EDSP 798: Independent Study

Concussion in Children

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Traumatic Brain Injury (TBI) is an alteration in brain functioning caused by an external force to the skull and brain. A concussion is the most common type of TBI, which is caused by trauma to the brain from an impact or sudden momentum change (Brain Injury Association of America, 2012). The Division of Injury Response Centers for Disease Control and Prevention defines concussion as "a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces" (Centers for Disease Control and Prevention, 2013b). Concussions are caused by bumps, blows, or jolts to the head, which may come from direct hits to the head, gunshot wounds, violent shakings of the head, or forces from whiplash-type of injuries (Brain Injury Association of America, 2012; Centers for Disease Control and Prevention, 2013a). The external force to the head leads to a "wave of energy that passes through the brain tissue to trigger neurodysfunction," which is referred to as the "Neurometabolic Cascade of Concussion" (Centers for Disease Control and Prevention, 2013b). Despite the common reference to it as "mild brain injury" (MBI or MTBI), all concussions and TBI are brain injuries, can impact many aspects of a person's life, and may have long-term consequences if not dealt with properly (Centers for Disease Control and Prevention, 2011b; 2013b).

The injuries to the brain caused by concussions typically do not show abnormality on standard diagnostic imaging studies such as an MRI or a CT (Centers for Disease Control and Prevention, 2013b), which makes diagnosing the condition very difficult. To complicate the diagnostic process further, contrary to common belief, loss of consciousness due to concussions only occurs in 10% of the cases (Centers for Disease Control and Prevention, 2013b). Therefore, a concussion is considered to be a "Complex Neurobehavioral Syndrome" (Brain Injury Association of America, 2012). Recovery is generally slower for older adults, young children,

and those who have had multiple concussions (Centers for Disease Control and Prevention, 2013a). However, in the majority of instances, patients make full recoveries (Centers for Disease Control and Prevention, 2013b). It is still important to keep in mind that even if the symptoms of a concussion may appear to be mild, if not managed properly, they can lead to significant, life-long impairments that affect an individual's physical, cognitive, and psychological functioning.

Concussion and TBI Statistics

Currently, there are 5.3 million Americans who live with Traumatic Brain Injury related disabilities around the country, with the numbers steadily rising, with 3.8 million concussions reported in 2012 (double the reported number in 2002) (Head Case, 2013). The overall rate of Traumatic Brain Injury related hospitalizations, emergency department visits, and deaths climbed from 521 per 100,000 in 2001 to 824 per 100,000 in 2010. Emergency department visits drove the rate up sharply, from 421 per 100,000 in 2001 to 716 per 100,000 in 2010 (Centers for Disease Control and Prevention, 2014c). Every year, emergency departments in the United States treat over 173,000 sports and recreation related Traumatic Brain Injuries (including concussions) among children, from birth to 19 years of age (Centers for Disease Control and Prevention, 2011a). The American Academy of Pediatrics reported that emergency room visits for concussions in children 8-13 years old have doubled in the past decade, and concussions have tripled for 14-19 year olds in the same time frame (Head Case, 2013). Between 2007-2008 data and 2009-2010 data compiled by the Centers for Disease Control and Prevention (CDC), the rate of visits for young children 0-4 years of age increased by more than 50%, and the rate of emergency department visits were typically almost twice the rate of those in the next highest age group (15-24 year olds) (Centers for Disease Control and Prevention, 2014b).

Concussion Signs and Symptoms

There are four categories of signs and symptoms of concussions, as defined by Centers for Disease Control (CDC). The four categories are: Somatic, Cognitive, Affective, and Sleep (Centers for Disease Control and Prevention, 2013b). Somatic symptoms are also called "Physical" symptoms, and some of the main signs of concussions in this category are: headache, dizziness, balance disruption, nausea, vomiting, lethargy, lack of energy, visual disturbances (such as photophobia, blurry vision, or double vision), and phonophobia. Cognitive symptoms are also called "Thinking/Remembering" symptoms, and some of the signs are: confusion, anterograde or retrograde amnesia, loss of consciousness, disorientation, difficulty thinking clearly, vacant stare, difficulty concentrating, delayed verbal or motor responses, slurred or incoherent speech, excessive drowsiness, and difficulty remembering new information. Affective symptoms are also called "Emotional/Mood" symptoms, and some common signs are: irritability, emotional lability, fatigue, anxiety, sadness, and nervousness. Some of the major symptoms of concussion related to sleep are: trouble falling asleep, and sleeping more or less than usual. Some of the symptoms may appear immediately following a concussive event, while others may take days or months before being noticed (Centers for Disease Control and Prevention, 2010b; 2013b).

Symptoms from a concussion are broad, but can overlap with many other possible diagnoses, making diagnosis of a concussion difficult without proper understanding of the condition. It is considered an "evolving injury" because symptoms change or "evolve" as time progresses (Brain Injury Association of Virginia, 2013; Centers for Disease Control and Prevention, 2013b). To aid in the diagnosis, symptom checklists, which are available from organizations such as the CDC, should be used to evaluate the symptoms and their severities

throughout time (Centers for Disease Control and Prevention, 2013a; Halstead, McAvoy, Devore, Carl, Lee, & Logan, 2013).

Patients should be observed carefully for the first 24-48 hours after suspected concussions for signs of deteriorating neurological function, including worsening of any of the already present symptoms, which should prompt an immediate emergency department intervention. Some of the "danger signs" are: increasing or persistent headaches, repeated vomiting, any loss of consciousness longer than 30 seconds (though every loss of consciousness should be taken seriously), slurred speech, increased confusion, restlessness or agitation, unusual behavior, irritability, seizures, weakness or numbness in the extremities, significant cervical pain with tenderness, loss of range of motion, enlargement of one pupil over another, decreased coordination, and in children, not eating or nursing and crying incessantly (Centers for Disease Control and Prevention, 2010b; 2013b).

In rare cases, a dangerous condition called a contusion may occur to a patient with a concussion. A contusion is bruising or bleeding of the brain, which may push the brain against the skull. Some of the major symptoms of a contusion are: persistent headaches (that worsen), weakness, numbness or decreased coordination, repeated vomiting or nausea, and slurred speech. In some cases, the force of impact is great enough to cause a contusion at the site of impact as well as on the other side of the brain, as the brain moves to slam into the other side of the skull. This phenomenon, called "Coup-Contrecoup Injury," often causes additional complications in the patient's condition, such as "hematomas (brain bleeding), brain swelling, disruptions to the flow of cerebrospinal fluid (which surrounds, protects, and nourishes the brain), and problems with skull fragments compressing or entering brain tissue" (Centers for Disease Control and Prevention, 2010b; 2013b; Smith, 2013). In 5-8% of patients with a history of multiple

concussions, a rare condition called “Post-Concussive Syndrome” can occur, where the symptoms of concussions can persist for months (Centers for Disease Control and Prevention, 2013b).

Complication in the Recovery Process

There are many risk factors that should be considered for potential complications in recovery processes of patients with concussions. The patient’s concussion history is a very important component in the recovery process, because there are many potential risk factors in his history that could complicate recovery. Some of them are the number of occurrences, the severities of the concussions, mechanisms (causes) of prior concussions, and the duration of symptoms in the previous concussions (Centers for Disease Control and Prevention, 2013b). Having multiple concussions places a patient at risk for “Post-Concussive Syndrome,” which is a combination of concussion symptoms which last for weeks or months after the injury (Centers for Disease Control and Prevention, 2013b; Mayo Clinic, 2011b). In most cases, the Post-Concussive Syndrome symptoms occur within the first week to 10 days, and go away within 3 months. However, the symptoms may persist for over a year in rare cases (May Clinic, 2011b). The cumulative effects of multiple concussions, which in turn cause multiple brain injuries, may lead to lasting and progressive cognitive impairments in the patient that limit many aspects of their daily functioning abilities (Mayo Clinic, 2011a).

Improper management of the concussion recovery process and not allowing the brain adequate time to heal can aggravate the healing process, and even prove to be fatal. When a patient who had experienced a concussion has another concussion before the symptoms of the first concussion has subsided (perhaps by returning to contact sports too early), the second concussion may cause a rapid and often fatal brain swelling called “Second Impact Syndrome”

(Mayo Clinic, 2011a). Second Impact Syndrome, also known as SIS, has a 90% mortality rate, according to a study published in the Journal of Neurosurgery by Lupkin (2013).

Other risk factors are personal and family medical history; especially those with a neurological basis, such as migraines, depression, mood disorders, anxiety disorders, and developmental disabilities (such as Learning Disability and ADHD) (Centers for Disease Control and Prevention, 2013b). These previously present disabilities or medical conditions, especially in the patient, should be taken into account because many of the symptoms of a Post-Concussion Syndrome are vague and can be attributed to many different conditions. However, at the same time, concussion symptoms could be missed because of prior conditions that had similar characteristics (WebMD, 2013). Concussions in teenagers have been shown to cause mental illnesses, such as depression and anxiety disorder, as well as ADHD (Barton, 2014; Kahn, 2014). Some hypotheses on the reasons for the rise in mental illnesses are: the effects of the brain injury itself, diagnostic bias due to repeated medical visits for concussions, doctors mistaking concussion symptoms for depression, and the effect of social isolation experienced during recovery (Kahn, 2014). Along with the risk for mental illnesses and ADHD, people who experienced concussions double the risk of developing epilepsy within the first half decade (Mayo Clinic, 2011a). There are many factors to look for that could cause complications after a concussion, and there are equally as many signs to look for of complications after a concussion that could have detrimental effects in the recovery.

Concussion in Children

Generally, young children, teenagers, and older adults have longer recovery periods and are more likely to sustain concussions than people of other age groups (Centers for Disease Control and Prevention, 2010b; 2013b). The child's developing brain is much more sensitive to

concussion than a professional athlete, because it is still undergoing development. The brain tissues are unable to recover from trauma as quickly as the adult brain, and a child's brain is more sensitive to neurochemical and metabolic changes than that of an adult. The axons in a child's brain are not as well myelinated or insulated, which may make the axons more vulnerable to injuries. Physically, younger athletes also have less-developed cervical and shoulder musculatures, which decrease their abilities to absorb mechanical energy throughout their bodies. Also, because of their lack of experience, children are less likely to use proper techniques to reduce risks when playing sports (Centers for Disease Control and Prevention, 2013b).

Concussion and TBI in Child Statistics

Every year, almost 9 million children are seen in emergency departments for injuries, and over 9000 children die. Injuries are the leading cause of death in children, and the annual cost of unintentional child injuries is nearly $11.5 billion in the United States (Centers for Disease Control and Prevention, 2012b). More than 2.6 million children are treated in the emergency department each year for sports and recreation related injuries alone (Centers for Disease Control and Prevention, 2012c). Of those, almost 208,000 a year of the emergency department visits were for concussions and other TBI related to sports and recreation activities (Centers for Disease Control and Prevention, 2011c). From 2001 to 2009, the number of emergency department visits due to sports and recreation related TBI rose from 153,375 to 248,418, which is a rate increase from 190 per 100,000 to 290 per 100,000. In 2001, the percentage of emergency department visits by children 19 years old and younger for sports and recreation related TBI was 5.5%. The percentage of emergency department visits for sports and recreation related TBI steadily rose in the next eight years, and in 2009, it had risen to 9.4% (Centers for Disease Control and Prevention, 2011c).

The number one cause for brain injury for all ages is vehicular accidents. In infants, accidental dropping and physical abuse are the two primary causes of brain injury; in toddlers, vehicular accidents and falls; and in preschoolers, vehicular accidents, serious falls, and physical abuse. In elementary school-aged children, vehicular accidents, bike accidents, falls, and recreation related injuries cause majority of the brain injuries. In adolescents, vehicular accidents, sports injuries, and assault cause majority of the brain injuries (Brain Injury Association of Virginia, 2013).

The percentage of children 0-4 years old who were taken to emergency departments due to TBIs stemming from sports and recreation related injuries were highest out of all the childhood aged populations, at 9.1%. The second highest was 15-19 year olds, at 7.0%, then 5-9 year olds at 6.9%. Children 10-14 years old were taken to the emergency department at the highest numbers (over 1 million between 2001 and 2009), but only 5.6% of their visits were due to TBI. However, the number of children taken to the emergency department because of TBI was second largest for the 10-14 years old population, at 60,272 children between 2001-2009, with 15-19 year olds coming in first, with 61,851 being taken to the emergency department in the same time frame. There were almost 10 times more 10-14 year olds taken to the emergency room for sports and recreation related injuries than there were 0-4 year olds between 2001 and 2009. There were 2.6 to 2.8 million children per year taken to emergency departments between 2001 and 2009 for sports related injuries, but the number of children being taken for TBI had risen from around 150,000 to almost 250,000. The most dangerous sports in terms of sustaining TBI were bicycling (8.1%) and football (7.2%). For boys 10-19 years old, football was the cause of largest percentage of TBIs (Centers for Disease Control and Prevention, 2011c).

Sports Concussions and Support

Athletes of all ages are at risks for concussions, regardless of the sports they are participating in (Centers for Disease Control and Prevention, 2013b). Statistically, 1 in 5 high school athlete will sustain a sport-related concussion during a season. Of those athletes, 33% of them will report having 2 or more concussions in the same year (Head Case, 2013). Football accounts for 47% of all reported sports concussions in high school, with tackling causing 34% and being tackled causing 36% of the football related concussions (Head Case, 2013; Raygo, 2013). Between 2005-2006 school year through 2011-2012 school year, there have been an estimated 743,000 football related concussions in high school. This number is nearly the number of concussions in all other sports combined. The next highest number of concussions happens in girls' soccer, which accounts for 18% of the sports related concussions in high school (Raygo, 2013). Between 2005 and 2012, the number of reported concussions in high school sports rose sharply, with the top 3 most highest increases being boys' basketball (up 236%), football (up 187%), and softball (up 181%) (Raygo, 2013). It is possible to make sports safer by diagnosing and managing concussions appropriately (Centers for Disease Control and Prevention, 2013b).

Proper concussion management is vital to a successful recovery. Students often seem "normal" after a concussion, which is why brain injury is often referred to as a "silent epidemic" (Brain Injury Association of Virginia, 2013). In reality, many of the symptoms may not appear until the students are placed back into environments that stress the injured brains, such as the bright lights and noisy classrooms of schools. Many students with brain injury exhibit similar behaviors and symptoms as those with other disabilities, especially neurologically based ones such as Attention Deficit Hyperactivity Disorder (ADHD) and Learning Disabilities (LD) (Brain Injury Association of Virginia, 2013). As a result, adults may fail to recognize the need for academic or environmental adjustments to facilitate successful recoveries, either through being

unaware of the differing needs, or wrongly classifying the students as having different conditions (Brain Injury Association of Virginia, 2013; Halstead, et al., 2013).

Support at home. The first place the student returns to after the hospital is the home, under the care of worried and frightened parents. Twenty seven percent of children who were hospitalized for TBI left the hospital with symptoms that limited their functionality and disrupted their activities of daily living (Schutz, Rivers, McNamara, Schutz, & Lobato, 2010). The primary responsibilities of the family are to enforce cognitive and physical rest, as well as to make adjustments to the daily routines to reduce stimulations to the student's brain (Halstead, et al., 2013). Parents may do this by setting limits to stimuli input, such as watching TV, playing video games, or using the computer, as well as limiting physical activities (Schutz, et al., 2010).

As they spend the most time with the children, family members have a large portion of the responsibility to be aware of worsening of neurological conditions. Parents must actively monitor the physical and mental conditions of the child, and report to the physician immediately if they find concerning points. Parents should request to see a concussion specialist if the symptoms have not gone away after 10-14 days, the symptoms worsen, or the child has a history of multiple concussions or risk factors that could prolong recovery (Centers for Disease Control and Prevention, 2013b).

Another important responsibility that the family has is to make the ultimate decision on when and how to return the student to school, with physician guidance. The physician should advise the parents that the school can make appropriate accommodations for the student to help ease the process (Centers for Disease Control and Prevention, 2013b). The parents must become advocates for the student, in order to effectively request accommodations for the student, as well as to actively participate in the education process. They must follow up with the interventions,

and keep open communications with the school personnel. It is recommended that parents consider beginning the academic transition process when the student can tolerate 30-45 minutes of cognitive stimulation without becoming symptomatic (Halstead et al., 2013).

Support in school. Complications resulting from brain injury are extremely varied, and it is often difficult to predict what areas of learning will be affected, or how much time recovery may take (Brain Injury Association of Virginia, 2013). The Brain Injury Association of Virginia suggests that "an encouraging environment that is oriented to best utilize the student's strengths will more likely lead to successful learning" (2013). A child with TBI may have cognitive, emotional, physical, and/or developmental challenges. Pairing a child who easily fatigues, has headaches, struggles with depression, anxiety, or emotional disorders, has memory difficulties, or is experiencing developmental delays, with a "destructive school environment" can be very detrimental to the recovery process. A "destructive school environment" may be loud and over stimulating, lacking clear structure, unpredictable, full of information being presented too quickly, too demanding, or lacking social support or understanding for the students' unique difficulties (Brain Injury Association of Virginia, 2013).

Traumatic Brain Injury (TBI) was first classified as a disability to be served by special education in the 1990 reauthorization of the Individuals with Disabilities Act (IDEA). Traumatic Brain Injuries occur because of external forces, but in many schools, students are only classified as a student eligible to receive special education services due to TBI if they have "extreme injuries that cause obvious physical and speech disabilities" (Brain Injury Association of Virginia, 2013). The classification of "Traumatic Brain Injury" also does not include brain injuries that have "internal" causes, such as strokes and brain tumors, though they have equally as complicated, if not even more so, recovery processes (Brain Injury Association of Virginia,

2013). Schutz et al. explained this issue adequately in their article: "Of 24,021 children who had been hospitalized for TBI, 27 percent left the hospital with some form of functional limitation as determined by hospital staff. […] Only 1.8 percent were later referred for special education services despite experiencing limitations with activities of daily living" (2010). The severe limitation for the classification of TBI has created an "epidemic of unclassified and therefore improperly managed head injuries" (Brain Injury Association of Virginia, 2013).

Some common cognitive deficits following TBI are difficulty focusing and sustaining attention, delayed response time, decreased ability to organize information, difficulty with simultaneous processing, limited ability to generalize, rigid or concrete problem solving, decreased concept formation, altered perceptual or special function, executive function disorder, and decreased judgment (Brain Injury Association of Virginia, 2013). All of these deficits would contribute to difficulties in actively participating and succeeding in the school setting. The school must develop a plan to properly manage cognitive exertion and stress of returning to school with an injured brain for the student (Centers for Disease Control and Prevention, 2013b). Some signs that a student is not yet ready to return to school may be increased problems concentrating or remembering new information, longer time required to complete tasks, increased symptoms when working (such as fatigue and headaches), greater irritability, and sudden poorer academic performance (Centers for Disease Control and Prevention, 2013b). Appropriate guidance from physicians may help to ease the transition back into the school environment and facilitate recovery (Halstead, et al., 2013).

"Cognitive Rest" is the concept that avoiding potential cognitive stressors such as video games, cellphone usage, school work, computer usage, and watching TV may lead to quicker recovery, as there are less stress and stimulation being forced on the injured brain. There are

many published statements condoning cognitive rest, but there is no research at this point documenting its potential benefits or harms (Halstead et al., 2013). However, Centers for Disease Control and Prevention recommends physicians to advise their patients to engage in cognitive rest to avoid mentally exerting activities that could aggravate symptoms (Centers for Disease Control and Prevention, 2013b).

The fact that many of the students look physically well after concussions may cause the school to be reluctant to make academic adjustments for the students, because they do not fully comprehend the extent of deficiencies experienced (Halstead et al., 2013). However, the cognitive difficulties after concussions clearly affect the students' learning capabilities. It has also been found that using concussed brains to learn may worsen their symptoms, and perhaps even prolongs the recovery process because increasing cognitive activities adds stress to the injured brain (Halstead et al., 2013).

The goal of the transition plan is to avoid overexerting the injured brain to the point of worsening or reproducing concussion symptoms. To do so, the school, in cooperation with the child's doctors and parents, must determine the "right balance" between cognitive exertion and rest by creating multidisciplinary team called the "Return to Learning Team" for the student (Halstead et al., 2013). The Return to Learning Team must balance the need for the student to be attending school, with making appropriate adjustments in the school setting in terms of cognitive demands and stimuli to avoid increasing symptoms. The smaller sub-teams in the Return to Learning Team are the Family Team, Medical Team, School Academic Team, and School Physical Activity Team. All of the teams must keep open communication with each other, and must be well versed in their roles and responsibilities as a part of a concussion management team, to ease the transition process for the student. Each sub-team has different responsibilities, such

as the Medical Team being responsible for evaluation of the concussion, gathering data, and informing the schools of medical recommendations, while the Family Team is responsible for enforcing rest and making the decision to return the student to school. The School Physical Activity Team would safeguard the student from further potential injury, and the School Academic Team will work with the student to adjust the environment to meet his specific needs to facilitate successful academic reintegration without overwhelming the brain (Halstead, et al., 2013).

As the student begins recovering, the work demands, mental stimulation, and social activities should be increased, as long as they are safely tolerated by the student. Unless the neurological disturbances remain after 3 weeks, the student should be serviced predominantly by the general education classroom teachers through academic adjustments. The academic adjustments should not jeopardize the curriculum or require alterations to standardized testing. If the recovery process is still continuing after 3 weeks, the Return to Learning Team may consider longer term needs through the use of a 504 Plan. A 504 Plan will help the student access grade-level curriculum in the general education setting, but with accommodations such as extra time and change in schedule. If the symptoms last for 5 or more months, a more permanent disability may be considered, Child Find obligations are activated, and the student may be referred to special education (Halstead, et al., 2013). If the child is found to be eligible for special education services, an Individualized Education Program (IEP) will be developed for the student to modify the curriculum with specialized instruction and programs.

A 504 Plan is provided when it is determined that the concussion "substantially limits one or more major life activities, such as learning," and an IEP will be created if it is determined that the concussion "results in total or partial impairment that adversely affects educational

performance" to an extent that the student requires extensive modification to the curriculum to succeed and learn (Halstead et al., 2013). However, it is also important for the Return to Learning Team to evaluate the student for school related anxiety and avoidance issues before moving on with the accommodations or modifications, as the student's perceived fear of school may be adversely affecting his academic success, rather than his cognitive deficits (Halstead et al., 2013). As the number of concussion incidents rise in children, most schools will encounter children who are recovering from concussion symptoms. Therefore, it is imperative that schools conduct training and instruct their personnel on concussion management, along with educating the staff (especially the sports team personnel) about the importance of cognitive and physical rest (Halstead et al., 2013).

Support in Sports. Concussions sustained through high school football accounts for 47% of all reported sports concussions. The next two highest concussion sports are ice hockey and soccer. One in five high school athlete will sustain a sports related concussion during a season, and 33% of high school athletes who have one concussion will report two or more in the same year. There is also a rising number of middle school athletes sustaining concussions, which is around 4-5 million annually (Head Case, 2013). Athletes of all ages are at risk for a concussion, but young children and teenagers are exceptionally vulnerable (Centers for Disease Control and Prevention, 2013b). Along with the higher risks of concussions, a report by the Institute of Medicine and National Research Council declared that young athletes also "face a 'culture of resistance' to reporting head injuries" (Gier, 2013). The committee called for a "National Surveillance System" to improve data collection on youth sport concussions, and declared that "despite increased knowledge about concussions… there is still a culture among athletes and military personnel that resists both the self-reporting of concussions and compliance

with appropriate concussion management plans" (Gier, 2013). According to surveys conducted on youth and teenage athletes, majority of student athletes considered the games and their teams to be more important than their individual health, and responded that they would rather play through injuries and concussions than let their teams down (Gier, 2013). This culture and mentality is dangerous, not only for physical injuries, but also for concussions and TBI, because of the high risks stemming from complications such as the Second Impact Syndrome, which has an exceptionally high mortality rate.

Effective concussion management is an important component for sports concussions, because many athletes and peers are unaware of the catastrophic implications of going back on the fields before fully recovering. Students should not engage in same-day play, even if they seem "fine." This is due to the "evolving" nature of concussion symptoms. Same-day play could exacerbate the concussion symptoms, prolong recovery, and increase chances of complications (Centers for Disease Control and Prevention, 2013b). The athlete should be strictly monitored for at least the first and second hour after the brain injury, and observed for the next 24 or 48 hours after being sent home. Any detrimental changes in symptoms should prompt an immediate transport to emergency care. The physician or emergency department personnel should not give a "date of return" to the student for returning to play, because it is impossible to tell what timeline a student's recovery may take (Centers for Disease Control and Prevention, 2013b). A rule of thumb with student athletes, according to the Centers for Disease Control and Prevention is: "Younger the athlete, more conservative the treatment" due to their higher risks (Centers for Disease Control and Prevention, 2013b).

Athletes should only return to the field after their injuries have completely healed, to minimize the risks of complications. Physicians are recommended to follow the "Five-Step

Process," which could take days, weeks, or even months to complete, depending on the individual cases. The progression should be monitored carefully through a team approach, involving the physician, family, student, and coach.

Before the Five-Step Process is started, a baseline should be taken, when there have been no symptoms for at least 24 hours, and the athlete was in cognitive rest. Once the baseline data has been taken, the athlete may begin the Five-Step Process by engaging in light aerobic exercise, which aims only to increase the heart rate. The second step is engaging in moderate exercise, with very limited body and head movement. The third step is non-contact exercise, where the work out is more intense, but still strictly non-contact. The fourth step is reintegrating into the full contact practice, though with limitations. In step five, the student may return to play and competition. At any point, if symptoms resurface, the activities should be immediately stopped. After the symptoms have subsided for at least 24 hours, the athlete should go back to the step below the one he was partaking (Centers for Disease Control and Prevention, 2013b). It is important to emphasize to the athletes that taking the time to rest and recover fully will ultimately help them get back on the field earlier. Students should refrain from returning to physical education classes, sports practices or games, or physical activities at recess until they receive approval from healthcare professionals. Coaches and parents should encourage resting and recovering as responsible behavior (Centers for Disease Control and Prevention, 2010a).

Prevention

There is currently no sports equipment specifically designed to protect athletes against concussions. The helmets used in sports, such as football and hockey, do not meet the standards to prevent concussions, because they are designed to prevent catastrophic injuries, such as skull fractures (Centers for Disease Control and Prevention, 2013b). However, there are steps that can

be taken in order to help prevent and reduce the severity and number of concussions student athletes sustain every year. Coaches and adults should emphasize following the rules of play, good sportsmanship, and appropriate techniques (especially tackling techniques in football, which will help to decrease head and nervous system injury). Though the protective equipment do not prevent concussions, it is still imperative that they fit properly, are age and activity appropriate, are well maintained, and are worn consistently in order to minimize the risks (Centers for Disease Control and Prevention, 2013b).

The CDC states that "the best way to protect students from concussions is to prevent concussions from happening" (Centers for Disease Control and Prevention, 2012a). While a risk of concussion is a real threat for children in all situations in life, especially stemming from falling in children 0-14 years of age, there are precautions that can be taken to help prevent many of the brain traumas from occurring (Centers for Disease Control and Prevention, 2014a).

Parents should always buckle children in the car using child safety seats, booster seats, or seat belts which are developmentally and age appropriate. They should also make sure that children wear helmets when playing sports (especially contact sports) or riding vehicles (such as bikes, scooters, skateboards and snowboards), and modeling the safety behaviors themselves. Guardians should make their living areas safer, by modifications such as removing tripping hazards, using nonslip mats in bathtubs, improving lighting throughout the home, installing window guards to prevent children from falling out of open windows, and using safety gates at the top and bottom of the stairs. They should also make sure that the playground surfaces that the children use are made of shock-absorbing materials, such as hardwood mulch or sand (Centers for Disease Control and Prevention, 2013c).

Conclusion

Proper concussion identification, management, care, and awareness are all important components of making sure that patients can make the most optimal recovery possible. Concussion management care requires a multi-disciplinary team consisting of the family, work or school, and healthcare providers. For children, it is imperative to have supportive and knowledgeable teams at the school to help with the reintegration back into the school system, and perhaps even back onto the sports field safely.

Though there was limited evidence that concussion education programs were responsible for changing behavior towards head injuries, they have been shown to be effective in increasing awareness and concussion knowledge (Gier, 2013). There is still much to be done to raise concussion awareness, to improve diagnosis and management, and to abolish the culture of silence among athletes that "resists both the self-reporting of concussions and compliance with appropriate concussion management plans" (Gier, 2013). More emphasis must be placed on the concept that taking time to rest will help the patient recover more quickly and completely (Centers for Disease Control and Prevention, 2013b).

There are a myriad of resources available to patients, clinicians, and schools to aid in concussion awareness, management, and recovery. Table 1 illustrates some very useful resources in variety of mediums. The Centers for Disease Control and Prevention's website provides extensive information, resources, support, and even certified training for coaches and clinicians. Many of their printable PDF resources published on their website about concussions are available for free in printed form through the ordering page of their website.

Table 1.

Resources for Those Affected by Concussions

Title/URL	Type	Audience	Description
Brainlash: Maximize Your Recovery from Mild Brain Injury, 3rd Edition (Dr. Gail L. Denton)	Book	Family Physician Patient	Provides tools and facts to understand "Mild Traumatic Brain Injury" better for a large variety of audiences affected by MTBI, and covers options and services, health and vocational issues, medicolegal topics, psychological and emotional implications, etc. to be used as a general resource guide for MTBI.
Heads Up Concussion – Clinicians Training (CDC) www.cdc.gov/concussion/HeadsUp/clinicians/index.html	Online Training	Physician	Free online concussion training for clinicians, which goes over the pathophysiology of concussions, diagnosing a concussion, management of concussions, and preventing concussions, with a quiz at the end to check for understanding (Generates 1 CEC credit and certificate of completion)
Heads Up Concussion – Resource Center (CDC) www.cdc.gov/concussion/HeadsUp/clinicians/resource_center/resource_center.html	Online Resource	Physician School Coach Parent	Educational resources, prevention tips, assessments and tools, information about complications of concussions, video gallery, and resources to get involved in promoting awareness and sharing stories
Concussion Signs and Symptoms Checklist (CDC) www.cdc.gov/concussion/pdf/TBI_schools_checklist_508-a.pdf	Printable Resource Assessment	School Nurse Sports Coach School	A printable comprehensive checklist of common concussion signs and symptoms for school nurses, including a section with "danger signs" for immediate emergency intervention, and ability to chart changes in conditions overtime (because concussion is an "evolving injury"); Tear-off pads available for free
Heads Up Concussion in Youth Sports Coach Online Training (CDC) www.cdc.gov/concussion/HeadsUp/online_training.html	Online Training	Sports Coach School Parent Athlete	30 minute-long free online concussion training course for sports coaches to prepare for the sports season, to help keep athletes safe from concussion, involving interviews with experts, dynamic graphics, interactive exercises, and stories to learn how to recognize and respond to concussions (Generates certificate after completion of training and quiz)
Heads Up to Schools (CDC) www.cdc.gov/concussion/HeadsUp/schools.html	Resource Brochure Printable	School Nurse Teacher School Parent	Printable fact sheets, cards, posters, and brochures for school nurses, teachers, counselors, school professionals, and parents about concussion awareness, management, and recovery in PDF form, many of the pieces available in English and Spanish (Also possible to order free printed copies from CDC)

Facts about Concussion and Brain Injury: Where to Get Help (CDC) www.cdc.gov/concussion/get_help.html	Resource Brochure Printable	Family Patient	Resource brochure and fact sheet which provide information about concussion symptoms, danger signs, tips for healing, and information on where to obtain help (Free printed copies available from CDC)
Heads Up: Brain Injury in Your Practice Toolkit (CDC) www.cdc.gov/concussion/HeadsUp/physicians_tool_kit.html	Resource Brochure CD Printable	Physician	Toolkit for physicians containing clinical information and tools such as booklets with information on diagnosis and management of MTBI, patient assessment tool, care plan to assist recovery, fact sheets on preventing concussions, palm card for on-field management of sports related concussions, and a CD with downloadable kit materials and MTBI resources, which can be ordered for free from CDC, or downloaded as PDF files from the webpage
Sport Concussion Assessment Tool 3 (SCAT3) bjsm.bmj.com/content/47/5/259.full.pdf	Printable Assessment	Physician	Standardized tool for evaluating injured athletes (13+) for concussions that can be downloaded and printed to be used by medical professionals Includes Glasgow Coma Scale and Maddocks Score
Acute Concussion Evaluation (ACE) www.cdc.gov/concussion/HeadsUp/pdf/ACE-a.pdf	Printable Assessment	Physician	ACE provides evidence-based clinical protocol to conduct initial evaluation and diagnosis of patients with known or suspected MTBI for physicians
U.S. Trauma Centers (University of Pennsylvania) www.traumamaps.org/Trauma.aspx	Online Resource	Physician School Sports Coach Family	An interactive map of trauma centers all around the United States, with search function that allows the user to provide a location to find the closest trauma centers in the area, as well as manipulate the map to provide more detailed information such as the trauma levels served Beneficial to have searched before sports season for schools and noted
Concussion and Mild TBI http://www.cdc.gov/concussion/	Online Resource	Everyone	Resource page for information about concussions, and also to all of the "Heads Up on Concussion" programs and toolkits for physicians, coaches, and schools, especially focusing on high school sport concussions
Brain Injury and the Schools: A Guide for Educators http://www.doe.virginia.gov/special_ed/disabilities/traumatic_brain_injury/brain_injury_schools.pdf	Printable Brochure Resource	Teachers	A comprehensive brochure for teachers to educate them about brain injury in their students, and how to best approach the situation, including a section on brain injury, overview of how to manage students with TBI in the classroom, educational implications of TBI, transition planning, and how to support families
Traumatic Brain Injury Networking Team Resource Network	Online Resource	Teachers School Family	Website for educators, professionals, and parents with resources such as the TBI identification protocol documents, "Brain Injury in Children and Youth: A Manual for Educators," assessment

http://cokidswithbraininjury.com/			matrix, concussion information, brain injury resources in the state and nation, available services for children, etc.

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