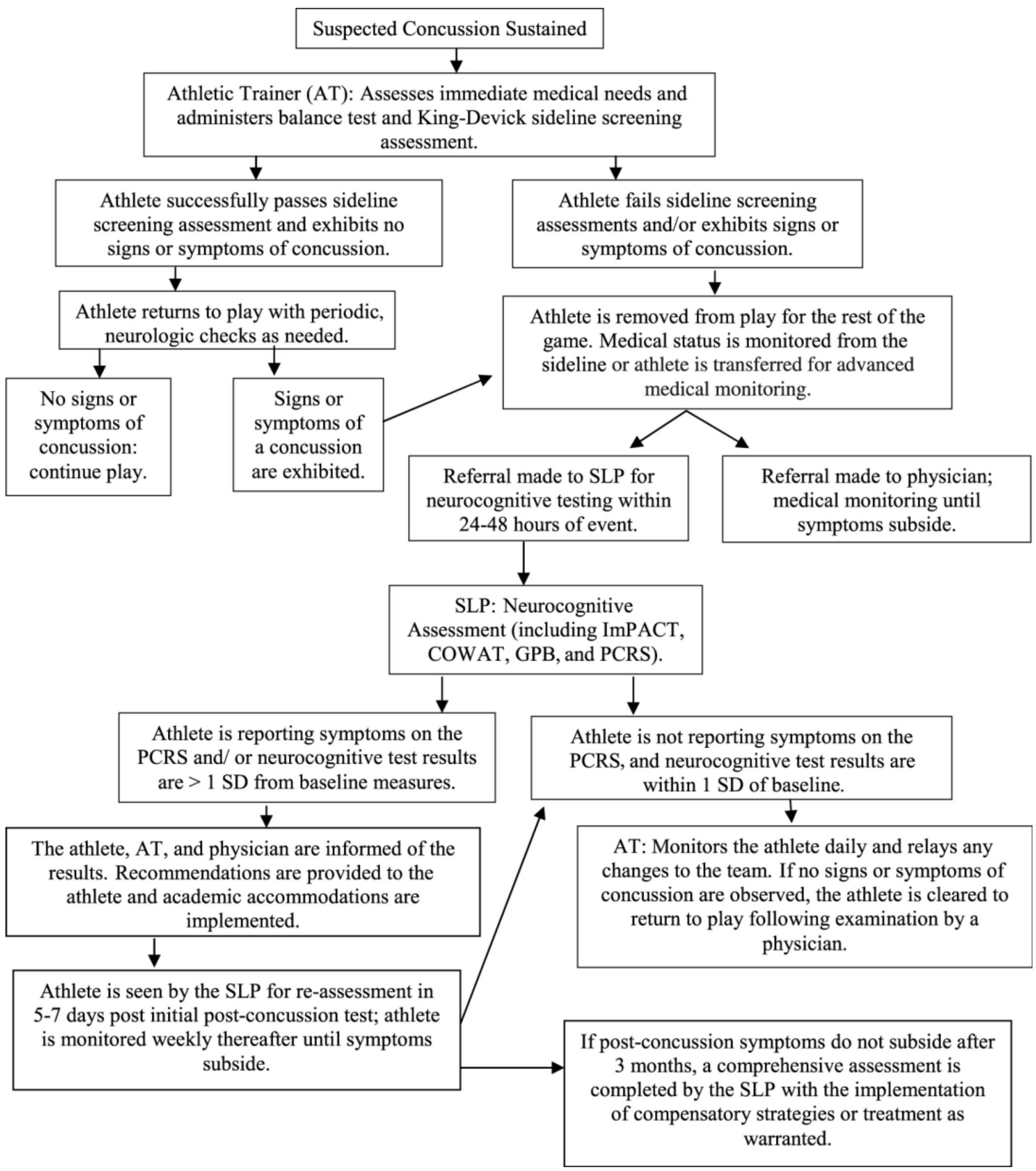
Current discussions are focused on a return to play protocols but less attention on return to a work or school protocols. There needs to be an agreement in the sports community to determine when a player is safe to return to play as well as daily activities.

As of 2017, there is no one standard concussion management protocol. Kirkwood, et al. (2006) noted over 20 published expert guidelines for managing athletic concussions. The legitimacy of each guideline depends on the qualifications of the expert. However, none of the expert guidelines are evidenced based (McCroy et al., 2001). Athletes, coaches and athletic trainers should ideally follow the same protocol standard for continuity and for both all-athletic playing levels (Knollman et al., 2014). Intramural and professional teams are at risk for concussions.

The NFL has developed a return to play protocol based on the Concussion in Sports Group conference in Prague. In the years 2001-2012, there have been four consensus statements regarding concussion management (McNamee et al., 2015). Questions surrounding concussions are discussed in order to bring standard practice to concussion management. Big sports corporations such as FIFA and NHL have also developed their own return to play protocols based on the conference's recommendations. While the conference serves as an attempt for continuity in concussion management, professional sports concussion guidelines vary. For example, the conference has recommended that players cannot return to play the same day as a diagnosed concussion, but the NFL allows its football players to return to the game the same day as a concussion diagnosis. The reason for allowing a player to return to play is unknown. The fifth, and latest conference to date was held in October 2016, and articles will soon be released on any changes and updates.

Appendices

Appendix A: Concussion Management Decision Tree



(Knollman, Constantinidou, & Hutchinson, 2014, p.512)

Appendix B: Post Concussion Scale

Rate your symptoms over the past 2 days.

Symptom	None	Mild		Moderate		Severe	
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
Visual Problems	0	1	2	3	4	5	6

Figure 1. Post-Concussion Scale.

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(Lovell, Iverson, Collins, Podell, Johnston, Pardini, D., Pardini J., Norwig, Maroon Maroon, 2006, p.168)

Appendix C: Cognitive-Linguistic Assessment Questions

Orientation: Ask the athlete the following questions:

What stadium is this?

What month is it?

What city is this?

What day is it?

Who is the opposing team?

Anterograde amnesia: Ask the athlete to repeat the following words:

Girl, dog, green

Retrograde amnesia: Ask the athlete the following questions:

What happened in the prior quarter or period? What was the score of the game before the hit?

What do you remember just before the hit? Do you remember the hit?

Concentration: Ask the athlete to do the following:

Repeat the days of the week backward (starting with today).

Repeat these numbers backward: 63 (36 is correct), 419 (914 is correct)

Word list memory: Ask the athlete to repeat the three words from earlier.

Girl, dog, green

Any failure should be considered abnormal. Additionally, the following information should be gathered regarding signs and symptoms:

(Salvatore & Fjordbak, 2011, p. 6)

Appendix D: External Cognitive Aids

TABLE 7.2. Examples of Assistive Tools Used to Compensate for Different Types of Cognitive Impairments

Cognitive impairment	Common behavioral manifestation	External aid option	Description of aid
Memory domain: *decreased recall*	Unable to access desired verbal or visual information	Voice recorder (Van den Broek et al., 2000)	Mid-tech, multifunction, commercially available, mainstream design
Memory domain: *decreased prospective memory*	Inability to initiate intended actions at target time	Alphanumeric pager (Wilson et al., 2001)	Mid-tech, multifunction, commercially available, mainstream design
Memory domain: *multiple processes (prospective and retrospective memory)*	Forgetting to make phone calls, arrive at appointments	Commercial smart phone (Svoboda et al., 2009)	Mid-tech, multifunction, commercially available, mainstream design
Attention domain: *decreased sustained attention*	Poor task persistence; increasing errors over time	Task guidance system (LoPresti et al., 2008)	High-tech, multifunction, commercial, designed for CI population
Attention domain: *decreased selective attention*	Difficulty focusing when distractions present; poor performance at school or work	Use of desk screen (Sohlberg & Mateer, 2001b)	Low-tech, specialized task, clinician adapted, designed CI population
Attention domain: *alternating attention*	Unable to switch between tasks or find place when interrupted	Checklist paired with alarm (Sohlberg & Mateer, 2001b)	Low-tech, multifunction, clinician generated, developed for person with CI
Executive function domain: *decreased initiation*	Does not begin goal activities	Reminder card with self-monitoring checklist (Sohlberg, Sprunk, & Metzelaar, 1988)	Low-tech, specialized task, clinician generated, developed for person with CI
Executive function domain: *decreased organization*	Begins multiple tasks without finishing	PDA (Gentry et al., 2008)	Mid-tech, multifunction, commercially available, mainstream design
Executive function domain: *decreased self-regulation*	Acts before thinking, resulting in performance errors	Use of a posted "stop sign" in work space (Sohlberg & Mateer, 2001b)	Low-tech, specialized task, clinician generated, developed for person with CI
Problem-solving domain: *decreased sequential processing*	Unable to carry out multistep tasks	Memory notebook with task sequences (Donaghy & Williams, 1998)	Low-tech, multifunction, clinician adapted, developed for person with CI
Problem-solving domain: *decreased reasoning*	Poor repair and strategy generation, resulting in difficulty completing task after making error or dealing with novel situation	Planning and Execution Assistant and Training System (PEAT; Levinson, 1997)	High-tech, multifunction, commercial, designed for CI population

Note. CI = cognitive impairment; PDA = personal digital assistant.

(Sohlberg, 2011, p.146)

Appendix E: Cueing Hierarchy for Word Retrieval Therapy

TABLE 1
A cueing hierarchy

1. ''What's this called?''
2. Directions to state the function of the item.
3. Directions to demonstrate the function.
4. Statement of the function by the clinician.
5. Statement and demonstration of the function by the clinician.
6. Sentence completion.
7. Sentence completion + the silently articulated first phoneme of the response.
8. Sentence completion + the vocalized first phoneme.
9. Sentence completion + the first two phonemes vocalized.
10. Say ''______.''

(Linebaugh, Shisler & Lehner, 2005)

Appendix F: Concussion Prevention Resources for Education

TABLE 2 Concussion Prevention Resources

Bicycle Helmet Safety Institute
- Clearinghouse Web site and technical resource for helmet information
- www.helmets.org; 703-486-0100

Brain Injury Association of America
- General information about head injury prevention, as well as brain injuries in several sports
- www.biausa.org; 800-444-6443

Canada's National Brain and Spinal Cord Injury Prevention Foundation
- Includes awareness and education program focused specifically on concussion; "smart hockey" videotapes designed to prevent concussion are available for purchase
- www.thinkfirst.ca; 800-335-6076

Centers for Disease Control and Prevention
- Wealth of brain injury information including free concussion fact sheets for athletes through the recently released high school coaches' tool kit
- www.cdc.gov/ncipc/tbi/coaches_tool_kit.htm

National Safe Kids Campaign
- Dedicated to the prevention of all unintentional childhood injury; available fact sheets are focused on sports and recreational injuries
- www.safekids.org; 202-662-0600

National Youth Sports Safety Foundation
- Educational organization focused on reducing injuries in youth sports; sports-safety fact sheets are available for purchase
- www.nyssf.org; 617-277-1171

Pashby Sports Safety Fund Concussion Site
- Web site devoted to providing education about concussion specifically, including proper recognition and prevention tips
- www.concussionsafety.com

(Kirkwood, Yeates, & Wilson, 2006, p. 1362)

Appendix G: Accommodation Examples

Table 2
Accommodations for postconcussion effects affecting school

Postconcussion Effect	Functional School Problem	Accommodation/ Management Strategy
Neuropsychological deficits		
Attention/concentration	Short focus on lecture, classwork, homework	Shorter assignments, break down tasks, lighter work load
Working memory	Holding instructions in mind, reading comprehension, mathematics calculation, writing	Repetition, written instructions, use of calculator, shorter reading passages
Memory consolidation/ retrieval	Retaining new information, accessing learned information when needed	Smaller chunks to learn, recognition cues
Processing speed	Keep pace with work demand, process verbal information effectively	Extended time, slow down verbal information, comprehension checking
Fatigue	Decreased arousal/activation to engage basic attention, working memory	Rest breaks during classes, homework, and examinations
Symptoms		
Headaches	Interferes with concentration	Rest breaks
Light/noise sensitivity	Symptoms worsen in bright or loud environments	Wear sunglasses, seating away from bright sunlight or other light. Avoid noisy/crowded environments such as lunchroom, assemblies, and hallways
Dizziness/balance problems	Unsteadiness when walking	Elevator pass, class transition before bell
Sleep disturbance	Decreased arousal, shifted sleep schedule	Later start time, shortened day
Anxiety	Can interfere with concentration, student may push through symptoms to prevent falling behind	Reassurance from teachers and team about accommodations, workload reduction, alternate forms of testing
Depression/withdrawal	Withdrawal from school or friends because of stigma or activity restrictions	Time built in for socialization
Cognitive symptoms	Concentrating, learning	See specific cognitive accommodations (above)
Symptom sensitivity	Symptoms worsen with overactivity, resulting in any of the earlier-mentioned problems	Reduce cognitive or physical demands below symptom threshold, provide rest breaks, complete work in small increments until symptom threshold increases

(Sady, Vaughan, & Gioia, 2011, p.714)

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