12-2021

An Exploration of Effective Patient Education with an Emphasis on Concussion

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Fall 2021

Exercise Science

College of Education and Health Professions

The University of Arkansas

Abstract

Concussion is a prevalent healthcare issue in the US, with approximately 1.6-3.8 million sports and recreation-related concussions each year in all ages. A concussion can be defined as a traumatic brain injury caused by biomechanical forces. When an athlete sustains a concussion, a physiologic cascade of events occurs. The most common signs and symptoms of a concussion include: loss of balance, disorientation, headache and confusion. Concussion assessments are important in order to determine the presence of an impairment and there are a multitude of tests that clinicians can use in order to isolate each type of damage. Studies have shown that behavioral regulation and active treatment are key components to a fast and successful recovery from a concussion.

Data regarding patient education in specialty clinics, such as those focused on concussion, is limited. This is a concern due to the need for education both prior to the injury and after the concussion is diagnosed. Health education, also known as patient education, refers to the process of providing information to individuals and allowing them to make knowledgeable decisions regarding their healthcare. In order to maximize the effectiveness of health education, professionals should be aware that the delivery of the information should be tailored to the learning preferences of each individual patient. Finding ways to overcome the disconnect in knowledge transfer between healthcare professionals and patients is essential for better treatment outcomes. Since limited time with the provider is shown to be the most significant barrier to quality patient education, utilizing time spent in the waiting room is essential to overcome this.

Definition of Concussion

A concussion can be defined as a traumatic brain injury caused by biomechanical forces. It is common to use the term *mild traumatic brain injury* in place of 'concussion'; however, experts have stated that this term is too vague and may encapsulate several mild brain injuries (McCrory et al., 2017). The Berlin expert panel (2017) defines a concussion and notes several common features of the injury. For example, SRC can result from a direct blow to any body part if a force is transmitted to the head. This may or may not cause a loss of consciousness. Also, SRC may impair the nervous system as the result of a functional disturbance in the brain, rather than a structural injury. The functional disturbance does not appear on imaging such as an X-ray, MRI or CT. In addition, this neurological deficit is brief and resolves on its own (McCauley et al., 2013; McCrory et al., 2017).

Although the definition of a concussion may seem simple, it continues to evolve over time with new research. According to Robbins et al. (2014), early definitions state that the symptoms of a concussion are both severe and long-lasting; but current researchers and clinicians agree that this is inaccurate. The definition of SRC has been revised many times, but has stayed stagnant since the 3rd International Conference on Concussion in 2008 (McCrory et al., 2009). The information from the Concussion and Sport Group (2013, 2009, 2017) consensus statements provide similar definitions with added detail. In the consensus statement from the 5th international conference (McCrory et al., 2017), the Berlin expert panel provides more detail discussing the biomechanical forces, the pathophysiology of the injury, the presentation and duration of symptoms. The National Athletic Trainers Association (NATA) provides a position statement on concussions that includes a similar definition, defining an SRC as an acceleration or deceleration of the brain from a force to the head. But, they state that the term concussion can be interchanged with *a mild traumatic brain injury* (Broglio et al., 2014), which differs from previous statements (McCrory et al., 2017).

Prevalence of Concussion

Concussion is a prevalent healthcare issue in the US. Approximately 1.6-3.8 million sports and recreation-related concussions occur each year in all ages (Langlois et al., 2006). Annually, an estimated 300,000 of those injuries are seen in athletes ages 15-24 (Gessel et al., 2007) and 136,000 in ages 13-18 years (Meehan et al., 2010). These numbers are an approximate on account of multiple factors. First, the year of data collected makes a difference. According to Zhang et al. (2016), concussions in the adolescent population have increased 60% from 2007-2014. This could be due to increased knowledge about concussion signs and symptoms or stricter rules to self-report (Selassie et al., 2013). Second, the number of annual concussions could differ slightly based on where the data was collected. In the study performed by Meehan et al. (2010), the concussions were recorded using the high school reporting information online injury surveillance system (HS RIO). The number of annual injuries could be slightly lower because not all high school athletes get diagnosed at the school. The students that were diagnosed in an ED or doctor's office may not have reported their case.

An athlete may be at a higher risk for concussion based on gender. According to a study by Covassin and colleagues (2003), girls experienced 9.5% of the concussions and boys experienced 6.4% of the concussions during games. When male and female athletes are compared in similar sports (e.g., soccer, basketball, baseball/softball) female athletes report higher concussion rates. Specifically, female soccer players suffered .36 concussions per 1000 athletics exposures (A-E) and male soccer players had 0.22/1000 (Gessel et al., 2007). Also, girls in basketball reported 0.21 per 1000 A-Es compared to boys' in basketball reported at 0.07/1000

(Gessel et al., 2007). Lastly, boy baseball players and girl softball players had similar concussion rates with girls suffering 0.07 concussions per 1000 A-Es and boys experiencing 0.05/1000. But, concussions in softball players represents a larger portion of total injuries at 5.5% compared to baseball players, only representing 2.9% of injuries (Gessel et al., 2007). This differing rate could be due to the fact that boys are stronger and are less likely to fall or get pushed around (Mollayeva et al., 2018). Also, boys have larger and stronger necks which can be used to stabilize the head, preventing injury (Mollayeva et al., 2018). Another factor that could lead to more concussions is that girls are more likely to report the injury compared to boys (Mollayeva et al., 2018). Boys tend to hide their injuries in order to continue playing.

Risk of concussion also differs by the type of sport. Concussion rates are the highest in football (40.5%) and women's soccer (21.5%), with football having the most sports-related concussions in adolescents per year, with an estimate of 55,007 (Gessel et al., 2007). In a study performed by Powell & Barber-Foss (1999), they found that of the 23,566 reported high school sport-related concussions, 63.4% were from football players. Wrestling and women's soccer followed with 10.5% and 6.2% of the cases. The CDC reports similar findings with 26.8% of the sports-related concussions seen in the ED being from football players (Sarmiento, 2019). The primary contributor to a higher risk of concussions is the level of contact a sport entails, but the sport-specific biomechanics can also have an impact.

Biomechanics of Concussion

Biomechanical forces associated with concussions can be described by location and direction of force. The process of sustaining a concussion can include either acceleration or deceleration of forces. The brain and head either absorb (acceleration) or release (deceleration) kinetic energy (Shaw, 2002). This kinetic energy transfer can come from two types of forces:

Linear and rotational (Guskiewicz & Mihalik, 2011). Linear or translational forces move in a straight line. In sports, this type of force can be seen when a baseball player gets hit directly in the head with a baseball. The linear acceleration passes through the center of gravity in the head (Shaw, 2002). In contrast, rotational or angular forces move in a curved path. An example of this type of force is observed when a boxer gets punched under the chin. The acceleration is no longer direct; instead it moves around the center of gravity (Shaw, 2002). Brain injuries from rotational acceleration are usually both focal and diffuse. However, linear acceleration causes only focal brain damage (Rowson et al., 2012). Although both types of forces can occur at once during a particular mechanism of injury, when angular acceleration is isolated, it is shown to cause more concussions (Shetter & Demakas, 1979). Rotational forces are more likely to cause loss of consciousness due to their ability to alter the midbrain and upper brainstem. The midbrain and brainstem control alertness, so when the cerebrum rotates and injures these structures, loss of consciousness can result (Guskiewicz, 2011).

Another way to describe the forces associated with concussions is by labeling the head injury as coup or contrecoup. Coup injuries occur at the point of contact; while contrecoup injuries occur on the opposite side of the head (Toma et al., 2020). For example, when someone slams their forehead against a wall, the coup injury is located in the front of the head at the site of impact, while the contrecoup injury is located in the back of the head. Contrecoup injuries are an example of deceleration (Shaw, 2002). Once the head receives a direct force, the brain is pushed in the opposite direction, striking the skull (Allen, 1896). This occurs because the brain has the ability to move. The brain floats in cerebrospinal fluid, a gelatinous fluid within the subarachnoid space, which provides protection and cushion (Holbourn, 1943). But, when the magnitude of the force is large enough, the brain has the ability to make contact with the skull, resulting in injury to the nervous tissue (Shaw, 2002).

To date, scientists have not agreed upon an exact threshold of force that is necessary to cause a concussive injury. Threshold of injury is the amount of force needed for the brain to sustain a concussion. Pellman et al. (2003) performed a study on football players, testing the minimum acceleration of a force needed for an athlete to suffer a concussion. Pellman et al. (2003) placed a system called HITS in the player's helmet in order to record the location and magnitude of the forces to the head. They concluded that the injury threshold for a concussion was 70g-75g (g=-9.8m/s^2) (Pellman et al., 2003). In contrast, Gurdjian (1972) claimed that the threshold for a concussion was 80-90g if the linear acceleration was continued for longer than 4ms. However, studies have found the data collected from threshold experiments to be inconclusive. According to Guskiewicz & Mihalik (2011) in some cases, lower magnitudes, such as 60.51g, resulted in higher symptom scores than higher magnitudes like 119.23g. The exact injury threshold is difficult to calculate because researchers use many different methods to measure it. Since brain movement is hard to evaluate ethically in humans, researchers measure either linear or rotational acceleration instead (Pellman et al., 2003). Although researchers believe that a certain amount of force is needed for the brain to undergo injury, they believe that the number may differ based on individual differences (e.g., cerebrospinal fluid levels, the brain's vulnerability to injury, weakness, and the mechanism of injury) (Guskiewicz & Register-Mihalik, 2011; Rowson et al., 2012). These individual differences can make finding an exact concussion injury threshold very difficult.

Pathophysiology of Concussion

The underlying pathophysiological changes that occur with concussions are complex and dynamic. When an athlete sustains a concussion, a physiologic cascade of events occurs (Giza & Hovda, 2001). First, the biomechanical forces cause the neuron to become more permeable, triggering ions to rush in and out of the cell at disproportionate rates, altering homeostasis by moving the neuron's charge away from resting membrane potential. This leads to the use of the sodium/potassium pump. Through the pump, a potassium efflux and sodium influx occur. Simultaneously, calcium rushes into the permeable membrane of the cell and glutamate is released (Katayama et al., 1990; Takahashi et al., 1981). Glutamate is an excitatory neurotransmitter in the brain. The release of glutamate slows brain functioning and slows neuron communication (Danbolt, 2001). These actions trigger voltage-gated or ligand-gated channels to open, further altering the cells voltage (Katayama et al., 1990; Takahashi et al., 1981).

As the cell attempts to restore homeostasis, an energy crisis occurs. An energy crisis takes place when the energy demand is greater than the energy supply (Giza & Hovda, 2014). The membrane pumps that activate to restore the resting membrane potential of the cell require adenosine triphosphate (ATP) (Yoshino et al., 1991). The energy supply is also low due to the influx of calcium. The more calcium surrounding the mitochondria, the less effective they are in creating ATP. Also, cerebral blood flow decreases following a concussion. The energy crisis following a concussion explains why the brain is so vulnerable after the initial injury (Yoshino et al., 1991).

Concussions also damage the neuron structurally, making it difficult for neurons to communicate. Biomechanical forces can damage key components of the neuron structure including the axon and the dendrites (Pettus & Povlishock, 1996). Axons are vulnerable to stretch from the biomechanical forces involved in a concussion (Pettus et al., 1994). In a fluid percussion injury study by (Reeves et al., 2005), they found that unmyelinated axons were more vulnerable to injury compared to myelinated axons. Since myelination develops with age, children could be more likely to experience structural deformity following a concussion (Reeves et al., 2005) In addition, cytoskeleton damage negatively impacts neural communication. Axonal stretch damages the microtubules in the cell, preventing the neurotransmitters from traveling to the synapse and communicating with an adjacent neuron (Büki & Povlishock, 2006). The lack of communication could potentially explain the slow processing and reaction times in concussion patients (Singleton et al., 2002).

There is also an inflammatory response following a concussion. Studies show that both microglia and inflammatory markers are present following both mild and severe traumatic brain injuries (Israelsson et al., 2008; Kelley et al., 2007). Microglia are cells that produce an immune response in the central nervous system following injury (Aloisi, 2001). A theory proposed by (Blaylock & Maroon, 2011) correlates this immune response with the influx of glutamate that occurs shortly after injury.

The likelihood of cell death and long-term structural damage from a concussion remain unclear (Smith et al., 1997). However, all of the biological processes that occur following a concussion present themselves in a multitude of signs and symptoms. For example, the influx of sodium and calcium and the efflux of potassium correlate with migraines (Leao, 1947). Also, as stated previously, the energy crisis is associated with vulnerability to another head injury. Since the biological processes occur in a cascade, these signs and symptoms can arise at different times during the recovery process (Giza & Hovda, 2014).

Signs and Symptoms of Concussion

Understanding the signs and symptoms of a concussion is necessary in order to diagnose a concussion. A sign is something that the observer or professional can see (LeBlond et al., 2009). The most common signs of a concussion include: loss of balance, disorientation, and confusion (Alla et al., 2009; Ellemberg et al., 2009; Gessel et al., 2007; Guskiewicz et al., 2003; Makdissi et al., 2010). In contrast, the least common sign of a concussion is loss of consciousness, which is observed in less than 10% of concussed patients (Ellemberg et al., 2009; Gessel et al., 2007; Halstead et al., 2010; Meehan & Bachur, 2009).

A symptom is an abnormality that cannot be observed and must be self-reported by the patient (LeBlond et al., 2009). There are many more possible symptoms than signs for a concussion. The most common symptom is headache, with 75% of patients experiencing this symptom (Collins et al., 2014). Other common symptoms include but are not limited to: irritability, anxiety, blurred vision, and nausea (Gessel et al., 2007; Guskiewicz et al., 2003; Makdissi et al., 2010; Meehan & Bachur, 2009). The common symptoms of a concussion are similar among sources but differ slightly due to age and gender influence. In a study by (Frommer et al., 2011), they found that female athletes reported more somatic symptoms (e.g., headache and dizziness) while male athletes reported more cognitive symptoms (e.g., trouble with concentration and balance). If a study included more girls, they would find that symptoms such as drowsiness and sensitivity to noise would be more common (Frommer et al., 2011). Also, age can influence a studies' findings. For example, younger athletes reported less sleep problems than college athletes (Kontos et al., 2012).

An impairment is the negative effect a concussion has on a person's normal functioning. Impairments are determined by comparing the post-concussion score to either an individualized baseline score or a normative mean (Schmidt et al., 2012). An index of reliable change is created to determine if the difference in the baseline and post-concussion abilities are significant (Nelson, 2015). There are 3 main categories of impairment: neurocognitive, mood, and vestibular and oculomotor. They differ in their symptoms, prevalence, and how they are measured.

First, neurocognitive impairment includes executive function, learning, memory, and attention (Rabinowitz & Levin, 2014). These abilities can be tested by clinical assessments, symptom checklists, postural assessments, and computerized neurocognitive tests. Computerized neurocognitive testing is the most effective measure of neurocognitive impairment due to its ability to perform baseline (Barth et al., 1989; Collins et al., 1999; Erlanger et al., 1999; Guskiewicz et al., 2001). Neurocognitive assessments will be reviewed in a later section of this literature review. Baseline testing is important because baseline scores are much more useful than normative scores. Normative scores do not account for certain factors such as: preexisting medical history (e.g., learning disorder, attention deficit disorder, history of concussion), race, and culture (Covassin, Elbin, & Stiller-Ostrowski, 2009). Also, computerized neurocognitive tests are preferred because they are more accurate than symptom reports when determining if the athlete is ready to return to activity. Neurocognitive impairment can take about 3-5 more days than symptoms to resolve, which shows that symptom checklists can be misleading (Covassin & Elbin, 2010; McInnes et al., 2017). The ImPACT test, a common type of computerized assessment, measures for 6 domains: attention, verbal recognition memory, visual working memory, visual processing speed, reaction time, numerical sequencing ability, and learning (Iverson et al., 2003). As listed previously, these are key components of neurocognitive impairment.

The second main type of impairment alters mood. This impairment affects one’s emotions and mental health. Common symptoms of a mood factor include: anxiety, panic, depressed mood, increased alertness, and apathy (Collins et al., 2014; Henry et al., 2016; Reynolds et al., 2014). These symptoms develop later in the recovery compared to the symptoms from a neurocognitive impairment (Kontos et al., 2012). Disrupted mood is observed in about 20% of college athletes following a sports-related concussion (Vargas et al., 2015). Risk factors for this impairment include: biological sex and pre-existing mental health conditions (Sandel et al., 2017). According to (McCauley et al., 2013), individuals with prior mental health disorders are at an increased risk for anxiety and depressive symptoms post-concussion. Also, a concussion can worsen the symptoms of a pre-existing psychological disorder. For example, an athlete that has been diagnosed with anxiety may feel more nervous following a concussion (Bombardier et al., 2010). Gender acts as a risk factor for mood impairment because females report more emotional symptoms following a concussion than males (Iverson et al., 2015; Kontos et al., 2012). This is not surprising because anxiety and mood disorders are more common in females than in males, which results in females reporting more emotional symptoms even prior to injury (Iverson et al., 2015; Kontos et al., 2012; Merikangas et al., 2010).

Lastly, the third category of impairment is vestibular and oculomotor impairment. The vestibulo-ocular system keeps the head stable during movement, preventing dizziness from visual instability (Cullen, 2012; Mucha et al., 2014). Common oculomotor and vestibular symptoms include: headache, abnormal eye movement and function, dizziness, and balance problems (Collins et al., 2014; Henry et al., 2016; Reynolds et al., 2014). Approximately 40% of athletes report balance problems following a concussion (Kontos et al., 2012), and about 30% report abnormal vision (Kontos et al., 2012). The high prevalence of this impairment is important due to its effect in recovery time. Dizziness, a common symptom of vestibular and oculomotor impairment, is associated with a 6.4x greater risk in prolonged recovery (>21 days) (Kontos et al., 2012). Therefore, rehabilitation is important for athletes suffering from this type of impairment.

Assessment of Concussion

Concussion assessments are important in order to determine the presence of an impairment. There are a multitude of tests that clinicians can use in order to isolate each type of damage (Ellemberg et al., 2009; Guskiewicz, 2011; Guskiewicz & Mihalik, 2011). Neuropsychological tests are used in conjunction with symptom reports to make a diagnosis (Graham et al., 2014). An example of a symptom report is the Post- Concussion Symptom Scale (PCSS). This is a 22-symptom inventory where athletes rank each symptom on a scale from 0-6. 0 for the symptoms that are not present, and 6 being the most severe symptoms. The maximum score someone can score on the PCSS is a 132 (Meehan et al., 2013). This test should be taken in a quiet room within the first 7 days after injury (Kontos et al., 2012). For best results, athletes take this inventory multiple times throughout their recovery process, beginning at the time of their concussion (Meehan et al., 2013). A factor analysis can be taken from the PCSS results. Common symptoms are grouped together into 4 categories, called factors, in order to create a more targeted assessment and treatment. These factors include cognitive-fatigue-migraine, affective, somatic, and sleep (Kontos et al., 2012).

Using symptom reports as the only form of assessment can result in an inaccurate diagnosis. Symptom reports are important so that the clinician can focus the assessment on a particular impairment (Covassin, Elbin, Stiller-Ostrowski, et al., 2009). However, some athletes do not describe their symptoms to the full extent, in order to return to their sport faster. Others blow up their symptoms to receive attention (McLeod & Leach, 2012; Reddy et al., 2008).

Experts suggest assessing the patient clinically in addition to obtaining a symptom report due to these biases (Broglio et al., 2007).

Testing impairment is not only necessary to obtain an accurate diagnosis, but also to track recovery (Halstead et al., 2010; Harmon et al., 2013; McCrory et al., 2009). Studies have reported that athletes can test below the normative values in neuropsychological tests even after symptoms have dissolved (Broglio et al., 2007; Iverson et al., 2006; Peterson et al., 2003). For example, a study performed by Prichep et al. (2013), documented that 37% of athletes diagnosed with a concussion had at least 2 cognitive testing (imPACT) composite scores lower than expected after 10 days, but their symptoms were gone after 5 days. This suggests that assessment is important for determining whether or not the athlete can safely return to their sport (Graham et al., 2014).

Concussion assessments began on pencil and paper, assessing for impairments in many different cognitive functions. Popular tests included: the Stroop Color Word Test, the Trails A and B test, and the Wechsler Number and Letter Sequencing assessment. First, the Stroop Color Word Test is a neuropsychological assessment that tests for cognitive interference, which occurs when a response to a stimulus interferes with another (Stroop, 1935). In the assessment, a board containing 20 rows of 5 words is presented to the patient. The words consist of, “red”, “blue”, “yellow”, and “green”, but are colored randomly. The participants are asked to verbalize the color of each word (Stroop, 1935). This exercise also assesses attention, processing speed, and cognitive flexibility(Kane & Engle, 2003). Next, the Trails A and B assessment discloses impairments in many cognitive function such as: attention, visual search and scanning, sequencing, psychomotor speed, ability to execute and modify plan of action, and flexibility (Lezak et al., 2004; Salthouse & Fristoe, 1995; Strauss et al., 2006). The test is broken into 2 parts: A and B. In part A, the patient is told to connect circled numbers in a numerical sequence as fast as they possibly can. In part B, the patient must connect both circled numbers and letters by alternating them (1-A-2-B…) (Partington & Leiter, 1949). Lastly, the Wechsler Number and Letter Sequencing task assesses for an impairment in the patient's working memory capacity (Mielicki et al., 2018).The patient listens to a sequence of letters and numbers and then must report them back verbally in alphabetical and ascending order By incorporating listening, speaking, memorization, and sequencing, the clinician can assess for multiple impairments at once (Mielicki et al., 2018).

Currently, most clinicians use computerized testing to measure cognitive impairments. Computerized testing is the most effective measure of impairment due to its objectivity and the ability to perform baseline testing (Barth et al., 1989; Collins et al., 1999; Erlanger et al., 1999; Guskiewicz et al., 2001). First, to test cognitive impairment, many clinicians use the computerized Immediate Post-Concussion Assessment and Cognitive test (imPACT). This assessment utilizes baseline testing, which is a very important aspect for concussion diagnosis and return to play (Covassin, Elbin, & Stiller-Ostrowski, 2009). Obtaining a baseline helps to determine the severity of an impairment because individuals differ in attention, memory, concentration, information processing, and reaction time performance (Covassin et al., 2009). The imPACT neurocognitive assessment contains 3 categories: demographics, concussion symptoms, and neurocognitive tests. Within the neurocognitive tests' category, there are 6 components that test for attention, verbal recognition memory, visual working memory, visual processing speed, reaction time, numerical sequencing ability, and learning. Clinicians evaluate and compare each component to the patient's baseline scores in order to collect a detailed understanding of their impairment. (Covassin et al., 2009). Next, only one vestibular and oculomotor impairment assessment exists that is specific to concussions. This test is called the Vestibular/Ocular Motor Screening (VOMS) assessment. The VOMS consists of 5 domains: smooth pursuit, horizontal and vertical saccades, convergence, horizontal vestibular ocular reflex (VOR), and visual motion sensitivity (VMS). Patients rate the changes in their vestibulo-oculomotor symptoms on a scale of 0 (none) to 10 (severe) after each test. This determines what type of assessment elicits symptoms. The VOMS has been shown to accurately identify concussion patients 90% of the time (Sufrinko et al., 2017). By performing this assessment, studies have shown that 60-70% of sports-related concussions result in vestibular and/or oculomotor impairment (Corwin et al., 2015; Mucha et al., 2014).

Management and Treatment of Concussion

The Management and treatment of a patient with a concussion is a team approach. Management should start with a centralized clinician (e.g. orthopedic surgeon, neuropsychologist, or primary care sports medicine physician), whose role is to coordinate and monitor the patient’s recovery (Collins et al., 2014). The clinician performs an initial assessment and can refer the patient to specialists for vestibular therapy, vision therapy, exertion therapy, neuroradiology, or neurosurgery (Collins et al., 2014). Also, the centralized clinician must give instructions to other members of the team, such as the Physical Therapist (PT) and Athletic Trainer (AT), regarding the patient’s condition. From there, the PT and AT work with the athlete and progress them through the return to play (RTP) protocol (McGrath et al., 2013). The RTP protocol begins when the athlete is free from any signs, symptoms, or impairment, so the athlete must be tested throughout recovery. (Collins et al., 2014; McGrath et al., 2013). Repeated testing is important for clinicians to form a timeline for the RTP protocol since symptom reports cannot determine the severity of the impairment. Studies found that 1/3 of athletes who were symptom free performed poorly on at least one neurocognitive test, indicating that impairment can last longer than symptoms (Mcgrath et al., 2013).

Studies have shown that behavioral regulation and active treatment are key components to a fast and successful recovery from a concussion (Tepper & Tepper, 2010). Professionals recommend that patients follow a regulated schedule following injury which includes: a regular sleep schedule, meal times, proper hydration, light physical activity, and stress management (Tepper & Tepper, 2010). Research shows that use of these techniques can improve symptoms, relieve stress, and decrease medication use (Tepper & Tepper, 2010). Also, in a study performed by Relander et al. (1972), patients that were treated with active therapy were able to return to work 14 days earlier than those on bed-rest. Clinicians are advising patients to rest initially, but then participate in short submaximal (60%) exercise throughout recovery (Gagnon et al., 2016; Leddy et al., 2010, 2012).

Concussions are grouped into 4 clinical profiles (i.e., vestibular/ocular, migraine, mood, and cognitive) instead of being categorized by a grade (e.g., grade I, II, or III). These clinical profiles are also accompanied by 2 modifiers: sleep and cervical (Collins et al., 2014; Reynolds et al., 2014). Cervical impairment from whip-lash injuries contributes to the migraine clinical profile; while sleep problems can be seen in mood, migraine, cognitive, and vestibular ocular concussions (Collins et al., 2014; Kontos et al., 2019; Reynolds et al., 2014). Clinical profiles are a way for clinicians to classify a concussion and specialize a treatment for a patient. First, vestibular and oculomotor function controls balance, vision, and environmental awareness. Therapy is specific for an individual and the symptoms that they are experiencing (Kontos et al., 2017). The clinician must test for specific impairments by utilizing the 5 domains in the VOMS. For example, VOR is treated by gaze stability training, while VMS is treated by exposure to visually stimulating environments (Broglio et al., 2015). These therapies all tend to focus on dynamic movements involving the head and eyes (Kontos et al., 2017). Second, a migraine profile occurs when a patient's headache persists and is accompanied by nausea, and light and sound sensitivity (Collins et al., 2014; Headache Classification Committee of the International Headache Society (IHS), 2013; Reynolds et al., 2014). Treatment for this profile incudes: behavioral regulation (i.e., maintaining a routine schedule), school and work accommodations, and referral to a headache specialist (Kontos et al., 2019). Furthermore, Athletes with a mood clinical profile struggle with anxiety and report overwhelmed feelings, sleep problems, and ruminative thoughts (Collins et al., 2014; Reynolds et al., 2014). Professionals treat mood impairment with cognitive behavioral therapy, exposure therapy, medication, and behavioral activation (Kontos et al., 2016, 2019). Lastly, the cognitive profile is both common and short-lived, while also presenting symptoms from other profiles such as migraine, mood, and sleep (Collins et al., 2014; Kontos et al., 2012; Reynolds et al., 2014). Although cognitive symptoms usually do not persist, treatment is still advised by professionals. Research suggests that patients should be prescribed work and school accommodations, behavioral regulation, and stimulant medication (Kontos et al., 2019).

Patient Education

The phrase "learning styles" has been used in education for many years. The premise is that individuals process and comprehend information in different ways (Pashler et al., 2008). In other words, a learner must determine their preferred learning style in order to absorb content optimally. However, this concept is controversial due to a lack of research. Studies have shown that individuals can verbalize their learning preferences, but research has not validated that varied delivery methods improve learning outcomes (Pashler et al., 2008). These studies suggest that one could benefit from utilizing a learning style that suits them, but they have the ability to learn other ways. This is just a preference, not an absolute. (Husmann & O'Loughlin, 2019). One tool used to determine learning preferences is the VARK method; a model that classifies individuals into one of the four categories: visual, aural, read/write, and kinesthetic (Prithishkumar & Michael, 2014). VARK consists of a questionnaire that groups the learner into one of the four categories. If an individual has preference for more than one learning style, they can be labelled as unimodal, bimodal, trimodal, or quadrimodal (Husmann & O'Loughlin, 2019). Suggestions for information delivery are then presented for each of the categories. Examples include: looking at graphs for the visual style, listening to seminars for aural, reading textbooks for read/write, and use of models for kinesthetic learners (Prithishkumar & Michael, 2014). This concept of "learning style" is a valuable factor in successful patient education. In order to maximize the effectiveness of health education, professionals should be aware that the delivery of the information should be tailored to the learning preferences of each individual patient.

Health education, also known as patient education, refers to the process of providing information to individuals and allowing them to make knowledgeable decisions regarding their healthcare (Bellamy, 2004). Professionals practice three types of patient education: information only, counselling, and behavioral treatment (Pellisé et al., 2009). However, non-compliance is a significant problem in medicine (Bellamy, 2004). To overcome this obstacle, healthcare workers should identify barriers and build a rapport with their patients (Bellamy, 2004). This can be explained by the health belief model, which suggests that an individual's compliance depends on their perception of severity, susceptibility, benefits of preventative action, and barriers. Demographics and social influences can also play a role in determining their actions (Bellamy, 2004). Furthermore, the theories of self-efficacy and learned-helplessness relate to health-related behavior following patient education. Self-efficacy is defined as, an individual's belief in their ability to perform a behavior (Bellamy, 2004). In the healthcare setting, this refers to a patient's confidence that they will be able to follow the professional's direction and guidance. Learned helplessness occurs when the individual has very low self-efficacy, which can result in non-compliance (Bellamy, 2004).

Finding ways to overcome the disconnect in knowledge transfer between healthcare professionals and patients is essential for better treatment outcomes. According to Rosenberg (1971), Hermiz et al. (2002), and Ryan et al. (2003), patients who are given more information and feel more educated on their illness have fewer complications. Also, significant increases in compliance occur when the patient believes that they play an active role in their own care (Chambers et al., 1999). An individual must be adequately informed in order to understand their illness and prognosis, utilize the limited time in a consultation, assist in at-home care, seek help, and prevent further problems (Pellisé et al., 2009). Due to consultation time constraints and the abundance of information, current studies are analyzing the most efficient way to educate patients and utilize the time a patient spends in a healthcare setting.

Limited time with the provider is shown to be the most significant barrier to quality patient education, but utilizing the time spent in the waiting room helps to overcome this (McColl et al., 1998). According to Beckwith et al. (2016), patients spend more time in the waiting room than with the physician, so this time should be better utilized. Studies suggest that clinics use both printed and technological methods for patient education (Pellisé et al., 2009). Some examples include video, audio, computer kiosks, posters, and pamphlets. Medical providers could also provide patient-specific information in the waiting room so that the patient feels more informed on their condition during the appointment (Sherwin et al., 2013). A combination of waiting room materials and a follow-up with the physician is the most effective method of patient education. (McDonald et al., 2005; Pellisé et al., 2009). This method was demonstrated in a study by Moerenhout et al. (2013), in which the investigators asked 903 participants questions about their experience with waiting room leaflets in a questionnaire. They found that 94% of people read the leaflet in the waiting room and 78% stated that they understood the content. But, only 19% of participants discussed the content with a physician (Moerenhout et al., 2013). This shows the disconnect between the information provided before and during healthcare appointments. Another study by Jung et al. (2007), took this concept further and assessed whether education posters or verbal education from the physician was more effective. They found that using only the posters in the waiting room to educate patients was less effective than the advice of physicians (Jung et al., 2007). Therefore, in order to ensure that the patient retains, understands, and collects the proper information regarding their condition, a combination of both written or audiovisual waiting room materials and a follow-up discussion with the physician would be ideal.

The value of patient education is a more recent concept, with most research into this subject conducted after the year 2000. As a result, data regarding patient education in specialty clinics, such as those focused on concussion, is limited. This is a concern due to the need for education both prior to the injury and after the concussion is diagnosed. By utilizing some of the media recently discussed, such as an info graphic, the patients in the clinic could educate themselves on concussion and its prevalence in the US before even seeing a physician. The Centers for Disease Control and Prevention (CDC) produces guidelines for concussion treatment and releases surveillance data, but this vital information is not always prioritizes in the clinic nor made readily available to patients. The CDC also creates pamphlets on concussion symptoms, discharge information, safety tips, and more. By making information available in the waiting room, concussion clinics can empower patients with information about their condition and result in more productive and efficient interactions between doctor and patient.

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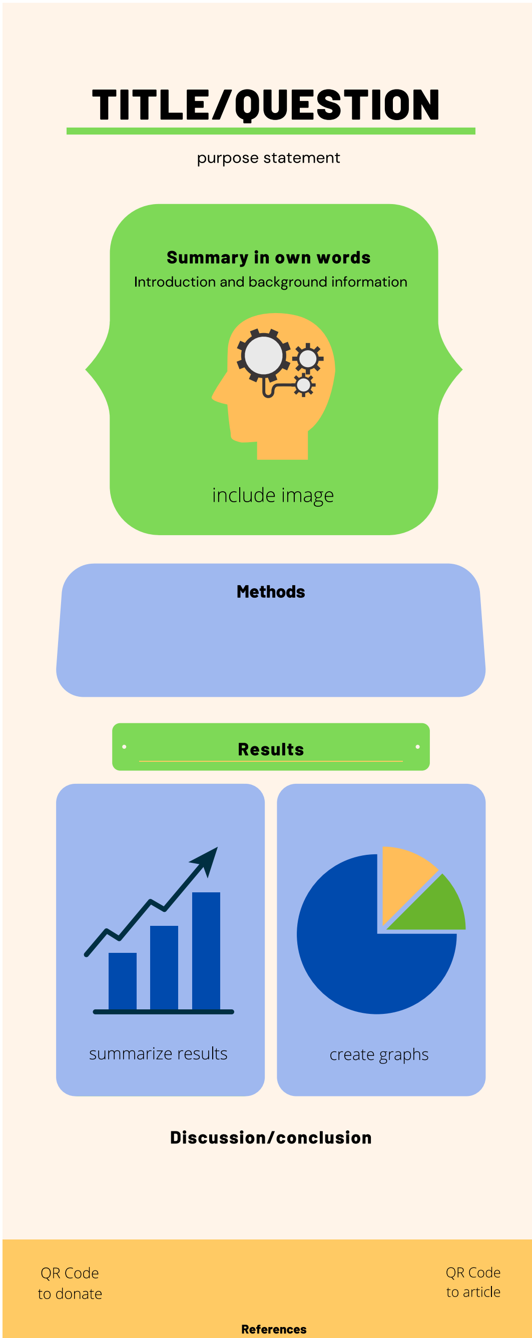
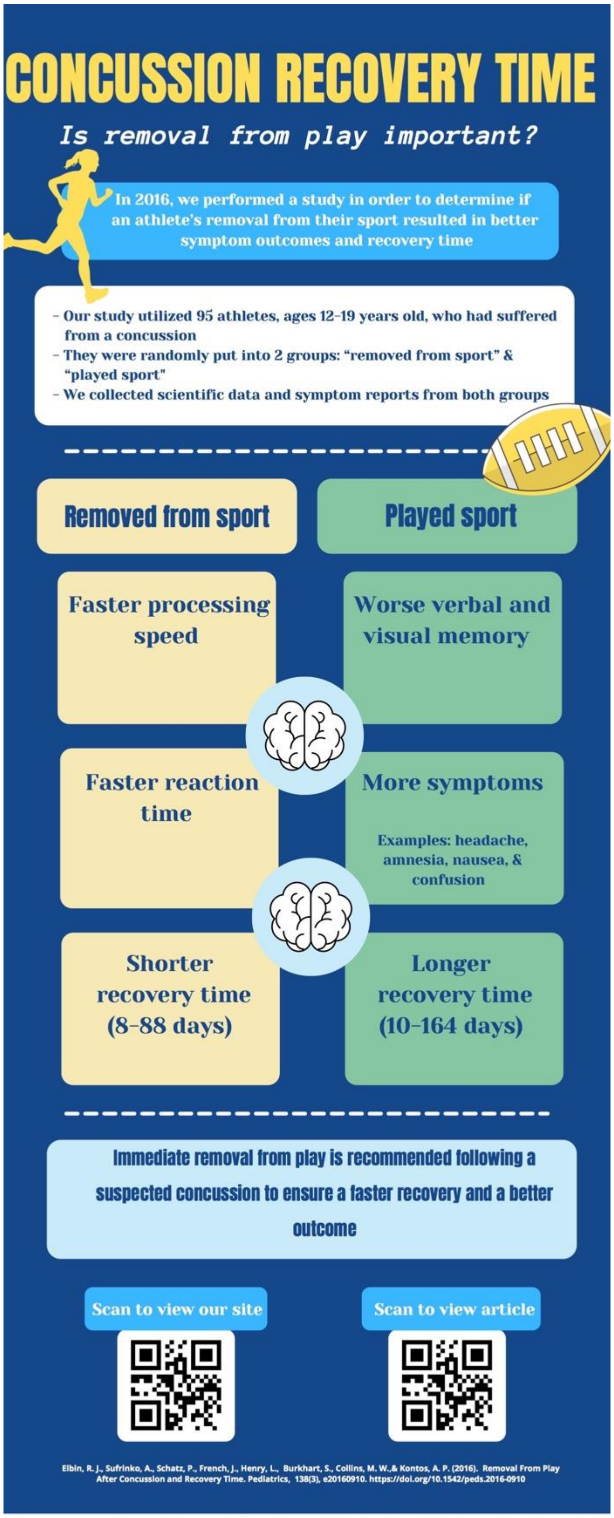
Appendices

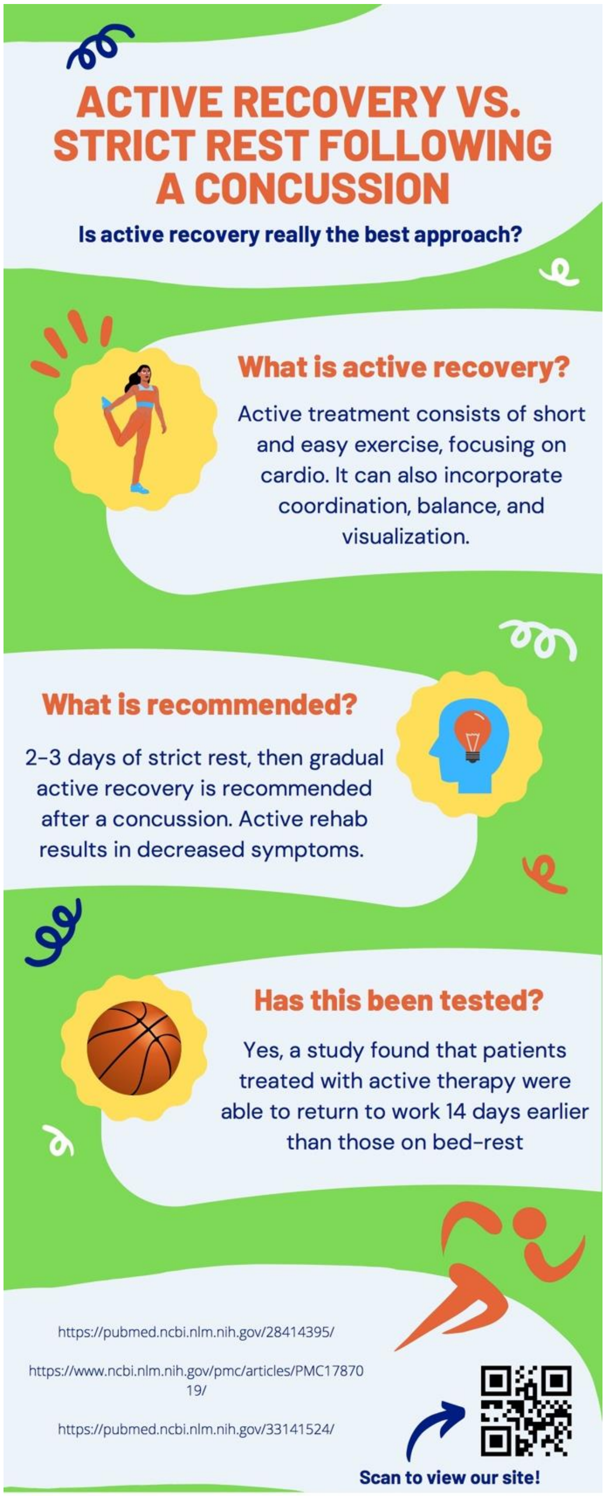
Appendix A.



Appendix B.


CONCUSSION RECOVERY TIME
Is removal from play important?
In 2016, we performed a study in order to determine if an athlete's removal from their sport resulted in better symptom outcomes and recovery time
- Our study utilized 95 athletes, ages 12-19 years old, who had suffered from a concussion
- They were randomly put into 2 groups: "removed from sport" & "played sport"
- We collected scientific data and symptom reports from both groups
Removed from sport
Played sport
Faster processing speed
Worse verbal and visual memory
Faster reaction time
More symptoms
Examples: headache, amnesia, nausea, & confusion
Shorter recovery time (8-88 days)
Longer recovery time (10-164 days)
Immediate removal from play is recommended following a suspected concussion to ensure a faster recovery and a better outcome
Scan to view our site
Scan to view article
Elbin, R. J., Sufrinko, A., Schatz, P., French, J., Henry, L., Burkhart, S., Collins, M. W.,& Kontos, A. P. (2016). Removal From Play After Concussion and Recovery Time. Pediatrics, 138(3), e20160910. https://doi.org/10.1542/peds.2016-0910

Appendix C.


ACTIVE RECOVERY VS. STRICT REST FOLLOWING A CONCUSSION
Is active recovery really the best approach?
What is active recovery?
Active treatment consists of short and easy exercise, focusing on cardio. It can also incorporate coordination, balance, and visualization.
What is recommended?
2-3 days of strict rest, then gradual active recovery is recommended after a concussion. Active rehab results in decreased symptoms.
Has this been tested?
Yes, a study found that patients treated with active therapy were able to return to work 14 days earlier than those on bed-rest
https://pubmed.ncbi.nlm.nih.gov/28414395/
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1787019/
https://pubmed.ncbi.nlm.nih.gov/33141524/
Scan to view our site!