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Heads Up: The Importance of Brain Rest After a Concussion A Paper Presented to Meet Partial Requirements

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Chapter I: Introduction

Sport-related concussions are a noteworthy problem in the pediatric acute care setting, resulting in over 173,000 children and adolescents in the United States being treated annually in emergency departments (CDC, 2011). Over the past ten years, sport-related concussions have increased by 60%. Visits to the emergency room involving sport-related concussions commonly involved 10 to 19 year olds, with boys being the largest portion, 71%. More than 62,000 concussions are sustained each year in high school contact sports. Football and girls soccer claim the highest rates with 55,000 and 29,000 respectively, suffering from concussions on an annual basis (CDC, 2011).

A concussion, as defined by the American Association of Neurological Surgeons, is an injury to the brain that results in temporary loss of normal brain function. It can be caused by a blow to the head, often with no signs of external injury. Not all concussions involve a loss of consciousness. People with concussions often experience amnesia and cannot recall what happened before or after an injury. A concussion can affect memory, judgment, reflexes, speech, balance, and muscle coordination. The three basic features of concussions include: inability to maintain a coherent stream of thought, a disturbance of awareness with heightened distractibility, and inability to carry out a sequence of goal-directed movements (AANS, 2013). Often, a single concussion does not cause permanent damage. However, multiple concussions can have serious consequences.

Traumatic brain injury (TBI) is defined as a blow to the head or a penetrating head injury that disrupts the normal function of the brain. A TBI can result when the head abruptly and forcefully hits an object, or when an object pierces the skull and enters brain tissue. A TBI can present as mild, moderate, or severe, depending on the extent of damage to the brain. Mild cases may result in a brief change in mental state or consciousness, while severe cases may result in extended periods of unconsciousness, coma, or even death (AANS, 2011). Post-concussion syndrome results from microscopic tears in the brain tissue. Symptoms include headache, dizziness, hearing loss, sleep disturbances, loss of taste or smell, attention deficits, and memory problems. Slower recovery time is evident in high school athletes who suffer a concussion compared to adults. Students who experience multiple head injuries in a short amount of time may suffer devastating or even lethal reactions related to second-impact syndrome (SIS). SIS occurs when someone receives a brain injury before they can recover from a prior brain injury. The post-concussive symptoms are more prevalent when this occurs. A second injury will greatly increase the chance for long-term neurological deficits, SIS, and death. All students who experience signs and symptoms of a concussion should receive medical attention, evaluation, and follow-up (Cobb & Battin, 2004).

Since 2009, there has been 44 states and Washington, D.C. that have passed youth sports TBI laws. However, these laws do not focus on primary prevention, but increase coaches' and parents' ability to identify and respond to concussions, and reduce the risk of multiple concussions. TBI laws require children and teenagers to be removed from play a minimum of 24 hours and cleared by a licensed health professional before returning. There is no established definition of what type of licensed health professional can determine return to play. Only 26 states require that the health professional be trained in TBI identification and management (Harvey, 2013).

The theoretical framework used for this literature review is the Dynamic Systems Theory (DST). The DST, as discussed by Levac and Dematteo (2009), suggests that motor development results from the interaction of multiple subsystems within the child. Those subsystems include the central nervous system and work jointly to accomplish a practical goal. During a DST assessment, functional tasks are evaluated in different settings, such as physical and social. These tasks are reviewed to evaluate whether changes in demands and environment impact the behavior of the different systems within the child (Levac & Dematteo, 2009). Cognitive function is essential to growth and development and if damaged can alter a child's future. This theory relates to pediatric brain injuries by presenting cognitive function as an essential aspect in growth and development in children and adolescents.

The justification for this review is whether brain rest and return-to-play guidelines can improve results for the pediatric patient. Obtaining a more thorough evidenced based knowledge will further enhance provider awareness by improving prevention, recognition, and response to concussions in the pediatric population. Early interventions of patients with a TBI may reduce neuropsychological shortfalls (CDC, 2011).

For school age children and adolescents who have a concussion related to sports injuries, how long should they rest and recover prior to returning to play to improve outcomes and prolong participation in athletics?

Literature Review

Chapter II: Methods and Results

School age children and adolescents who have experienced a concussion related to sports, brain rest, and return-to-play guidelines are the topics of this literature review. CINAHL, Medline, and PubMed from the Southern Adventist University Library were the main sources that were utilized. The key words used for the literature searches were "school age," "adolescents," "pediatrics," "concussion," "brain rest," "brain injury," and "return-to-play." The articles chosen were peer reviewed and from respectable national journals that varied from 2004 to 2014. The Levels of Evidence also known as the Hierarchy of Evidence was used for the citations (Oregon Health & Science, 2014).

The official medical definition of a concussion, recognized by the American Association of Neurological Surgeons, is a clinical syndrome characterized by immediate and transient alteration in brain function, including alteration of mental status and level of consciousness, resulting from mechanical force or trauma. The brain is protected by the skull and is cushioned by cerebrospinal fluid. Any abrupt blow to the head can cause the brain to move back and forth inside the skull. This occurrence sets up the brain to be at risk for tearing blood vessels, pulling nerve fibers, and bruising. A CT scan will not always show immediate or any damage to the brain (AANS, 2013).

As soon as a person experiences a concussion, microscopic tears of the brain tissue, neurotransmitters are released and unchecked ionic influxes occur. The binding of excitatory transmitters results in further neuronal depolarization with efflux of potassium and influx of calcium. Acute changes in cellular physiology immediately follow. The sodium-potassium pump begins to kick into gear. Adenosine triphosphate activates an increase in glucose metabolism. While the brain is experiencing diminished blood flow, the end result is a cellular energy crisis. This subjects the brain to something known as post-concussion vulnerability. The brain will then be susceptible to a second injury as well as short to long-term deficits (Giza & Hovda, 2001).

Cognitive Function

Bigler, et al. (2013), looked at children who suffered from mild to severe traumatic brain injuries and the impact on their social behavior. Twelve children with identifiable brain lesions in characteristic regions for social-emotional functioning were examined. The children ranged in age from 5 to 11. There were three Theory of Mind (ToM) tasks examined: cognitive, affective, and conative. Cognitive ToM assesses the information content of people's minds. Affective ToM looks at people's facial expressions, emotions, and speech in how one communicates an emotion different from the one felt. Conative ToM examines different forms of social communication and how a speaker might influence the way one thinks. The social-cognitive and social-affective functions were impaired in all twelve children involved in the study. Half of the children performed poorly on cognitive ToM task. The cognitive task consisted of the children viewing three cartoon frames on a computer screen. The frames included a character, two hats (blue and red), and a ball. The ball was initially hiding under the blue hat, but was switched to the red. The children had to pick which hat the character would anticipate the ball hiding under, assuming the character believes it is still hiding under the original hat. Half of the children had difficulty with the affective ToM task. The affective task included the children listening narratives from multiple short stories and choosing the appropriate emotion that goes along with the story. They were evaluated on five emotions including happiness, sadness, fear, disgust, and anger. Approximately 75% of the children performed poorly on the conative ToM task. During the conative task the children were shown different pictures with characters performing various tasks. They were shown the goal of the task, the outcome, and were told about the character's personality. They were evaluated on their ability to relate words to meaning and their comprehension of the various tasks (Bigler et al., 2013).

Jonsson & Anderson (2013) studied adolescents who suffered a mild traumatic brain injury (mTBI). Approximately 40% of the 173 youths evaluated showed signs of cognitive impairment one year after their injury. The youths suffered from impaired mental well-being and impaired health-related quality of life. If you previously were very active in sports and social activities and abruptly stop performing these tasks, you feel less comfort as before. The adolescents had trouble with eye and hand coordination that leads to impaired performance in leisure and daily activities. For example, children who enjoyed playing ball did not want to return to that activity because of lack of coordination they were experiencing one year post injury. Subsequently, this leads to a struggle in verifying and evaluating their own ability to perform tasks. There was a reduction in daily life activities that include shopping, cleaning, and cooking. The adolescents also did not return to perform leisure activities that they previously participated in before suffering a mTBI. Leisure activities included sports, exploring, celebrating, and pretending (Jonsson & Andersson, 2013).

Miles, et al. (2008), examined diffusion tensor imaging (DTI) metrics to evaluate predictors of cognitive function six months after patients who have suffered a mTBI. Patients underwent an MRI that included DTI between one and ten days after injury. DTI may provide short-term non-invasive predictive markers of cognitive function, such as changes in memory, attention, concentration, and daily function. Approximately 41% of the 17 patients in the study suffered cognitive impairment within an average of four days post-injury (Miles et al., 2008).

Scherwath, et al. (2011), examined children and adolescents following a mTBI using preliminary findings from a neuropsychological testing study. There were 10 children in the study who suffered from a mTBI, and 12 children diagnosed with a moderate or severe TBI. None of the children had previous motor or language delays. Half of the children were injured during a fall. There were 12 children who were studied that suffered from a moderate or severe TBI with an average age of 13. Of the children with a mTBI, 12% (shortly after injury) and 30% (two months post injury), were classified as cognitively impaired. Half of the children who suffered from a moderate or severe TBI were also found cognitively impaired. Cognitive impairment included language problems (finding words and vocabulary), concentration, and memory that were studied using three standardized tests. Children and adolescents are also at risk for developing emotional and behavioral problems. Children with no psychiatric history are at risk for developing hyperactivity (Scherwath et al., 2011).

Post-Concussion Syndrome

Fry, et al. (2010) looked at the effects of fatigue on post-concussion individuals, who suffered from a moderate to severe TBI, and how they handle performing tasks such as planning and decision-making. Fatigue is very common in patients who have suffered a brain injury, regardless of how severe. Up to 73% of patients can experience fatigue, whether mental or physical. Mental fatigue is associated with reduced cognitive flexibility and reduced inductive reasoning. Activities performed throughout the day such as concentrating, warding off distractions, and planning become more difficult. Participants with a TBI had significant reduced cognitive flexibility as compared with those who did not have a TBI. Fatigue had a greater impact on cognitive flexibility in individuals who had a TBI as compared to those who did not (Fry et al., 2010).

Montreal Children's Hospital implemented a rehab-after-concussion program that looked at ways to manage children who were slow to recover after receiving a sports-related concussion. Symptoms of post-concussion can appear nonspecific, such as school-related stress, anxiety, attention deficit disorder, or sleep disturbances. Children and adolescents can also seem depressed and have a sense of worthlessness if they are unable to participate in sports after a concussion. Mead, et al. (2009) argued exercise in adults could be used as a treatment for depression. Furthermore, it is likely that exercise in children can have a positive effect on post-concussion symptoms. Gagnon, et al. (2009), concluded that a close, supervised active rehabilitation program after one-month post-injury improved recovery times and outcomes. The sixteen children who participated in this study were able to return to sports and daily activities after participating in the program for a minimum of four weeks with twelve weeks being the longest duration of recovery (Gagnon et al., 2009).

Sveen et al. (2010), looked at 63 individuals between the ages of 16-60, who sustained a mild to severe TBI on admission, three month, and twelve month intervals. The Patient Competency Rating Scale (PCRS), a self-rating scale of ability in activities, was conducted 12 months post-injury. Such competency includes scheduling daily activities, participating in group activities, and keeping appointments. Persistent post-concussion symptoms were present in 47 of the 63 individuals at three months. Those symptoms can include school-related stress, anxiety, and sleep disturbances that last for several weeks on a regular basis. Patients reported fatigue, forgetfulness, and poor concentration. Problems in competency during daily activities were reported by 45 of the 63 individuals at twelve months. Patients who are experiencing symptoms at three months may suggest the need for further rehabilitation to prevent long-term unfavorable effects from concussions. There is indication that post-concussion symptoms that still exist three months post-injury can still have an affect on a person’s daily life at one year after injury (Sveen et. al, 2010).

Pickering et al. (2012) spearheaded a study to estimate the prevalence of post-concussive symptoms following head injury among adolescents in full-time education, and sought to identify prognostic factors at the time of presentation to the emergency department that may predict the development of post-concussive symptoms. Prognostic factors included a GCS of less than 15 at the time of injury and being assaulted as the cause of injury. Head injury was defined as any blow to the head causing the diagnosis of head injury to be given. Of the 188 patients studied, 142 were reported making a full recovery one month post-injury and were therefore not looked at during the six month follow-up. Of the 46 remaining patients, 82% were assaulted as the cause of their injury. Nine out of the eleven of those patients were still experiencing symptoms six months post-injury.

Head-to-Head Contact

High-school football players account for up to 67,000 concussions every year. However, it is suspected the number could be much higher due to underreporting of injuries. In 2007, 35 high-school varsity football team players from a single central Illinois school were observed over a season for head-to-head contact. Using a wireless monitoring device called The Head Impact Telemetry System, impacts were evaluated that were capable of producing an injury. The device offered immediate data to the clinician on the sideline. Impacts to the top of the head yielded the greatest linear acceleration and impact force magnitude. The front, back, and side of the helmet returned less of an impact, respectively. The increased impact to the top of the helmet puts the player at risk for not only a concussion, but a cervical injury as well. Coaches should teach proper tackling techniques to reduce the risk of concussions and other injuries. (Broglio et. al, 2009).

Protective Equipment and Injury Prevention

A level 1 pediatric trauma center in Northern California initiated a collaborative helmet safety program with a local nursing school and the school district. The purpose of this partnership was to improve utilization, knowledge, and attitudes toward helmet use in school-age children. Persaud, et al. (2010) determined in a study on the nonuse of bicycle helmets that helmet use decreases the risk of head injury and death among children involved in bicycle accidents. The helmet safety program proposed that in-school helmet safety education could increase helmet use in children which in turn changes their attitude and increases their knowledge on helmet safety (Adams, et. al, 2014).

Benson, et al. (2009) piloted a literature review in regards to helmet use and head injury in organized sports including football, hockey, lacrosse, and boxing ranging from high school to college-aged. However, the effect of helmet and headgear use specifically on concussion risk remains questionable. There is no substantial evidence that mouth guards and face-shield use will reduce the risk of a concussion. Although, 56% of all concussions sustained among 2,470 football players from 21 Alabama high school players over three consecutive seasons were sustained by players who did not wear mouth guards (Benson et. al, 2009).

Mouth guards have played a role in sports for many decades. Winters & DeMont (2014) compared the impact of custom made, properly fitted mouth-guards to over-the-counter mouth guards and the reduction of concussions in high school football. Twenty-four players suffered a concussion during the season. Eight of the players were wearing greater than 3mm thick mouth guards. Thirteen players were wearing a mouth guard with less than or equal to 2.5mm thickness. One player was wearing a mouth guard with no support and the others were wearing no mouth guards at all. Athletes who were fit with custom made mouth guards that had a greater than or equal to 3mm thickness had a reduction in the numbers of concussions suffered compared to those who wore over-the-counter mouth guards. The reduction was due to repositioning or realigning of the mandible to better absorb, dissipate, or reduce potentially concussions due to interlocking of the teeth. The basis behind the findings is that custom mouth guards limit the acceleration of the head in impacts to which the mandible experienced the primary point of impact (Winters & DeMont, 2014).

Children often sustain a mTBI during play and sport activities. Andersson, et. al (2012) concluded that the most common cause of injury of children between the ages of 0 to 16 were falls at 44%. Andersson, et al. (2012) challenged parents and professionals to provide meaningful activities in a safe environment for children. Proper supervision at home and better-designed schoolyards are just two examples of ways to prevent accidents (Andersson et. al, 2012).

Pelletier & Dunham (2006) examined key characteristics of injuries suffered by amateur football players between the ages of 7 and 19. An injury was defined as any physical complaint or tissue damage that occurred during a football game or scheduled practice. The largest group that reported injuries was between the ages of 12-14 at 38%. The data of reported injuries included, but no limited to the thoracic and lumbar spine (15%), brain (13%), and cervical spine (8%). Mild injuries were reported in those between 10-12 years of age. Seven to ten year olds were more likely to develop back, cervical spine, and upper extremity injuries. It was determined that identifiable, reliable factors influence the level of risk for injury. Training programs and coaching techniques should be modified to reduce the risk of injury (Pelletier & Dunham, 2006).

Educating children and coaches about concussion in sports is essential to preventing and recognizing head injuries. There have been numerous materials offered to coaches that include educational videos, posters, and pamphlets on the seriousness of concussions in children. The CDC spearheaded an educational initiative in 2007 called, “Heads Up: Concussion in Youth Sports.” The purpose was to better inform coaches on how to recognize and respond to concussions in athletes. Of the 340 youth coaches surveyed, 63% of them stated that they now view concussions as a more serious injury after receiving the “Heads Up” materials. The more coaches who have these materials on hand the likelihood of increased education and awareness among communities (Covassin et. al, 2012).

Prognosis and Management

There are many factors that play a role in survival and recovery from a head injury. Age, injury severity, initial glascow coma scale (GCS), and pupil reflexes can determine a patient's outcome. Factors such as gender, age, injury severity, pupil reflex, CT features, and laboratory results are strong predictors in patients with TBI. Factors associated with unfavorable outcomes include older age, male gender, lower level of education, lower GCS score, no pupil reaction, duration of coma, and intracerebral lesions. Blunt head trauma is associated with a higher mortality rate. GCS is the most widely used tool to evaluate level of consciousness. It should continually be assessed with brain injury patients. Patients who have a GCS of 8 or higher are more likely to survive. Decreased oxygen to the brain can cause long lasting effects and should be recognized early in treatment. It is critical to identify those who have a need for immediate intervention, such as surgery, to minimize disability and death (Kim, 2011).

Rivara, et al. (2012) performed a study in Washington State between 2007-2008 that looked at children under the age of 18 who suffered a disability after a TBI. A disability was noted if a patient needed aid from community resources that included tutoring, rehabilitation therapies, speech therapy, physical therapy, and mental health services 12 months after injury. The burden of disability caused by TBIs in children is primarily from mild injuries. A mild TBI was defined as any period of observed or self-reported transient consciousness as recorded in the patient's medical record; any period of observed or self-reported amnesia lasting less than 24 hours; or observed signs of neurological dysfunctions such as posttraumatic seizures, irritability, lethargy, or vomiting. The GCS must also have been recorded between 13-15 at the time of injury. A total of 436 patients participated in this study. Approximately 222 of the patients were receiving services 12 months post-injury. Of those, 14.3% were mild TBIs and 61.6% were moderate to severe. Although moderate to severe had a higher incidence of disability services, the population burden of disability was mostly due to mild TBIs. The population incidence rate of children receiving new services at 12 months was 9-fold higher among those with mild TBI than those with moderate or severe. Efforts to prevent these injuries as well as to decrease levels of disability following TBIs are necessary. (Rivara et. al, 2012).

Minimal and mild TBI are common, representing a significant burden on individuals, families, and healthcare providers. Early intervention has been noted to play a significant impact on the outcome of the patient. Russo, et al. (2010) that examined the number of children with minimal and mild TBIs and their demographic factors, causes, and associated signs/symptoms and management. Falls accounted for the most common cause of injury with blunt TBI and sports-related TBI close behind. Over 68% of the children observed were discharged from the hospital and followed up with their regular doctor. Older children are more at risk for mild TBI most likely due to the fact that there is an increase in participation in sports (Russo et. al, 2012).

Stippler, et al. (2012) executed a review of literature from over 70 respected articles looked at routine follow-up CT scans after an mTBI. CT scans of the head show abnormalities in 6 to 12% of patients who suffer an mTBI. Neurosurgical intervention is only required in up to 0.3% of these patients. Routine follow-up CT scans did not predict the need for neurosurgical intervention. Follow-up CT scans based on neurological decline, however, did alter treatment five times more often than routine follow-up. The National Institute for Health and Clinical Excellence guidelines recommend observation without routine follow-up CT scans except with risk factors such as increased agitation, decline in GCS, vomiting, or new focal neurological deficits (Stippler et. al, 2012).

Project Brain

In 2000, the TBI Program in the Tennessee Department of Health was awarded a Health Services and Resources Administration (HRSA) grant with the goal of improving educational outcomes for students who experienced a TBI. Project BRAIN (Brain Resource And Information Network), focuses on the education and training for educators, families, and health professionals who take care of adolescents and children with TBI. With continued grant funding from HRSA and Tennessee Department of Education (DOE), and with financial support of the Tennessee Disability Coalition for one year, the program has expanded since its inception to encompass the continuum of care from hospital to home to school. Families now go home from three children's hospitals in the state of Tennessee with information about TBI, which establishes a bridge of support for the school and the family. In 2009, Brain Injury Transition Liasions (BITL), were placed in children's hospitals across Tennessee. They are a bridge of communication between the hospital, family, and school. The hospital will diagnose a patient with a TBI. The staff will then present the family with an information packet on Project Brain and the BITL process and will need to obtain consent from the family so they may be contacted. The family will be contacted by the BITL at 2 weeks, 3 month, and 6-month intervals to check in on the family and patient and provided any needed resources. The BITL will also contact the child's school if consent is given so the principal and teachers are aware of the child's injury and offer resources for further education and support (Denslow et. al, 2012).

Limitations

Project Brain is a continued work in progress. There are still children who are missed through the process on a daily basis. Not every child is seen at a Children's hospital for head injuries. Whether they are taken care of at an outlying facility or are assisted by staff at school or on the field, depending on where the injury takes place. As mentioned previously, educating children and coaches about concussion in sports is essential to preventing and recognizing head injuries. CDC's "Heads up" materials are a great way to increase awareness and education about head injuries in sports and provide information to coaches on prevention and recognition regarding concussions.

Brain Rest and Return to Play

When an athlete is suspected of having a concussion, he must be removed from play immediately. Brain rest includes avoiding physical exertion, electronics, reading, and television. Brain rest is individualized by patient. There is no set time, because every patient and injury will be different. The main goal is no symptoms at rest and if the patient has return of symptoms upon activity, the patient must stop the activity. Communication between the athlete, family, and the medical professional caring for the child is essential regarding any return of symptoms or new symptoms that may develop (AANS, 2014).

Conclusions

Concussion is a concerning and complicated problem in sports requiring a multifaceted approach to diagnosis and management. Athletes, coaches, and parents need to be properly educated on how to recognize a concussion and to seek appropriate health care. A licensed health care professional trained in the evaluation and management of concussion is in the best position to correctly diagnose a concussed athlete. Standardized sideline tests provide a helpful, uniform approach for examination, but further studies are needed to delineate their accuracy. Any athlete who is suspected or diagnosed with a concussion should not return to play on the same day (Harmon et. al, 2013).

The American Academy of Neurology (AAN) endorses return-to-play guidelines. They are a set of instructions created from evidenced-based literature reviews that recommends any athlete suspected of having a concussion immediately be pulled from play. The athlete should then not participate in athletics until cleared by a licensed health professional (AAN, 2013). Without needed brain rest, a child is at risk of not making a full recovery and jeopardizing their future.

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