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A Review of the Progression of Concussion Protocols used over time in High School and College Athletics

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A REVIEW OF THE PROGRESSION OF CONCUSSION PROTOCOLS USED OVER TIME IN HIGH SCHOOL AND COLLEGE ATHLETICS

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ABSTRACT

A Review of the Progression of Concussion Protocols used over time in High School and College Athletics

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Concussions have a significant impact on teenagers and young adults. Most concussions occur when participating in sports. Therefore, the focus is on high school and college athletes for this review. Over the years many new concussion studies and protocols have been implemented and removed. Concussions are head injuries, where the person has suffered trauma causing the brain to shift and receive damage. This typically impacts brain tissue and a variety of symptoms results. Concussions were traditionally not considered with the same severity as broken bones or bloody wounds. Head injuries can have extreme effects on the body and daily living without evident bruising or cuts. Some symptoms are obvious, with loss of consciousness, seizures, brain bleeds, skull fractures, and others. Players used to be sent right back on the field or told to take time off school and not participate in any physical or mental activities; now there are more protocols for rest while participating in classes. By reviewing the basics of concussions, past concussion protocols, and current treatment plans, there is hope to gain a better picture of available and future research to improve care for players who sustain concussions both immediately and in the long term.

KEYWORDS: Concussion, Protocol, Symptoms, Treatment, Past, Present

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CHAPTER ONE:

Concussion Overview

Defining a Concussion

The brain is a vital component to life and something humans are constantly working on and developing. Concussions are a common enemy of a healthy brain, causing lasting impacts that negatively influence sensation and function. A concussion is a form of traumatic brain injury (TBI), commonly occurring through force directly to the head or body, ultimately impacting the brain (Harmon et al., 2013). These head injuries can cause the brain to shift in the skull (Cohen, 2019). Shifts caused by bumps, bouncing, or twisting of the brain lead to further inflammation, swelling, and damage to brain cells (Cohen, 2019). Concussions can commonly result in an altered mental status that is the important part in defining and treating the symptoms and experiences associated with a mild TBI (Beckwith et al., 2018).

Different levels of hits can cause various effects to the brain tissue and ultimately functional impairment of the person (Beckwith et al., 2018). With differing degrees of injury, it is important to pay attention to where the impact occurred, and the levels of force applied. Concussions can occur in four different areas of the brain, the cerebrum, cerebellum, brain stem, and corpus callosum (Beckwith et al., 2018). Additional research is being done to determine the impact of biomechanics that lead to a sport-related concussion (SRC) or a mild TBI, which were first discovered when studies were completed on animal and human cadavers, analyzing the intracranial pressure from controlled impacts (Beckwith et al., 2018). Mild TBIs and concussions are becoming

more widely recognized and understood, as additional research has been conducted and further protocols are put in place to prevent such occurrences (Beckwith et al., 2018).

The research field of concussions is evolving as more studies are being completed and information is collected on how to better help individuals who sustain a TBI. However, concussions are still underreported as there are about 300,000 reported concussions yearly in high school athletes (Lindner, 2023). Considering these levels, the commonality of concussions is higher than the known numbers, even within sports that use helmets and those deemed "non-contact"; practices account for 35% of concussions (Lindner, 2023; Klossner, 2007). Up to 50% of athletes who sustain a concussion continue without reporting it to a healthcare professional (Lindner, 2023; Harmon et al., 2013). The underreporting of concussions leads to less monitoring about when a player can return and can lead to players in competition without fully recovering from their last head injury. About 40% of young athletes who have been diagnosed with a concussion return to play sooner than is suggested by guidelines (Valentine et al., n.d.). With many players returning before they are completely healed, there is the added risk of making the first concussion worse or causing possible long-term effects. Clear concussion protocol is important for maintaining a healthy understanding of symptoms and keeping young athletes safe.

Symptoms

Head injuries can cause unexpected symptoms and side effects. These side effects can be broken down into categories based on what they affect; the physical, emotional, thoughtful, or resting ability of the individual (Valentine et al., n.d.). It is important to be aware of the possible signs and symptoms to know when someone should be assessed by

an athletic trainer or other health care professional. Timing is important, as some individuals can suffer severe symptoms making it difficult for them to think clearly or take care of themselves. Some clear signs of a concussion are different size pupils, slurred speech, numbness, decreased coordination, vomiting, and loss of consciousness (Cohen, 2019). Everyone will likely have a unique range of symptoms and there is not one specific symptom that can definitively determine this diagnosis (Cohen, 2019). This variability makes it even more important for people to be aware of the signs and symptoms, to look out for each other and provide care or get help if needed. For example, some individuals will present with a greater sensitivity to light while others will be sensitive to sound, dizziness, or confusion (Valentine et al., n.d.). Some symptoms can be as severe as memory loss, loss of consciousness, onset of seizures, and trouble with muscle control or sight.

Each concussion should be analyzed individually. The athlete will likely have a unique set of symptoms and a different recovery timeline. There are many symptoms that can be observed in an athlete who has suffered a concussion. Loss of consciousness is sometimes thought of when looking for a concussion diagnosis. However, it should be noted that less than 9% of concussions have been seen to cause a loss of consciousness (Ritter, 2023). Other symptoms are seen at varying levels through different types of hits and severities regarding where in the brain the damage occurred (see Table 1 for common signs and symptoms). Different concussions result in different effects and can cause a wide range of symptoms within each person and based on the hit (Valentine et al., n.d.). Table 1 below lists the differences in signs and symptoms that can be experienced by the individual. In addition to common signs and symptoms, the following red flags would

require immediate medical attention: worsening headache, slurred speech, repeated vomiting, very drowsy or can't wake, seizures, neck pain, increased irritability or confusion, weakness or numbness in extremities, unusual behavioral changes, can't recognize people or places, and loss of consciousness. Any of these changes should be followed with a visit to a health care professional for further evaluation.

Table 1

Common Signs and Symptoms

Physical	Physical	Cognitive	Emotional	Sleep
Headache	Nausea	Mentally Foggy	Irritability	Drowsiness
Sensitivity to Light	Sensitivity to Noise	Problems Concentrating	Sadness	Sleeping More
Fatigue	Numbness/ Tingling	Problems Remembering	Feeling More Emotional	Sleeping Less
Visual Problems	Vomiting	Feeling More Slowed Down	Nervousness	Trouble Falling Asleep
Balance Problems	Dizziness			Trouble Staying Asleep

Note. Table to depict signs and symptoms of concussions is on page 10 of Valentine, V., Lystad, J., Carlson, M., Bergeron, M., Odney, T., & Reed, B. (n.d.). *Dear Colleague.* Sanford Orthopedics Sports Medicine. http://www.sdhsaa.com/HeathSafety/ConcussionManagementAndRTPLegislation.pdf

It is helpful when there are witnesses to the injury to best understand the force, angle, and possible severity of the blow (Klossner, 2007). However, head injuries are not always what one would expect and can have a variety of different looks and blows that may impact the brain in ways that are not expected. These variabilities in how people sustain a concussion and what symptoms they exhibit are reasons why it is not always easy to track concussions, and some go unreported.

When analyzing a possible TBI or SRC on the field, it is important to look at measurements including the frequency, the location, and the kinematic responses that

occurred at the time of impact (Beckwith et al., 2018). Often a skilled paramedic, EMT, nurse, or athletic trainer will be present at sporting events if injury occurs during the game. These healthcare professionals are equipped with the knowledge to help a player who recently sustained a concussion or send them to the hospital. In occurrences outside of sports, an evaluation by a paramedic or other healthcare professional would be warranted when concerning symptoms were present. This is another important reason why knowledge of concussions is important and increasing symptom awareness can lead to better treatment and recovery. While most symptoms occur within minutes of obtaining a head injury, there are some symptoms that may take a few hours to show up and other symptoms days later, or only under certain conditions when the brain is under stress (Cleveland Clinic, 2020). A person may not initially be nauseous but could later be affected by bright light or a loud noise leading to vomiting, severe headaches, or dizziness.

More severe concussions may result in possible bleeding in the brain (Klossner, 2007). Brain bleeds are extremely important to watch for, as they can lead to more severe side effects later or even death. After receiving a concussion diagnosis, it is important to avoid taking aspirin or other types of blood thinners due to possible brain bleeds (Klossner, 2007). Brain bleeds additionally have similar symptoms to a concussion and should therefore be taken even more seriously, as the two problems could be difficult to distinguish. Although most concussions are termed a “mild” brain injury, it is important to understand the serious symptoms and side effects, even though all are not life-threatening (Cohen, 2019).

Common Causes

Concussions are caused by a variety of different events resulting in movement of the brain within the skull and damage to the brain cells. The most common causes of concussions are from accidents involving motor vehicles, falls, and sporting events (Cleveland Clinic, 2020). Motor vehicle accidents can result in people hitting their heads on steering wheels, dashboard, seats, or airbags to name a few. Accidents involving motor vehicles cause approximately 17% of all TBIs (Sheldon, 2022). Concussions do not have to be caused specifically by a blow to the head as they can occur through force to other areas of the body as well, causing the movement of the head and subsequently the brain. An example of one such instance would be someone who obtained a concussion through impact to the chest or neck, causing whiplash including abrupt movement of the skull and brain, resulting in a concussion. Concussions can also be caused by people falling and hitting their head on various furniture, objects, or the floor. In older adults, over 60% of head injuries are the result of falls (Schonnop et al., 2013). Finally, concussions can happen during various sporting events, especially contact sports such as football, basketball, ice hockey, lacrosse, wrestling, and soccer. These head injuries can be caused through contact between players, field equipment, and the ground (Cleveland Clinic, 2020). Protective measures that have been put in place for specific areas where the most concussions are seen.

Incidence

Concussions are present in all sorts of activities and have various causes. Instances where contact leads to a concussion are not uncommon at different sporting events. The Center for Disease Control and Prevention (CDC) estimates that athletes will

experience concussions during any sports season at about 5-10% (Michigan Medicine, 2023). Research additionally depicts that a person who has one concussion is 1-2 times more likely to get a second, while a person who received 2 concussions is 2-4 times more likely to sustain a third, and further, someone who has sustained 3 concussions is 3-9 times more likely to get a fourth concussion (The Live Better Team, 2016). However, the reporting rate for concussions is low, with an estimate of 50% of concussions going unreported (Harmon et al., 2013). These high levels of underreporting depict more concussions than what is currently seen.

Once a concussion is sustained, there have been a variety of protocols put in place over the years, leading to different return to learn and play timelines. It is important to make sure the athlete has healed completely before returning to competition, as there is the added risk of compiling concussions and being more susceptible to a second concussion when not fully recovered from the first (Daniels, 2023; Klossner, 2007). Sequential concussions can have a higher risk with each one, such that by the third concussion, the person is 3-9 times more likely to sustain a concussion with much less force than the first (The Live Better Team, 2016). The long-term effects of trying to come back from a concussion too soon can have a significant impact on quality of life both currently and far off in the future (Ritter, 2023). Thus, it is important to take time and go through return to learn and play protocols thoroughly. For example, after sustaining a concussion, 40% of young athletes return to play before it is suggested (Valentine et al., n.d.). This can lead to premature hits and consecutive head injuries, furthering the damage done to the brain and the necessary recovery time.

Most Common Sporting Events

One of the most common sporting events to see concussions in is American football. In a typical season, it is reported that 10% of college players and 20% of high school players will obtain a brain injury ranging from mild to severe (Brain Injury Research Institute, 2023). Of the concussions occurring during football, 70% of them happened while at practice (Marquardt, 2021). With the continued brain development as a teen and young adult, it is especially important to avoid damage during these years of higher education. During games, the rate of brain injuries is one in every five and a half games played (Brain Injury Research Institute, 2023).

In soccer, there are players who are hit with the ball straight to the head, taken down by slide tackles, run into the post, and even kicked in the head. With many ways to be injured, whether it is scraped knees, broken bones, or deep bruising, monitoring and medical personnel are needed at games. In all the different injuries reported by soccer players, 22% are concussions (Levy et al., 2012). With about a quarter of all injuries being brain related, it is important to understand what to do and how to safely care for everyone. In addition, 5% of soccer players sustain a brain injury due to playing (Brain Injury Research Institute, 2023). Since it is easier for players that have sustained a concussion to get another, making a full recovery is a crucial step to getting back into the game. The repetitive nature of blows to the head in soccer is different in nature from boxing, but it is seen that the total effect of heading in soccer is similar to boxing for years (Broglio et al., 2003). Cumulative effects of small head impacts can additionally impact the long-term effect on brain injuries and function.

Concussions can happen in basketball; a body check gone wrong, elbow to the temple, ball gone wild, or even a collision with the wall. Basketball is a full-contact sport and can result in serious injuries, some of which are broken bones, chipped teeth, or mild TBIs. Concussions are not as common in basketball and have been observed to take an average of 37.3 days to recover (DeFroda et al., 2022). This time frame is less than most broken bones or torn tendons. These athletes were reported to have a 100% return to play rate and 88% returned even within the same season they were injured during (DeFroda et al., 2022).

In other sports, there are different paddings used to try to protect against such brain injuries. In ice hockey, there is the use of full body padding and helmets to avoid unnecessary head injuries and try to help prevent brain damage (Cummings, 2024). These protective measures are purely that and are by no means able to eliminate the risk of brain injuries which are commonly seen despite attempts to avoid them. The same is seen in men's lacrosse with the addition of helmets and padding as opposed to women's lacrosse, where it is typical for players to wear only a small eye protector and mouth guard (MonkeySports, 2023). The variances of gear by sport are typically reflective of the contact seen, however, there are some sports that have no additional protection, and still have high numbers of concussions.

Conclusion

Concussions are a unique type of injury in how they are formed, developed, expressed, and healed. Individual cases are new and have their own characteristics within the realm of TBIs. Presenting different signs and symptoms according to how the individual is hurt. Mild TBIs differ in many regards and the importance of these

differences have an impact on the recovery and treatment plan implemented. Concussions tend to require attention to symptoms, sleep cycles, and prioritizing recovery processes. The steps to get back to daily living activities are crucial and it is important not to rush back into strenuous mental activities, sporting events, or other activities that could put the individual at increased risk for injuries. Implementation of the correct recovery process is decided after a diagnosis and symptom testing. This allows for better individualization of the treatment plan within the concussion protocol.

CHAPTER TWO:

Medically Determining a Concussion

To determine if players truly fall under the category of sustaining a concussion, it is important to first pull the player from the game. A coach should be aware of the education on concussions, know when this is a possibility, and be responsible enough to pull players for evaluation on the sidelines (Ritter, 2023). The trained medical professional would then be able to provide an evaluation and track players' symptoms. The evaluation would likely involve a series of questions, testing players general awareness, short- and long-term memory, and a balance test.

Concussions typically refer to the neurochemical and neurometabolic state of the brain, which makes it harder to immediately and accurately diagnose a concussion and its severity as compared to broken bones and such (Ferry & DeCastro, 2023). To best identify if a concussion has occurred, it is important to investigate four different domains that contain many of the common symptoms associated with concussions, using the Sideline Concussion Assessment Tool 5 (SCAT5; Ferry & DeCastro, 2023). The first domain deals with emotions, particularly looking for changes in mood and irritability from the individual. The second is a cognitive function evaluation, assessing confusion, amnesia, mental fogginess, and difficulty concentrating. The cognitive domain is typically tested on the sidelines with a few easy questions to assess the player's awareness of the environment and memory. The third domain is physical and somatic symptoms, seen through headaches, dizziness, difficulties with balance, and changes in vision. When testing for the third domain, simple questions can be asked for some symptoms, like headaches. Balance can be assessed with a few easy actions such as

balancing on one foot, walking in a straight line, and others. The fourth domain is sleep, and includes drowsiness, excess napping, and difficulty staying awake, commonly seen throughout the day and recovery. The sleep domain includes drowsiness, sleeping more or less than usual, and difficulty falling asleep (Ferry & DeCastro, 2023). Some other important symptoms for immediate attention include blood or fluid out of the ears or nose, seizures, repetitive vomiting, and trouble walking, breathing, or speaking (Proctor & Baird, 2023). When analyzing a player, paying attention to detail is crucial to bettering their diagnosis and safety.

In competitive sports, healthcare professionals should be present in case anything was to happen. The availability of healthcare professionals is particularly important in high school and collegiate sports where injuries are not uncommon. Trainers are critical in on-field examination and determining if the player needs to be removed from play along with what steps they should follow (McLeod, 2022). When determining a concussion, professionals will use a variety of tests including verbal, written, or computerized tests to check the individual's thinking ability, problem-solving skills, memory, and concentration (Cleveland Clinic, 2020). When performing an evaluation, athletic trainers typically look for five primary concussion profiles; they can also use common tests seen in the SCAT5 and SCAT6 protocols. These include cognitive function and fatigue, ocular-motor movement and focus, headache or migraine symptoms, vestibular effects primarily with dizziness, and emotional function through anxiety and mood changes (McLeod, 2022). If the concussion is severe, it is possible that the player may be required to continue observation at a hospital for further analysis of concerning symptoms (Ferry & DeCastro, 2023). In head injuries, automatic red flags are seen as

loss of consciousness, ataxia, tonic posturing, and post-traumatic seizure, and call for an immediate diagnosis of a concussion at the minimum (McLeod, 2022). If an individual is suspected of sustaining a recent concussion, the healthcare professional would perform those same tests and additionally ask them questions concerning changes in their mood, sleep schedule, and behavior (Cleveland Clinic, 2020). While it is best to diagnose concussions immediately, sometimes the symptoms worsen over a couple of days and the individual will then seek treatment.

When attempting to diagnose a concussion, it is tempting to want some test results to automatically indicate that the person has a concussion. It is difficult to definitively tell a concussion with scans, because when using a CT or MRI scan, the effects of a concussion may be unable to be detected (Cleveland Clinic, 2020). The scans can be beneficial when there is bleeding inside the skull, swelling in the brain or spinal cord, or if the symptoms seem to worsen. However, these types of concussions are less common, so a more beneficial way of detecting concussions would be to closely monitor symptoms and changes in behavior, balance, cognition, and headaches.

Before the beginning of a sporting season, players often complete baseline concussion tests where healthcare providers typically administer an online test to examine and record the athlete's brain and balance functions (Beaumont, 2023). These baseline tests activate a variety of brain functions including the memory, learning, focus, and reaction times of an individual. The tests can also be used to help diagnose concussions, as there will be a difference in the player's cognitive function between the baseline testing and the current player's ability. One of these tests is known as the ImPACT neuropsychological Test, and is used to evaluate the athlete's brain function,

including short- and long-term memory (Cleveland Clinic, 2020). The baseline values are compared with test scores received after a potential concussion to determine changes and the areas of impact. A concussion is determined by having the score drop significantly from the baseline.

Between 2010 and 2015, concussion diagnoses have increased 40% overall, and 71% in youth (Beaumont, 2023). The CDC states that emergency centers saw an increase of 52% in people with TBIs over an 8-year time frame across the country (Beaumont, 2023). The increase in cases where a concussion diagnosis is made is primarily due to the knowledge and resources that are now available to more accurately assess and diagnose people, not necessarily because there is an increasing rate of concussions. With the continual increase in concussion and TBI diagnosis, more precise and accurate methods of determining concussions and their severity need to continue to be devised.

Conclusion

The first and crucial step to assisting someone with a concussion is the recognition of the injury and action of bringing attention to the person, followed by providing them with medical attention; someone who can determine if a concussion was sustained. Since concussions are seen through a mix of signs and symptoms, it is crucial that the provider asks the person questions along with performing various balance and cognitive tests. Tests and questions from the provider help to determine the mental status of the patient which is used to determine if the blow did in fact cause a concussion. More severe cases require immediate action and more drastic measures to ensure healing properly.

CHAPTER THREE:

Adverse Effects of Multiple Concussions

A concussion is the result of a hit, jolt, bump, etcetera, leading to the head and brain's rapid movement (Cohen, 2019). Once this has happened once, it is likely that individuals will be more susceptible to sustaining subsequent concussions (Proctor & Baird, 2023). If individuals have not fully recovered and sustain another concussion, they are at further elevated risk for recurrent, cumulative, and worsening consequences of each subsequent concussion (Valentine et al., n.d.). Sustaining a second concussion before fully healing from the first can cause secondary impact syndrome which can be a dangerous predicament and further reinforces the importance of correctly following return to play protocols despite additional time out of a sport. Cases with a second concussion adding onto the first and causing secondary impact syndrome tend to have further impacts on the person's daily living activities and what they can accomplish independently (Proctor & Baird, 2023). In addition, even with a full recovery after the first concussion, individuals with previously sustained concussions are at higher risk. Subsequent concussions have a cumulative effect and can lead to more severe symptoms and longer recovery periods (Proctor & Baird, 2023). Multiple concussions are evident in some of the long-term side effects and recurrent symptoms seen in some players.

When a person has sustained one concussion, it is not likely that there will be changes in their physical or intellectual abilities (Proctor & Baird, 2023). However, with multiple concussions, it becomes increasingly likely that long-term changes will be observed (Proctor & Baird, 2023). When a concussion occurs, abnormal proteins are made in the damaged brain tissue which can lead to brain cell destruction (U.S.

Department of Health & Human Services, 2023). The accumulation of abnormal proteins and subsequent brain cell death contributes to the more severe and longer-lasting symptoms seen in people with multiple concussions. With each additional concussion more tissue is damaged in the brain, more abnormal proteins are made, and the proliferation of cell death becomes more widespread. Most times the accumulation of abnormal proteins is not as severe; however, buildup can develop into chronic traumatic encephalopathy (CTE) if it is observed in large quantities.

High School Compared to College

When analyzing the difference between high school and college athletes, there are some variances with concussions and head injuries. High school athletes have been shown to typically require longer recovery periods than college athletes (Brain Injury Research Institute, 2023). With high schoolers at a younger age than collegiate athletes, their brains are at different developmental stages. Between the teen to adult years, people undergo alterations, switching from utilizing the amygdala for processing information as a teen, to the prefrontal cortex as an adult (Campellone & Turley, 2023). As the brain matures, it changes from a more emotional processing center to primarily rational thinking as an adult. These different brain processing centers can be affected uniquely by concussions in the demonstration of symptoms and the recovery process (Brain Injury Research Institute, 2023). With differences in age, force of collision, and area impacted, there are a wide range of symptoms and variable effects for everyone.

Chronic Traumatic Encephalopathy

The distinction of a CTE was first seen and differentiated by Harrison Martland in 1928, who described it in his seminal report, making it clear that multiple head traumas

are very dangerous (Casper, 2018). Martland's findings point to a distinction in long-term concussions that has been around for decades. These types of concussions resulting in CTE have a range of life-changing consequences and show the need for the best possible treatment and recovery plans for people affected by multiple concussions.

In extreme cases, a person might develop CTE. Severe types of head trauma, known as CTE, is seen as brain damage that gets to the core and affects the functioning of the brain (U.S. Department of Health & Human Services, 2023). Research on concussions and postmortem diagnosis of CTE suggests that CTE is related to long-term repeated head impacts. Diagnosis of CTE is subject to a variety of factors including sex, genetics, environment, and medical history (U.S. Department of Health & Human Services, 2023). Despite knowing a lot of possible factors that influence the person's likelihood of developing CTE in the future, it is currently unknown how to predict a person's individual odds. Additionally, although family members may suspect the development of CTE, there is no way to confirm a diagnosis until a postmortem autopsy of the brain can be performed.

As the diagnosis of CTE only occurs postmortem, researchers are working with biomarkers to create diagnostic testing for living individuals, but these techniques have not yet been validated (Mayo Clinic Staff, 2023). The symptoms associated with CTE can lead medical professionals to diagnose the patient with traumatic encephalopathy syndrome (Mayo Clinic Staff, 2023). Typically, scientists only test for CTE in cases where the individual experienced many head impacts and donated their brains to research. This group includes athletes in high collision sports, combat veterans, victims of partner violence, and others with a long-term history of head impacts (U.S.

Department of Health & Human Services, 2023). For CTE diagnosis, it is likely that the person had an extensive list of head traumas throughout their life.

Conclusion

The more concussions that a person has accumulated in their life, the more severe each of those resulting signs and symptoms can present. An initial concussion typically does not have as many or severe long-term effects as multiple concussions or those that happen before completion of a full recovery. Consequences of multiple concussions still have a variety of symptoms, but unlike when there is only one concussion, they typically result in more severe and/or longer-lasting impacts. The recovery process for each subsequent brain injury typically takes longer and will require adjustments to daily living based on the severity. Between the teenage years to mid-twenties there are changes in the primary processing centers in the brain, reflected by the more emotional processing turning into more rational thinking. The combination of multiple concussions brings to light the importance of CTE studies and the ability to recognize signs and symptoms to better provide more vulnerable players with the support that they need both before and after the diagnosis of a concussion.

CHAPTER FOUR

Variances in Concussion Protocols

With continual advancements and ongoing research, it is important to recognize the changes in concussion protocols and keep it up to date. There is a lack of federal protection for youth sports concussions, and the management of concussion protocols are left up to the states (Swim et al., 2021). The concussion protocols tend to vary a bit by each state, as the states are seen to have their own rules and regulations on concussion diagnosis and interventions (Valentine et al., n.d.). With the division of responsibility for concussion protocols, it is important to keep up to date with the latest research and modifications. The changes in standards are communicated through health care professionals and seen at each institution (Valentine et al., n.d.). Differences in concussion protocols by state and school has led to an acknowledgement of the lapses in care for concussions in general, leading to further legal concerns and modifications to methods (Swim et al., 2021). The comparison between states and institutions has encouraged implementation of better advancements. When comparing state levels, high school and college specifically, advancements are seen through how concussion protocol differs and comparing the overall rates of concussions and effectiveness of recovery processes that are implemented. The division of concussion protocols on these levels have been followed by a variety of lawsuits affiliated with sports associations including cases against high school athletic associations (*Bukal v. Illinois High School Association*), the National Collegiate Athletic Association (NCAA) with (*NCAA Student-Athlete Concussion Litigation*), and further expanding into professional teams (Swim et al., 2021). These lawsuits were an attempt at emphasizing the importance of healthcare

and concussion management (Swim et al., 2021). Comparisons and lawsuits have worked to set a standard for expected healthcare concerning head traumas. The compiling of data over concussions helps to display patterns and flaws in current concussion protocol, procedures, and management. Trends in the data are then implemented into new plans and provide the next round of advancements.

State Variances

All 50 states passed their own youth concussion laws by 2014 to better focus on providing young athletes with accurate care and healing after a concussion (Harris et al., 2019). Seeing many statistics on the necessity of full recovery makes it clear that providing optimal care is a critical expectation. Laws concerning healing have differences in important aspects within the laws, due to the states' differences in decisions (Harris et al., 2019). Even data collection is different between the states, as most keep records of concussions in the schools' files, while a few states are known to compile all the information in one report location (Harris et al., 2019). Filing systems, although still up to the state and location, play a crucial role in understanding connections between the causes of concussions and drawing necessary conclusions to make further advancements to the protocols used. Compiled concussion data allows for more comprehensive analysis and identification of concussion risks, which in turn, provides better opportunities to fix the differences (Harris et al., 2019). The data collected can then lead to better laws and regulations to aid in prevention in future cases. Some of the variances in restriction by state for return to play are shown in Table 2 listed below.

Table 2

United States Map of Restrictions by State

Other Restrictions or Graduated Return	Can't Play for 24 Hours	Can't Play on the Same Day	No Minimum Time Out
California	Indiana	Alabama	All other states
Connecticut	Missouri	Kentucky	
Hawaii		Mississippi	
Illinois		North Carolina	
New Mexico		Ohio	
New York		Oregon	
Maine		Tennessee	
		Virginia	

Note. This table is a representation of a map from this source with credit given to Sinduja Rangarajan, Gabriel Hongsdusit, and Casey Miner/Reveal with columns based on when athletes can return after receiving a concussion. Harris, E., Rangarajan, S., Miner, C. (2019, February 9). *Concussion laws: How does your state stack up?* The Center for Investigative Reporting. https://revealnews.org/article/concussion-laws-how-does-your-state-stack-up/

There are some states that have laws that require a return-to-learn policy to be followed (Harris et al., 2019). As of 2019 these states included California, Idaho, Nebraska, Iowa, Illinois, Oklahoma, North Carolina, Virginia, Maryland, Maine, Massachusetts, Vermont, Hawaii, Indiana, and New York, with the last two having local policies encouraged (Harris et al., 2019). Even within these states and laws, there are differences in the return to learn protocol. Some states have students take time off school, while others encourage getting back into learning with modifications (Harris et al., 2019). These variances in protocol not only change between each state, but within the individual cases, considering what is best for that situation (Brain Injury Research Institute, 2023). Each case requires specific attention and cannot be covered by a blanket law. The individual nature of concussions is what causes a general concussion protocol to vary so much throughout the states, schools, and even people with more than one concussion.

Differences between states can also be contributed to by the variances in accessibility of athletic trainers and retention rates of a full-time trainer. About one third of all high schools in the United States do not have access to athletic training services (Heubeck, 2023). Many schools consequently are not able to provide full concussion assessment and treatment protocol at the school due to a national shortage of high school athletic trainers and low budgets to get good trainers to stay.

While the states pose different laws that are a minimum standard for the state, within states there are additional regulations in individual districts that can further emphasize certain aspects of concussion protection (Harris et al., 2019). The division of power seen at a lower level can provide better area-based legal aid. The minimum standard for concussions allows for better management and a baseline to begin with that can be changed on a case-by-case basis (Harris et al., 2019). The changes seen between states and districts are the start of better regulations for head injury management for sports. Within the standard variances in concussion protocols between states, there are additional differences seen at the individual level (Brain Injury Research Institute, 2023). In most states, athletes must be taken out of games and practices until they receive clearance from a medical professional (Harris et al., 2019). The purpose of full removal demonstrates the importance of and desire to avoid compounding concussions.

Concussion History

A patient's history is an essential part of the recovery process. Individuals who have had at least one previous concussion are shown to have a 43.8% worse clinical outcome (Gaudet et al., 2022). In addition to having possibly worse outcomes, there are associations seen between needing a greater time to recover and the concussion history of

an individual (Gaudet et al., 2022). Players with previous concussions and faster recovery times should still be watched for additional hits or symptoms. Variances between patient's histories should be treated differently due to the statistics seen in the concussion recovery rates and possibilities of clinical outcomes. People who sustain a concussion typically have a recovery time of a couple months, but with individuals who have sustained multiple concussions, this recovery time is frequently lengthened while the likelihood of long-term symptoms increases (Broadview, 2021). Each concussion varies and will be evaluated before the appropriate recovery and treatment plan is set up. These evaluations allow for individualization of the treatment plan through monitoring, while providing a basis of standards for states and districts to follow (Harris et al., 2019). Standards are then used when analyzing the symptoms to provide an acceptable treatment plan for each affected person.

Conclusion

Concussion protocols vary by state and within some states based on level, school, and district. The differences in protocol are reflected through laws put in place and regulations for individuals. Protocols designed and implemented are constantly being updated and improved to reflect the latest developments in understanding and care. The protocols that are not kept up to date or do not provide satisfactory protection often lead to lawsuits and other consequences. The individualized nature of concussions tends to lead to the various protocols used as no one protocol can cover all types of cases. The differences between cases should be monitored closely, as variations in the number of concussions and their severity can impact the current symptoms and must be treated accordingly.

CHAPTER FIVE:

Oldest Forms of Concussion Protocol

The study of head trauma impacts has been continually expanding and improving treatment approaches over the centuries to assist people with returning to their daily routines. In the 10th century, Rhazes, a Persian physician made the first recognition of a concussion as having different effects from a severe TBI (McCrory & Berkovic, 2001). Following this discovery, more investigations focused on concussions from the mid-19th century to the present. These investigations from the initial concussion recognition to the present led to the acknowledgement that concussions could be added together in a sense, creating a compiled number of symptoms and effects leading to worsening injuries and long-term changes (Casper, 2018). Some of these compiled symptoms go as far as states of degenerative neurology to slightly less drastic changes, with permanent symptoms. Multiple concussions have clearly significant long-term effects, and the number of regular concussions is what adds up to these further impacts; these effects need to be addressed individually, to provide the best healing opportunities (Casper, 2018).

In the past it was seen as tough and desirable to be able to play through an injury. Playing through injuries is still seen in some cases presently; however, with more education for players and increased coaches' awareness this practice has decreased. A head injury, known today as a concussion, would not have been taken as seriously and a player would be encouraged to fight through and be tough. Zito Madu, in an excerpt from 2014, explains it as coaches praising players who would risk their future for the present (Ruston et al., 2018). The idea of fighting through the hurt was seen as noble and commendable, encouraging players to not acknowledge the seriousness of their injuries,

especially the severity of those occurring to the head. While research has shown that fighting through brain trauma is an unwise decision, there are still coaches, players, and relatives who encourage the practice. Some people motivating players to practice early return to play makes it more important for other people to recognize the severity of the injury and seek medical attention for the individual, as they may not want to acknowledge it themselves. With the encouragement of continued play, there was elevated risk for players to receive additional blows and ultimately more severe symptoms and greater chances of long-term impacts.

In the 21st century, further research has been conducted on concussions, including the long-term effects. Results of the research led to further changes in protocol and more in-depth analysis of the individual post-concussion. The concussion crisis seen in sports has led to further awareness and concern by the NCAA and the public (Ruston et al., 2018). In 2014, the NCAA launched its largest study on concussions with the U.S. Department of Defense, looking into types of protective equipment, better diagnostic techniques, and therapeutic technologies (NCAA, 2014). The study focused on better preseason evaluation, advanced monitoring, enhanced safety behaviors, and the culture of reporting and managing concussions (NCAA, 2014). The studies regarding concussions done by the NCAA have led to advancements of diagnosis with better background information on individuals, through the preseason evaluations and post-concussion testing. Through technology, healthcare professionals can better analyze changes in function and focus within affected individuals.

Concussions are primarily an internal injury, meaning they are not necessarily outwardly apparent. Since they are not always clearly visible, the importance of self-

reporting is emphasized and encouraged (Ruston et al., 2018). Through self-reporting of concussions, individuals can receive more timely care. As these head traumas are primarily experienced through symptoms within, rather than clearly broken bones or bruising, the NCAA has also pushed education on concussions to promote self-reporting (Bagley et al., 2012). Self-reporting needs continued improvement, as there are still many potentially serious brain injuries that go unreported despite additional pressure, encouragement, and precautions that have been put in place.

Outdated Practices

There are many old practices for treating concussions that have since been found ineffective or unhelpful. In the very beginning, concussions were not understood, and players would be encouraged to play through any sort of injury they could to demonstrate toughness and drive. There are quite a range of treatment plans that have been developed between then and what we utilize now.

Concussions used to be ranked by severity of symptoms on a grade scale from one to six, trying to determine categories for recovery practices (Nationwide Children's, 2023). These grades were assigned through an evaluation, typically completed by an athletic trainer or physician. The grade scale was used to influence recovery strategies and how quickly individuals were returned to daily activities and play. The use of grades for head injuries was not effective and has since been removed (Skerrett, 2013). The most important part of diagnosing and helping someone with a possible concussion is the removal of the player from the game so they may be assessed and provided with proper treatment.

There are many different protocols for post-concussion that have cycled through use. At one time, parents were supposed to keep their child from sleeping or to wake them every hour after having sustained a concussion to check up on them (Nationwide Children's, 2023). This practice has since been found to be counterproductive to healing when dealing with head injuries. However, at the time, it was thought that if someone fell asleep shortly after sustaining a concussion or other head injury, that they could fall into a coma and not be able to wake up (Figler, 2020). Further brain injury research has shown that sleep is productive in the healing process and there is no need to wake a person regularly who has sustained a concussion (Figler, 2020).

Concussion Headbands

To protect the head and reduce brain injuries the use of additional protection is common, for example, helmets on bicyclists and motorcyclists. In sports, the idea of additional protection has been explored, especially through helmets and headbands. This section will specifically focus on concussion headbands used in soccer. When conducting research on three types of headbands brands; Headers, Headblast, and Protector, a controlled impact and response study was done to test the effectiveness of each in reducing peak impact force (Broglio et al., 2003). All three types of headbands were determined to reduce the peak impact force, although they did vary some, ultimately the study concluded that the Protector brand was the most effective (Broglio et al., 2003). Although laboratory studies have shown that headbands are successful at dissipating some of the force, it is still difficult to know how effective they are (Iannetta, 2016). The differences between each concussion make it exceedingly difficult to quantify the

effectiveness of concussion headbands and how much they help to avoid these types of head injuries (Iannetta, 2016).

Despite the effectiveness seen in some concussion headband lines by some researchers, still other researchers claim that the headgear is ineffective. The study done by the University of Wisconsin-Madison (UW), shows that using headgear for soccer is no better than not wearing headgear in the prevention of head injuries (Galassi et al., 2019). Ultimately, the research shown by UW demonstrated that headbands do not result in less severe or fewer SRCs (Galassi et al., 2019). Another research study demonstrated that concussion headbands and protective gear are ineffective and can create false confidence which might encourage more aggressive play (Sports Medicine, 2020). More aggressive and confident play could potentially increase concussion rates with the players thinking they are safe and unconcerned with hard headers or unnecessary blows to the head (Sports Medicine, 2020).

Timeline of Advancements

Over the years many advancements have been made to concussion protocols and prevention. Changes have been enforced through rule developments and additional safety measures (Hainline, 2016). The NCAA has provided and enforced many head injury related improvements over the past years (Hainline, 2016). All these adjustments were made with the hope of reducing both the number and severity of concussions seen in sporting events. Advancements are shown in Table 3 below through additional protective equipment, rule changes, various scientific grants and studies, and additional protocols (Hainline, 2016).

Table 3

NCAA Concussion Timeline

Year	Change
1893	First leather helmet for football worn
1906	President Theodore Roosevelt renamed the Intercollegiate Athletic Association to the NCAA to reform the standards of safety and make changes to rules to remove brutality and change sports, especially football to a more positive game.
1917	Samuel E. Bilik published The Trainer's Bible for athletic trainers used through the 1950s
1939	All football players required to wear helmets
1964	No football player may purposefully use his helmet or head to hit an opponent
1982	Injury Surveillance System used to provide data on injury trends, then committee uses that to recommend changes to rules, equipment, and coaching
1994	NCAA adopts guidelines for return to play protocols after a concussion
1999	NCAA funds long-term concussion study with researchers Kevin Guskiewicz and Michael McCrea
2003	Guskiewicz and McCrea publish The NCAA Concussion Study laying the groundwork for additional research on SRCs
2006	Injury Surveillance System data shows: 7% all injuries in football were concussions, 22% in women's ice hockey, 18% men's ice hockey, 14% women's soccer, 6.3% men's soccer
2009	NCAA adopts rule changes limiting number of full-contact practices in football
2010	NCAA Creates a uniform concussion policy Division 1, 2, & 3 require all members to have a concussion management plan
2012	NCAA provides National Sport Concussion Outcomes Study Consortium with $400,000 grant to examine effects of head injuries in both contact and non-contact sports Ivy League places practice rules in lacrosse and soccer to limit contact
2014	NCAA & Department of Defense launch 3-year, $30 million longitudinal concussion study to be overseen by CARE Consortium and an educational challenge, that was announced at the White House Healthy Kids and Safe Sports Concussion Summit
2015	The NCAA passed concussion safety protocol legislation requiring schools to submit policy for detecting a concussion and return-to-play protocol to the NCAA for approval.

Note. This table is a table based on when regulations were made. Hainline, B. (2016). *Concussion Timeline.* NCAA Sport Science Institute. https://www.ncaa.org/sports/2015/12/11/concussion-timeline.aspx

Underreporting

Due to the internal nature of concussions, reporting relies heavily on the cooperation of the athlete and their truthfulness concerning symptoms and severity. A survey given to 156 incoming NCAA D1 athletes revealed that the more knowledge an athlete had about concussions, the more they hid their symptoms and played through (Conway et al., 2020). This survey showed that greater knowledge did not decrease the number of reasons why athletes would participate in concussion nondisclosure (Conway et al., 2020). In fact, this proved that more information on concussions and their severity was likely to do the opposite of the desired increased reporting, as reporting concussions was seen to be lower in athletes with more knowledge of the injury. It is additionally difficult for athletic trainers and health care professionals to determine if a concussion occurred without the athlete notifying them due to the wide range of symptoms seen (Ferry & DeCastro, 2023). Certain cognitive impacts cause necessary time off school, and there is additional stress on the student athlete about educational demands and taking time off or reducing their workload (Valentine et al., n.d.). Compiling restrictions can push an athlete toward wanting to continue without saying anything about a possible concussion (Conway et al., 2020). It is important to recognize the need for recovery, before putting oneself at further risk of another brain injury.

Conclusion

Head trauma has been around for as long as people have been alive. However, it took a long time to discover the meaning of head trauma and what that signifies, leading to concussion diagnoses and TBIs. The progression of concussion protocol has come a long way since the 1800s and 1900s. The development of protective gear and its

continual advancement has been a major component in preventing many concussions. Regulations through the NCAA and state protocols have had a significant impact on the number of diagnoses and the ways that head injuries are treated, resulting in better treatment options and advanced knowledge of symptoms to better assist individuals in their recovery. Better treatment options work to maintenance of as many daily living activities as seem fit based on their specific condition, rather than adding limitations. Despite advancements made in the knowledge of concussions and their effects, mixed with advancements in protocol regulation, there is still some underreporting of concussions and pressing to play through some of these symptoms. The underreporting seen in concussions is serious due to the risk players put themselves in with the possibility of compiling on another concussion before the first is fully healed.

CHAPTER SIX:

Current Concussion Protocols

Concussion protocols are something to be taken seriously and have been brought to light in many discussions which commonly point to how the optimal recovery can be achieved. Most recently, there has been emphasis on updating protocols and advancing evaluation forms (Pruthi, 2022). Evaluation forms are used to determine if a player has sustained a concussion, and these forms need to be updated to reflect the latest research ideas. In the last year, the University of South Dakota (USD) has updated their concussion protocol to include better techniques for symptom and balance evaluations (from SCAT5 to SCAT6; USD Athletic Staff, 2023). Symptom and balance evaluations can be completed on the sidelines or in other areas, such as a training room by a healthcare worker trained in concussion protocol. The SCAT6 has been updated from the SCAT5 with upgraded coordination and motor screening, revised immediate assessment, added timed component, and multiple other modifications (HITIQ, 2024). Modifications have been made to evaluations based on significant research findings to improve concussion diagnosis.

USD's updates include better processes for updating patients, family and friends, and professors on the expectations of the concussion symptoms and modifications to class and daily activities (USD Athletic Staff, 2023). The importance of a support system is crucial when discussing concussion symptom monitoring and the possibility that those symptoms may worsen over the following hours. There is now a letter for the athletes to take home with instructions and information for roommates, friends, or family to ensure they are not alone, and their symptoms are being monitored to help prevent further

worsening (USD Athletic Staff, 2023). This letter allows the athletes to have clear instructions and for those around them to also know the expectations and assist in accountability. Providing support is an important role as individuals with concussions can act differently and not think clearly. Examples of emotional and behavioral changes are evident in Table 1 in Chapter 1 (Valentine et al., n.d.). Changes in the mental state could cause alterations in reasoning and processing so the individuals may attempt something they would not otherwise do. Thus, it is important to keep the affected individuals under supervision (Valentine et al., n.d.). Support systems are encouraged in many medical procedures; however, with concussions there is a heavier emphasis as the individuals may not realize they are experiencing worsening symptoms and may not think about going to a doctor.

After the initial diagnosis, caretakers play a critical role in observing patients' symptoms and adjusting daily living accordingly. The symptoms experienced by individuals may change or worsen over the first few hours post-diagnosis (Pruthi, 2022). This is seen through symptom manifestation and should be followed up with serial evaluation from the day it occurred to 72 hours after a diagnosis (USD Athletic Staff, 2023). The ability for symptoms to form or worsen later emphasizes the importance of monitoring patients especially after the initial incident. As individuals experience worsening conditions, they should seek medical attention immediately. When observing individuals and symptoms start presenting as worse, patients should pay attention to specific activities causing the decline (Allen, 2023). These observations can then be used to provide a better individual plan of action moving forward and to make sure that the

patients' needs are being met with symptom-based restrictions primarily focusing on what events cause the reactions.

Various symptoms may be present or absent at differing levels by the individuals; some are more sensitive to light while others are impacted more by noise (Valentine et al., n.d.). The differences seen between individuals leads to further analysis to make sure they are monitored to appropriately modify activities while working to maintain normalcy (Lempke et al., 2023). Appropriately modifying activities while striving toward normalcy is the focus of healing while implementing the new data on active recovery. The process of easing back into routine is symptom based and crucial to recovery for the patient. With concussions too much rest is possible, as avoiding all exercise and mental activities can lengthen the recovery time (Allen, 2023). Avoiding all activity can also have negative impacts on the individual's improvement. Cocooning is a term used to describe overdoing rest, avoiding basically everything, which can delay recovery and worsen symptoms (Allen, 2023). Modifications should encourage use of the brain and activity to a tolerable level within the symptoms experienced (Lempke et al., 2023). Symptom limited activities can promote brain recovery and provide a smooth road back to normal.

Return to Learn

In most cases, it is recommended that students return to school immediately with modifications as needed by the symptoms the individuals can tolerate (Lempke et al., 2023). This could include wearing sunglasses, leaving classes early, taking breaks as needed, avoiding electronics, and others (USD Athletic Staff, 2023). Modifications are great alternatives to complete rest and prevent cocooning or the desire to avoid returning

to daily activities. Currently, the average amount of time to recover from a sports related injury is about 7 to 10 days, while the recovery time from a concussion from something other than a sport caused injury can be up to three months (Allen, 2023). Sports concussions have a significantly shorter recovery time on average. The period directly following a concussion sets up the individual for the recovery process. While working toward recovery, some things have remained the same, including the main points of recovery, seen through prioritizing the health of individuals, setting up a plan for recovery, making sure the pace is accurate and adjustable based on individuals (Sunnybrook, 2016). Recovery factors are implemented by a healthcare professional and emphasize the need for follow-up visits and, ultimately, clearance for full return.

The process of getting back into school is important to be monitored with emphasis on watching for signs and symptoms (Lempke et al., 2023). During the recovery process, it is important to emphasize the need for relative rest and activity limitation, especially the tasks requiring a lot of thought and concentration (Pruthi, 2022). Activities that put excessive stress on the brain can have negative impacts like those seen due to cocooning. Relative rest is highly recommended in the two days immediately following a concussion (Pruthi, 2022). The term relative rest fluctuates based on the individual and the severity of their symptoms. Relative rest allows for a mix of both getting back to school and normal daily routines, while highlighting the need for rest and recovery (Pruthi, 2022). Implementation of a slowed lifestyle for a short time promotes necessary healing. These modifications allow the individuals to go back to school, monitor their symptoms, and make additional adjustments as needed (Lempke et al.,

2023). Adjustments are made both with a healthcare professional, such as delaying tests, and on an individual level with sunglasses or early dismissal based on symptoms.

While focusing on individuals working on returning to learn, there are considerations of reducing screen time within the first 48 hours (USD Athletic Staff, 2023). Screens can trigger worsening symptoms for the individual and need to be addressed at the individual level. The reduction of screen time for student athletes is seen as part of the academic accommodations in USD's concussion protocol, with the potential for no computer testing, breaks from screens, and option to leave early if symptoms worsen (USD Athletic Staff, 2023). Early dismissal from class can prevent over stimulation of the brain while avoiding negative impacts. The current return to learn protocol has a big emphasis on getting back to regular routines while monitoring symptoms and making modifications as needed (USD Athletic Staff, 2023; Lempke et al., 2023). A wide variety of accommodations are available based on the many different symptoms each individual experiences.

Return to Play

Immediate return to play is prohibited after a concussion diagnosis, and return-to-sport is not to be allowed before completion of return-to-learn after head injuries (USD Athletic Staff, 2023). When players return to their sport too early, it can put additional stress on their brain and can cause worsening symptoms on top of opening opportunities to sustain another concussion before fully recovering from the first (Allen, 2023). The return to play protocol's last phase is returning the athlete to sport-specific activities and contact after a concussion occurred. Having compiled concussions would make the situation worse and could cause longer lasting damage and symptoms. With the risk of

concussions increased after sustaining one, it is especially important to avoid opportunities where another one could occur. The idea of removal from play has remained constant throughout concussion protocols and emphasizes the dangerous nature of continuing to participate in sports while recovering from a concussion (Nationwide Children's, 2023). The whole idea of returning to play revolves around the concept of removal from physical activities and situations where there is the possibility of further injury. One way to help with return to play decisions is the Buffalo Concussion Treadmill Test which monitors the heart rate at which exacerbation of exercise-induced symptoms occurs following a concussion (Leddy et al., n.d.). The data on heart rate and when symptoms occur can help diagnose and manage concussions and aid in making return-to-play decisions.

Most recently there are studies highlighting that an earlier return to exercise tends to positively influence the recovery rate and reduction of post-concussion symptoms (Lempke et al., 2023). Through the process of getting back to competition, there is the ability to monitor the player in different circumstances and track the variances in severity of symptoms as well as progression toward no symptoms and full recovery. The goal is to ease players back into school with an emphasis on symptom limited activity. Therefore, when working with a trainer, the individualized plan will allow for a gradual work back into activities and better adjustments based on how the athlete is feeling. This process is outlined in Table 4 below with a current walk through of return to play protocol. In the newest version of USD's concussion protocol a plan of light aerobic activity even within the first 24 to 48 hours was allowed and recommended although still symptom limited (USD Athletic Staff, 2023). The idea of light aerobic activity can allow better healing for

the affected individual and a faster recovery time. There is some data from observations and experiments that demonstrate the importance of light aerobic exercise on improving and working for concussions through the normalization of cerebrovascular physiological dysfunction (Leddy et al., 2019). Exercise works to improve the blood flow within the brain and promotes better healing to areas affected by head trauma, thus improving the recovery of the affected individual.

Table 4

Return-to-Sport Process

Step	Activities Involved
1	Symptom-limited activities of daily living
2	Aerobic exercise with light (up to about 55% max heart rate) then moderate (up to about 70% max heart rate) as tolerated
3	Individual sport-specific exercise without possibilities of head impact (continue only once signs and symptoms of current concussion are gone with and after physical exercise)
4	Non-contact practice; progressively increase resistance training
5	Unrestricted practice or training
6	Unrestricted return-to-sport

Note. The table depicts the process of returning to sport after an athlete is diagnosed with a concussion and is back to school. USD Athletic Staff. (September 2023). *University of South Dakota: Concussion Safety Protocol.* University of South Dakota.

Exercise is a process proven to be highly effective (Carzoli, 2020). By adding light exercise while watching symptoms, individuals can work back toward their normal lifestyle. Exercise increases the blood flow and provides better recovery for the brain than the complete rest that was previously encouraged (Leddy et al., 2019). Light aerobic exercise is the ideal way to work back into sports while promoting recovery for the brain and avoiding further opportunities for injury. Throughout the recovery process, monitoring symptoms is vital to a successful, gradual work back to full practice and competition based on the individual (Lempke et al., 2023). Monitoring symptoms allows

for continuous adjustments to both return-to-learn, then return-to-play protocol on a symptom-based schedule.

Conclusion

Protocol advancements have been made to continually work toward bettering the optimal recovery plan for individuals. The different concussion plans work to provide more specific adjustments per person to allow for flexible recovery and promote optimal healing. Current concussion protocol calls for the most updated evaluation techniques, seen as SCAT6 in the current USD protocol. The evaluations are updated by each organization to best tailor to the individual's needs. Adaptations rely heavily on the individuals reporting of signs and symptoms as well as the observations of the people around them. Through careful analysis of the patient’s mental status, the medical and training staff can adjust and monitor the person’s return to learn and play protocol. During this process, the continued prioritization of minimizing symptoms is seen and there are constant adjustments and daily monitoring to ensure there are no setbacks.

CHAPTER SEVEN:

Recommendations for Further Improvement

Over the years many substantial advancements have been made to concussion prevention, diagnosis, and treatment. With many research studies having been completed, there is a lot of information to digest and sift through to gain a full understanding of how players can best be protected against concussions, and if there is an ideal way to treat concussions. The ideal treatment is then thought about from the perspective of how one creates a protocol to treat everyone who suffers a concussion when it affects everyone so differently. The important take away message is that while there are some similarities, each individual presents different symptoms for varying lengths of time and at different degrees. The severity of a concussion for each patient must be considered, and the protocol should be modified accordingly. The best opportunity to encourage return to normal activity, emphasize recovery, and minimize the long-term effects of concussions are through the implementation of symptom limited activity.

An area that is difficult to monitor is how severe the symptoms are and when is the correct time to move forward with treatment and progression of activity. Some players rush through the process, checking the boxes and stating that their symptoms are less severe than they are in reality. The opposite is true through exaggeration of symptoms and emphasis on need for help, where players could use the system to get assignment extensions, additional time on tests, or time off practice. It is difficult to measure symptoms that are subjective; therefore, it is important for the player to assist with proper return to learn protocols. Through careful instruction, specific questions, and

careful body language analysis by a healthcare professional, there is the hope that adequate care is provided based on the symptoms shown.

It seems that further trends in returning to exercise early and continuing to be involved with additional help returning athletes from concussions could be a further benefit. These ideas on returning to exercise earlier than recommended would benefit from further research to monitor the levels and length of exercise that would be ideal for returning after a concussion. Levels are likely to vary with each individual, but through greater research and understanding of a larger sample of post-concussion recovery and exercise there is the hope that return to play protocols could be improved further to find optimal recovery for those students.

Better, more definitive assessment tools for measuring the severity and presence of concussions would greatly aid in the accurate diagnosis and optimal progression through treatment. The research to develop these assessment tools would be tedious but could greatly improve the long-term outcomes for individuals, as well as the optimal recovery plan with minimal disruption of their daily lives. An updated assessment instrument would require additional research conducted on the varying severity seen in the symptoms of affected individuals.

Conclusion

Understanding the differences between individual's symptoms of concussions is crucial to providing effective care and treatment plans. The symptoms are subjective to the individual and need to be monitored closely to ensure accurate care. People have different approaches to recovery as some push through too quickly and others take too much time. The effectiveness of treatment relies heavily on understanding how the

patient is feeling and providing accurate recovery plans on a case-by-case basis. Advancements in the future can help improve understanding of the patient's specific needs through better analysis of their symptoms.

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