ASSESSMENT OF POST-CONCUSSION SYNDROME TREATMENT AND MANAGEMENT RESOURCES

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ABSTRACT

The purpose of this paper was to understand the treatment options for Post-Concussion Syndrome, gain insight into the unmet needs of patients suffering from concussions, consider the factors that hinder patient recovery, and identify easily accessible information on treatment/management. In order to do so, current resources that focus on concussion management and treatment were assessed and concussion experts/providers were interviewed to understand their perspectives on and awareness of treatment and resources. The goal was to recognize how current resources can be improved and how future research can be guided to ultimately facilitate effective recovery. Results showed that there has been progress on resource creation but there is much need for improvement that may cut down the factors that hinder care. Specific features and suggestions were outlined. Second, a need for a systematic review and further scientific research to assess treatment options was identified. Lastly, randomized and large-sample size interviews/surveys to better understand the unmet needs of various groups like patients, providers, athletic trainers, and researchers were recommended. It is hoped that this study will inform practitioners and researchers about the current resources for concussion management and treatment, and be guided in future resource creation or improvement.
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Lastly, I would like to thank my family for supporting me through my own concussions and for fueling my passions to transform my setbacks into strength. My goal is to decrease the challenges and barriers for patients and their families, so that they do not have to endure the same struggles that my family faced.
Chapter 1 Background

A concussion is a type of traumatic brain injury, caused by a blow to the head or the body that temporarily impedes brain function (Sarmiento, et. al, 2014).

In a study of 285 patients, only 27% eventually recovered. If recovery does not happen within 3 years, symptoms concussion symptoms may become permanent. For each symptom, recovery rate is reduced by 20% (Hiploylee, C, et al, 2017).

Concussion may occur during sports, falls, accidents, and recreational activities. Most patients recover within a few days or weeks after enough rest and gradual return to activity. However, in some cases, symptoms can last much longer. Symptoms or deficits that continue beyond three months may be a sign of Post-Concussion Syndrome (PCS), which encompasses a wide variety of symptoms to be discussed in the section on Symptoms of Concussions.

Recovery from Post-Concussion Syndrome is quite complex and often "forc[es] patients to withdraw from their usual physical, professional, and social lives" ("What is PCS?"). Each case of PCS is unique- no two cases are identical.

A second concussion before the brain has had a chance to recover can cause worsening of symptoms, and even potentially life-threatening brain swelling. Repeated concussions can cause progressive cognitive and neurological decline.

The field of concussion management and treatment is still evolving. Much research has been done on diagnosis, but it is crucial to also look at the research and progress on the treatment/management side. Insufficient resources may lead to patients suffering symptoms for extended periods of time and/or incomplete recovery, which increase the likelihood of subsequent blows to the head.
The purpose of this thesis was to address the question: *What are the current resources for concussion treatment awareness and how effective are they for dispersal of reliable information that promotes recovery?*

The research team hypothesized that there would have been progress in resources, but there would still be a need for establishment of a new resource or development of a current ones. It was postulated that the concussion experts/treatment providers would feel that there is still a lack of centralized and reliable information on treatment options for Post-Concussion Syndrome that would be easily accessible to patients, families, care providers, and athletic trainers. Additionally, experts/providers were asked to discuss the factors that hinder patient recovery. It was hypothesized that the factors would be related to affordability of care and awareness of treatment options. Research on online resources and platforms provided us with further insight into the available information and features that needed to be built upon.

It is crucial to not only understand the treatment resources and tools that currently benefit patients, but also to understand the ones that are missing. If we can recognize what is lacking in the field of treatment of concussions, we can be better equipped to heal patients.
Chapter 2 Public Health Crisis

The Paradigm Shift of Concussions

Concussions were once viewed as trivial, free from the impairments that we now know are caused by blows to the head. The inconsequentiality of concussions was especially seen in the athletic world. Dan Bernstein, co-host of the sports radio program Boers and Bernstein referred to head injuries as- “You got dinged; you got your bell rung; you had cobwebs; you were seeing stars- there was every euphemism to say, ‘You’re OK’” (Cole, 2012). The mentality in sports towards concussions was that athletes should push through and get right back on the field. The “dings” that Dan Bernstein discussed were truly seen as harmless and only having momentary effect (Gupta and Sebastianelli, 2018).

In 1984, Dartmouth neurosurgeons Dr. Richard L. Saunders and Dr. Robert E. Harbaugh, were the first to theorize that second impact in a person who had a recent concussion could have devastating effects. They coined the term “second impact syndrome”. The term stated that once an athlete sustained a concussion, he/she was at a greater risk for a second one, especially if he/she returned to the field before recovered and that if a second head injury does occur, there is a possibility of this causing diffuse cerebral swelling, uncontrolled intracranial hypertension, and death. Their observation served as evidence that concussions could have extremely devastating consequences (Saunders and Harbaugh, 1984) (Bey and Ostick, 2009) (Gupta and Sebastianelli, 2018).

Dr. Robert Cantu, Clinical Professor of Neurology and Neurosurgery at Boston University and leading expert in concussion research, learned about the work of Dr. Saunders and Dr. Harbaugh and stated that sustaining a concussion could cause an athlete to become a “walking
time bomb”. In the early 1990s, Dr. Cantu composed a set of guidelines for coaches and trainers to know when and for how long a player with a concussion needs to be taken out of the game to prevent second impact (Gupta and Sebastianelli, 2018).

Within the last 10-12 years, well-known football players, like Andre Walters and Junior Seau, have committed suicide, creating a sense of panic and fear within the sports world. Research following these suicides, speculated the link between football and the neurodegenerative disease-chronic traumatic encephalopathy or CTE (McCrory et al, 2017). While research is still being done to understand CTE, there is now an acceptance that concussions can result in chronic headaches and depression and potentially even dementia and irrational aggression long-term. The paradigm has shifted from concussions being “shrugged off” to sports organizations striving to improve diagnosis and management procedures (Gupta and Sebastianelli, 2018).

**Epidemiology**

An estimated 5.3 million Americans live with disabilities caused by traumatic brain injuries (Thurman et. al, 1999). In high schools, approximately 300,000 sports-related concussions occur annually. Among individuals 15-24 years of age, motor vehicle crashes are the leading cause of concussions with sports concussions being second. In sports, 47.1% of concussions occur in athletes involved in football, 8.2% in girls’ soccer, 5.8% in boys’ wrestling, and 5.5% in girls’ basketball. Football has the highest concussion rate (6.4- this number corresponds to a rate ratio of concussion rate in football during competition in comparison to during practice), followed by boys’ ice hockey (5.4) and boys’ lacrosse (4.0). Girls show a higher concussion rate (1.7) compared
to boys of (1.0). The rate of concussion is higher for competition than in practice for all sports except cheerleading. It is important to note that there are varying levels of impact and contact among sports. Football has the highest player-player contact, followed by boys’ soccer and boys’ lacrosse (Marar, M., et al, 2012).

Concussions can range in their severity. Not all concussions are fatal. In fact, the CDC reports about that 2.5 million patients with nonfatal traumatic brain injury are seen in US hospital emergency departments annually. This is likely an underestimate as these 2.5 million people may have sought medical care and received a diagnostic code at the hospitals. Individuals who sustained concussions but were not seen in the hospital, were thus unaccounted for in the CDC survey. Out of the CDC sample, 75.0% of the head injuries were mild. The cause of brain injury caused by falls was substantially higher, in comparison, in those younger than 15 and older than 65 years, as seen in Table 1. Among the age group of 15-24, the most common cause was motor vehicle accidents (21.0% of the brain injuries) and assault (22.4% of the brain injuries). From 25 years and up, falls increased in frequency and above 65 years old, it was the leading cause of concussion, as graphically represented in Figure 1. It is estimated that 300,000 TBIs are mild to moderate and 235,000 require hospitalization (Voss, J, et al, 2015).
<table>
<thead>
<tr>
<th>Age Group</th>
<th>Motor Vehicle Traffic</th>
<th>Falls</th>
<th>Assault</th>
<th>Struck by/Against</th>
<th>All Other Causes</th>
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</tr>
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</table>

Table 1: Distribution of TBI-related Emergency Department Visits by Age Group and Injury Mechanism- United States, 2006-2010

Figure 1: Distribution of TBI-related Emergency Department Visits by Age Group and Injury Mechanisms- United States, 2006-2010
It is unclear if these categories include sports-related concussions. A significant portion of youth and collegiate “concussions” goes unreported by athletes, coaches, and athletic trainers. This is the case in spite of all legal and regulatory requirements. Both under-diagnosis and under-recognition of concussions have been evaluated among athletes (Voss, J, et al, 2015). A survey among athletes showed that at the end of a collegiate career, a total of 50% of athletes sustained a recognized, unrecognized, or unreported concussion (i.e., 34% of athletes with at least one recognized concussion, 11% with a recognized concussion they did not report, and 26% reported symptoms suggestive of an unrecognized concussion) (Llewellyn, T, et al, 2014).

Progress on Management

Managed care for concussions has drastically changed over the years. As previously stated, there has been quite a large paradigm shift in concussion diagnosis and management. New approaches to management are now a hot topic and athletes are more carefully monitored post-injury.

In 1997, management by physicians included immediate, early, and late management components. Immediate management involves care at the time of injury at a sporting event. This stage required the basic principles of first aid of Danger, Response, Airway, Breathing, and Circulation, or DR ABC. At this time, the presence of cervical spine or other injury was assessed. Immediate treatment focused on the ABC component. Early management occurred when an athlete was evaluated in a medical room or emergency room. A full neurological examination was done and symptoms like headache, dizziness, blurred vision, and nausea were assessed. CAT Scans and MRIs were also done to test for presence of fractures or bleeding. Referrals to a neurologist,
neurosurgeon, or team physician were common. Late management happened when a player had sustained a concussion and later wanted to be cleared to play again (McCrory, 1997).

At the time that this article was published, there was much debate about return-to-play protocols. Return to play strategies were "entirely arbitrary and should [have] been taken viewed as loose guidelines rather than scientific fact" (McCrory, 1997).

In November 2001, the first International Symposium on Concussion in Sport was held in Vienna, Austria. The purpose of the Symposium was to set guidelines and create recommendations for the safety, health, and recovery of concussive injuries. For the first time, they composed a protocol that included "clinical history, evaluation of symptoms, neuropsychological testing including paper/pen and computerized testing, imaging procedures, research methods, management and rehabilitation, prevention, education, future directions, and medico-legal considerations" (Aubry, et. al, 2001).

As part of the management and rehabilitation component, there is an acute response, rehabilitation, and return to play protocol. Acute response involves not letting players return to play, if there are any symptoms or signs of concussion, and ensuring that they are medically evaluated after the injury. Rehabilitation involves a "structured and supervised concussion rehabilitation protocol". Players start with "incremental increases in exercise duration and intensity". Return to Play Protocol is summarized as "no activity, complete rest, light aerobic exercise, sport-specific training, non-contact training drills, full contact training, and finally game play". In this protocol, it was also advised that there should be supportive educational "web-based resources, videos, outreach programs, working groups, and support groups" (Aubry, et. al, 2001).

Physical activity and cognitive activity both pose neuro-metabolic demand on the brain following a concussion. It is important for clinicians to carefully manage the neuro-metabolic
demands on the brain during recovery. "It is now well-accepted that excessive neuro-metabolic activity can interfere with recovery from a concussion and that physical rest is needed." Athletes are normally prevented from engaging in physical activities until they are "asymptomatic and then are progressed through a graded physical exertion return-to-play protocol". Physical rest alone cannot alone address brain dysfunction. Mental rest from school activities is also equally important. In a study, "88.5% of girls and 55.4% of boys" reported symptom exacerbation from cognitive activity after concussive injury (Parsons, et. al, 2010).

In another study observing the current management practices of primary care providers, it was revealed that nearly 68.4% of the 367 primary care providers interviewed indicated that they used published guidelines as the main tool to manage patients with concussions. 31.6% said that they did not use published guidelines due to a lack of awareness and confusion. 65.7% were aware that neuropsychological tests could be used, but only 16% actually had access to those tests at the time that concussion patients were seen (Pleacher and Dexter, 2006).
Chapter 3 Post-Concussion Syndrome and Treatments

It is important to note that every individual’s experience with a concussion is different. No two cases are the same. Below are the main overarching symptoms that tend to occur with concussions. These symptoms can truly vary with severity of the injury and potential predisposing factors.

Post-Concussion Syndrome Symptoms

University of Pittsburgh Medical Center, UPMC, categorizes the symptoms of post-concussion syndrome into cognitive/fatigue, vestibular, ocular, post-traumatic migraine, cervical, and anxiety/mood. This is certainly just one model of symptom assessment, but it covers the spectrum of symptoms quite well.
Figure 2: Concussion Clinical Trajectories- A Model for Understanding Assessment, Treatment, and Rehabilitation
Damage to the brain can produce a multitude of results, depending on which area of the brain received impact. It may be effective to localize potential presentation of symptoms based on the anatomy of the brain.

**Frontal Lobe Damage**

The frontal lobe is important for personality and impulse control. It is also crucial for perceiving and judging situations, solving problems, and making decisions based on available information. Other functions include memory and voluntary movements. The risk of damage the frontal lobe is quite high as it is large and in the front of the brain (Levin et al, 1987) Damage to the area can cause (Lehr, R, 2017):

- “Loss of simple movement of various body parts
- Difficulty in problem solving and completing multi-staged tasks
- Focusing on a task
- Loss of spontaneity in interacting with others
- Persistence of a single thought
- Disturbance in mood and personality
- Changes in social behavior
- Difficulty in expressing and language processing”

**Parietal Lobe Damage**

The parietal lobe has two functional areas that are involved with the integration of sensory input and spatial arrangement. It helps us physically differentiate between left and right, understand and process words and number, and interpret our physical surroundings. The parietal lobe is the
somatosensory processing center, which means that it processes information like pressure, pain, vibration, touch, temperature, and joint position (“The Role of the Parietal Lobe”).

Damage can cause (Lehr, R, 2017):

- “Inability to attend to more than one object at one time
- Difficulty with drawing objects
- Difficulty with distinguishing left from right
- Difficulty with eye and hand coordination
- Lack of awareness of certain body parts and/or surrounding spaces”

**Temporal Lobe Damage**

The temporal lobe is largely important for auditory and visual input processing, declarative and long-term memory, language perception and recognition.

Damage can cause (Lehr, R, 2017):

- “Difficulty in recognizing faces, known as Prosopagnosia
- Difficulty in understanding spoken words, known as Wernicke’s Aphasia
- Disturbance with selective attention
- Difficulty with identification of, and verbalization of objects
- Impairments of memory
- Inability to categorize objects”

**Occipital Lobe Damage**

The occipital lobe is crucial for visual perception and processing, color perception, and shape recognition. Projection of input from the primary visual cortex to the occipital area allows the brain to process and register any images or visual information in the surroundings. The two-streams hypothesis involves the ventral and dorsal streams. The ventral stream processes the
objects in the visual field and the dorsal stream processes the spatial arrangement of the object in
the visual field (Eysenck and Keane, 2013).

Damage can cause (Lehr, R, 2017):

- “Visual Field
- Difficulty with locating objects in the environment
- Saccadic or eye tracking deficiency
- Difficulties with eye teaming, leading to convergence or divergence excess
- Difficulty with focusing or visual accommodation
- Inability to recognize the movement of an object
- Blurred vision or double vision
- Sensitivity to light
- Headaches and migraines
- Difficulty with detecting colors
- Blindness in severe cases
- Word blindness- inability to recognize words
- Production of visual illusions and hallucinations”

**Brain Stem**

The functions of the brain stem are to control how the body responds to being startled as well as
processes of the autonomic nervous system like sweating, blood pressure, digestion, and
temperature. It is also crucial for regulating sleep and consciousness (“The Role of the Brain
Stem”).

Damage to the brain stem can cause (Lehr, R, 2017):

- “Decreased capacity for breathing and swallowing
- Difficulty with organization and perception of the environment
- Issues with balance and movement
- Dizziness and nausea
- Sleeping difficulties, like insomnia and sleep apnea”
Cerebellum

The cerebellum’s functions are important for balance and movement coordination.

Damage to the cerebellum can cause (Lehr, R, 2017):

- “Loss of ability to coordinate fine movement
- Loss of ability to walk
- Inability to reach out and grab objects
- Tremors and dizziness
- Slurred speech
- Inability to make rapid movements”

Limbic System

The limbic system is important for the regulation of our emotions and behavior. It also plays a role in the endocrine system regulation and response to emotion. The limbic system is what allows us to understand danger in the environment and trigger our brains to respond. It is a C-shaped area in the brain that overlaps the temporal, parietal, and frontal lobes (“Limbic Lobe”).

Damage to the limbic system can cause (Lehr, R, 2017):

- Difficulty with emotional regulation such as uncontrolled outbursts of crying, anxiety, or anger
- Increased feelings of anxiety and panic attacks
- Difficulty with memory, either long-term or short-term, and cognition
- Trouble with regulation of autonomic nervous system, due to hyperarousal, causing increase in heart rate and blood pressure
- Difficulty with speaking and/or understanding language

In a study done among a sample of 1936 concussions of athletes aged 18-24, the most commonly reported concussion symptom was headache (94.2%), followed by dizziness (75.6%) and concentration difficulty (54.8%). Other symptoms were confusion (45.0%), light sensitivity (36.0%), and nausea (31.4%) (Marar, et al, 2012).
Concussion experts and researchers believe that the best way to manage and rehabilitate a concussion is through individualized treatment plans, based on the patient’s symptoms and goals (Hunt and Asplund, 2010). The below methods are not necessarily treatments, but may be beneficial for reducing the symptoms of Post-Concussion Syndrome symptoms. Research is still being done to test the scientific evidence of each.

Cognitive- memory, concentration, fogginess, delayed thought processing

- Cognitive therapy (CPT and PE)
- Neurofeedback (alternative)
- Medications
- Acupuncture (alternative)
- Accupressure (alternative)

Vestibular

- Vestibular therapy
- Therapy for BPPV

Ocular

- Vision therapy- convergence, divergence, accommodation, eye movement, blurriness, double vision, ocular-motor dysfunction, reduced visual processing speed
- Occipital nerve block injections
- Neuro-optometric rehab therapy
- Corrective lenses
- Phototherapy programs

Migraines- headache, nausea, vomiting, sensitivity to light and sound

- Acupuncture (alternative)
- Medications
- Neurofeedback (alternative)
- Occipital nerve blocks
- Botox

Behavioral- anxiety, depression, mood swings, sleep patterns

- Neurofeedback (alternative)
- Medications
- Psychologist
- Cognitive-Behavioral Therapy

Physical and Cervical

- Physical therapy
- Vestibular therapy
- Chiropractor care- Atlas correction and Active Release Therapy
- Monitored physical exertion
- Osteo Manipulation Therapy
- Massage

Neurocognitive rehabilitation, which focuses on treating specific and individualized cognitive deficiencies, is one of the most widely used treatments, but there is no conclusive evidence to support an improved outcome. Pharmacologic treatment is used to alter the underlying pathophysiology of the concussion and stunt the duration of symptoms. The most common treatment is the use of migraine and cluster headache medications treat post-concussive headaches (Hunt and Asplund, 2010).

The somatic post-concussion symptoms include “headaches, nausea, vomiting, dizziness, balance problems, fatigue/low energy, visual changes, and photo/phono-phobia”. There are many types of headaches including “tension, migraine, cluster, fatigue, and mixed posttraumatic headaches”. For cervicogenic and tension-type headaches, medications that might be helpful are simple over the counter or prescription anti-inflammatories (Burton, 2012).
Prescriptions of amitryptiline are often given to ease tension and migraine type headaches for post-concussion syndrome. Beta-blockers have been used in the treatment of headache prophylaxis, before athletes return to play. For migraines, providers also recommend triptans. For more severe headaches, injections like dihydroergotamine or onabotulinumtoxinA may be helpful. Physical therapy and rehabilitation exercises may also be helpful in easing pain related to musculoskeletal injury; an example of this would be cervicogenic injury that causes headaches (Burton, 2012).

Cognitive impairments are also extremely common and cause patients to “complain of ‘feeling in a fog’, difficulty concentrating and remembering, and cognitive fatigue”. Teachers, school counselors, and nurses should be notified of cognitive impairment and symptoms to ensure that individuals receive the necessary accommodations. Neuropsychological evaluations should be done to properly understand the cognitive dysfunctions of patients (Burton, 2012).

For patients with prolonged post-concussion syndrome and with severe brain injuries, cognitive rehabilitation has been used (Comper et al, 2005). Medications are not typically given to treat cognitive impairment, but there have been studies to test the efficacy of Amantadine, methylphenidate, and atomoxetine (Burton, 2012).

Emotional symptoms are quite common and should be closely monitored. It is important to do a “thorough mental health history, including premorbid psychiatric conditions and family history”. Management approaches include cognitive-behavioral therapy and selective serotonin reuptake inhibitors, like sertraline, citalopram, and fluoxetine (Burton, 2011).

Hypersomnolence or insomnia, which are types of sleep disturbances, are common. Changing sleep hygiene is useful, but if symptoms of sleep disturbance continue, then medications like melatonin, trazodone, amitriptyline, nortriptyline, and ramelteon, may be considered.
Benzodiazepines, antihistamine, and anticholinergic medications should be avoided as they can interfere with cognition and have negative side effects (Burton, 2012).

To correct for ocular dysfunction caused by post-concussion syndrome, vision therapy is a potential treatment. Vision therapy is a form of therapy that is used to treat the functional deficiencies of the optic system, due to inherent issues or damage. Injury of the occipital lobe of the brain can cause damage such as issues with eye-teaming, focusing, visual tracking, visual processing, accommodation, and saccadic movements. Individuals with post-concussion visual related issues may experience blurred vision, visual stress from reading or looking at a computer screen, headaches, and/or vision-induces motion sickness (Gallaway, M, et al, 2017).

Table 2 shows the frequency of vision diagnoses from a study done of 218 patients who were referred to a vision therapist within 18 months following a concussion. 175 of the 218 patients (80%) were recommended by the vision therapists to begin therapy. Binocular vision refers to the ability of both eyes to work together while viewing an object. If the two eyes fail to work together, several issues can arise such as a convergence insufficiency (trouble with eyes focusing on nearby object), convergence excess (eyes over-focusing on nearby object and trouble with eyes relaxing to look at distant object), and vertical deviations. In a majority of cases, vision therapy had a successful or improved outcome (Gallaway, M, et al, 2017).
In a study done with office-based vision therapy (OBVT) for concussion-related convergence insufficiency (CI), participants were treated with OBVT weekly with home reinforcement. The outcome measures were the “average peak velocity for 4-degree symmetrical convergence steps… latency, accuracy, settling time, and main sequence”. There was a statistically significant increase in peak velocity, response accuracy to symmetrical convergence and divergence step stimuli, and main sequence ratio for convergence (Gallaway et. al, 2017).

Neurofeedback is non-invasive and painless. Patients’ symptoms and qEEG reports guide neurofeedback treatment. qEEGs detect electrical activity in the brain using small, flat metal electrodes that are temporarily attached to scalp. The patient’s brain activity is compared to a “normalized database” of uninjured brains of the same age. The sensors detect electrical signals coming from the brain and then feed back a signal that the patient does not notice, but the brain does. The computer, through the sensors, analyzes the speed of the strongest brainwave and feeds back a signal at a different speed in attempt to control some aspect of the brain’s impairment. Dr.
Mary Lee Esty describes the coordination between computer and brain like two dance partners. The brain leads and the computer follows, without the conscious effort of the patient. (Esty, 2014)

In a clinical study, 40 subjects with post-concussion syndrome were treated with EEG-guided neurofeedback and overall improvement was shown via the “Symptom Assessment-45 Questionnaire, Clinical Global Impressions Scale, Hamilton Depression Scale… Minnesota Mutiphasic Personality Inventory and Test of Variables for Attention”, with the Neuroguide Traumatic Brain Index also showing a decrease. 39 of the 40 subjects were followed up over an average of 3.1 years and results showed that 37 of the subjects were stable and no longer taking medication. Neurofeedback was overall seen to be effective (Surmeli et. al, 2017).

There are also studies to test the efficacy of acupuncture in subsiding the headache component of post-concussion syndrome. In one study, patients with mild-to-moderate TBI and headaches at three military treatment facilities were studied. They were treated with auricular or traditional Chinese acupuncture and these two groups were compared to a group treated with usual care (no acupuncture). Results showed that both acupuncture groups had statistically significant reductions using the Headache Impact Test and Numerical Rating Scale (Jonas, et. al, 2016).

Another article states that current evidence shows that “acupuncture is at least as effective as drug therapy for migraine prophylaxis and neurovascular and tension-type headaches”. This article featured 36 articles that were systematic reviews, meta-analyses, or RCTs that explored acupuncture intervention. The studies were required to have more than 60 subjects and adult subjects with “clinical diagnosis of mixed chronic headache, migraine, tension-type headache, neurovascular headache, cervicogenic pain, and neck pain”. Levels of evidence were assigned to the articles based on the scientific evidence presented. It was stated that acupuncture is most effective when done for 6 to 10 weeks, about 1-2 times a week (Khusid, et. al, 2015).
There is still limited evidence and information that fully support those treatments for concussions. In a systematic review, “a wide-range of treatments was studied, including cognitive/behavioral therapies (28.2%), medications (28.2%), devices (11.3%), dietary supplements (8.5%), return to play/rest (1.4%), and others (22.4%)”. The team concluded that there is certainly potential and promise for the therapeutics currently being studied. However, there were several insufficiencies like the scarcity of trials focusing on return-to-activity principles, small sample size, and trial heterogeneity (Burke, et. al, 2015).


Chapter 4 Current Resources

The Center for Disease Control has an educational initiative, called Heads Up, with the goal to protect kids and teens by raising awareness about prevention, recognition, and response to concussions. When Heads Up was first started, it primarily catered to health care professionals and provided them with information to diagnose and manage concussions. More recent efforts by the Heads Up initiative have been focused on sports programs and schools to disseminate concussion information to young athletes, coaches, parents, sports officials, and school professionals. They offer a free concussion-training course to better understand concussions and their potential consequences, to recognize concussion symptoms and how to respond effectively, to learn about steps for returning to activity after a concussion, and to focus on prevention and preparedness to keep athletes healthy. The CDC even has created an app to help identify a possible concussion.

Figure 3 shows the CDC’s advised recovery guide, that highlights five steps to follow before return to play:
Return to Play Progression

There are five gradual steps to help safely return an athlete to play:

**Baseline: No Symptoms**
- As the baseline step of the Return to Play Progression, the athlete needs to have completed physical and cognitive rest and not be experiencing concussion symptoms for a minimum of 24 hours. Keep in mind, the younger the athlete, the more conservative the treatment.

**Step 1: Light aerobic activity**
- The Goal: Only to increase an athlete’s heart rate.
- The Time: 5 to 10 minutes.
- The Activities: Exercise bike, walking, or light jogging.
- Absolutely no weight lifting, jumping or hard running.

**Step 2: Moderate activity**
- The Goal: Limited body and head movement.
- The Time: Reduced from typical routine.
- The Activities: Moderate jogging, brief running, moderate-intensity stationary biking, and moderate-intensity weightlifting

**Step 3: Heavy, non-contact activity**
- The Goal: More intense but non-contact
- The Time: Close to typical routine
- The Activities: Running, high-intensity stationary biking, the player’s regular weightlifting routine, and non-contact sport-specific drills.
- This stage may add some cognitive component to practice in addition to the aerobic and movement components introduced in Steps 1 and 2.

**Step 4: Practice & full contact**
- The Goal: Reintegrate in full contact practice.

**Step 5: Competition**
- The Goal: Return to competition.

---

**Figure 3: Return to Play Progression Timeline**

The main recovery methods of the above timeline utilize rest and monitored exertion. However, it is important to consider the patients who may have more severe symptoms or are not ready to return to play immediately after a few days of rest. Will those patients’ symptoms dissipate or will they be aggravated by return to play? If symptoms dissipate, which ones will? What steps does the patient take, beyond just resting, increasing exertion slowly, and getting checkups at a Neurologist or Sports Medicine professional? There are several questions, regarding the management and recovery of concussions that seem to be unanswered by the resources provided on the CDC website.
UPMC

University of Pittsburgh Medical Center is a highly respected and knowledgeable center for concussion research, diagnosis, and treatment. It is, in fact, the first and largest research and clinical program for mild traumatic brain injured athletes. Dr. Michael “Micky” Collins, executive director of UPMC Sports Medicine Concussion Program, is an internationally renowned expert in sports-related concussions. He believes that “a well-managed concussion is the best form of prevention”. UPMC launched the website “ReThink Concussions” to combine the expertise of neuropsychologists, sports medicine physicians, neurosurgeons, physical medicine and rehabilitation physicians, neuro-vestibular and exertion training experts, and others to give patients a more personalized approach to concussion management.

The website has background information about concussions, including graphics, videos, and Q&A style articles written by the team of UPMC experts. There is no dearth of information on the background of concussions.

The website also has a category for “treatment approach” that again consists of various articles and topics, including the process of assessment, the top clinical trajectories of patient symptoms (as discussed earlier), and the team of experts that aid in the rehabilitation of a patient. There are several articles focusing on debunking myths of treating concussions and stating that a majority of Americans do not recognize some of the best practices to treat concussions. UPMC wants the public to be aware that concussions are treatable. They even have stories about professional athletes, including players from the Pittsburgh Steelers team, who were part of the concussion center and helped spread awareness about the importance of treating concussions. The
last key feature of their website contains 19 patient stories, of all ages and genders. Some of the stories are shown as articles and some as videos.

UPMC’s ReThink Concussions is successful in several aspects:

- Grouping the symptoms by the key symptoms people experience
- Debunking myths about the treatment of concussions
- Giving more details about the certain dysfunctions that can occur, such as ocular dysfunctions
- Providing information about the team of treatment providers that UPMC has
- Explaining the typical treatments they may recommend
- Writing about the recovery of patients from the UPMC center

A patient and family looking at UPMC’s website may be willing travel to UPMC to set up an appointment post-injury based on the reputation, patient stories, individualized care plans, and expert diagnostic skills. There are several questions to ask- how long does it take for a patient to get an appointment there? What if the patient is too far from Pittsburgh or is unable to pay for the expenses associated with diagnosis and recovery? It is important to assess what resources primary care providers and school nurses/trainers use in other states and what treatment plans are recommended to patients in other centers across the country. It is crucial to ensure that similar resources are being provided to patients across the country.
Completeconcussions.com

This Canadian website has a feature to find a nearby clinic for a variety of treatment options. The clinics that are listed are mainly in Canada, with two in California and one in Massachusetts. They have courses to learn about concussion management. They do have a small blog from a team of 6 Canadian doctors. Finding a local clinic is a beneficial resource for patients. Of course, these clinics should be reliable and should have well-defined concussion management protocols.

This website has two main sections- Services and Resources. The Services section includes a page for patients and athletes, sports and schools, healthcare practitioners, and “become a clinic”. The patients and athletes section helps an individual find a clinic for exercise therapy, manual therapy, vestibular rehabilitation and vision therapy, diet and nutritional intervention, and education, and reassurance. They do have an article that shares the top five evidence-based treatment options for concussions that include those listed in the previous sentence. An individual may have to read this article, in order to better understand which treatment option would be right for him/her, as it is not too clear in the services section itself.

The Sports and School section includes Multimodal Baseline Testing; Return to Learn, Work and Play; Sport and School Policy Development; and Concussion Sideline Course. Again through this section, an individual could find a clinic or book a baseline test near him/her. This may help schools receive external aid from concussion experts to help patients heal from concussions.

The Healthcare Practitioners section includes a way to become a clinic listed on their website by taking a certification course that is an introduction to concussion management. The
website also has a feature for a doctor to upload a referral form and help his/her patient find a local clinic for certain treatments. This helps the doctor co-manage the recovery of patients, essentially extending the patient’s healthcare team. The website makes it simple to do so. It may be beneficial for a researcher to view the clinicians and treatments that are covered by health insurance in Canada, in comparison to those covered in the US.

In the resources section, there is a small blog, a few research articles, and some information on concussions. The information provided in this section is much less than that of UPMC’s website.

The organization also has an app called The Concussion Tracker App. There are less features in the app than on the website, including finding a clinic, reading some information on concussions, and booking a baseline test.

Again, this may a well known website and app in Canada specifically.

**Concussion Legacy Foundation**

Chris Nowinski, PhD, and Robert Cantu, MD created the Concussion Legacy Foundation, after Dr. Cantu treated Dr. Nowinski for Post Concussion Syndrome and taught him about the importance of diagnosis and treatment of concussions. The Concussion Legacy Foundation focuses on advancing the study, treatment, and prevention of effects of brain injuries. The team is extremely active on the diagnosis, training, and symptom tracking side. They also have collaborated with several well-known research centers, like Boston University, to study CTE.
The treatment options that this organization lists on their website includes vision therapy, vestibular therapy, physical therapy, exertion therapy, and cognitive behavioral therapy. These are the treatments that they believe are supported by peer-reviewed scientific articles. A brief explanation is given for each. There are also several patient stories, helping the general public learn more about PCS.

The foundation has exceptional resources for education about Post-concussion Syndrome, CTE, and prevention of concussions in youth. They have many influential individuals who support their work and spread their mission. Their work is done in person in various cities in the US, Canada, and Australia.
Chapter 5 Expert Opinions

In order to gain the perspective of providers, I spoke with 6 concussion experts including Dr. Robert Harbaugh, Dr. Wayne Sebastianelli, Dr. Harry Bramely, and Dr. Shelly Timmons, who are all connected to Penn State Health’s Concussion Clinic; Dr. Arlene Goodman at Saint Peter’s Sports Medicine Institute; and Dr. William Young, Neurologist, at Jefferson Hospital for Neuroscience.

I also spoke with 3 treatment providers, including and Jen Cho, NP at Jefferson Headache Center; Dr. Barry Tannen, ophthalmologist and specialist in vision therapy at Eye Care Professionals; and Dr. Maria DiDonato, specialist in Neurofeedback and Cognitive Behavioral Therapy, at Achievement and Wellness Center.

Tables 3-5 show the results from surveys of the 6 concussion experts, each assigned a number randomly. Table 3, specifically, shows the post-concussion symptoms that are commonly seen by the concussion experts. Table 4, specifically, shows the treatment options that the concussion experts most typically recommend to patients. Table 5, specifically, shows the 5 concussion experts’ awareness of the various treatment options. Table 6 shows the post-concussion symptoms that are typically exhibited by patients who seek vision therapy, medications/injections, or neurofeedback. Above each table, are the questions that were asked in the survey. The “x” represents a check mark.
Which Post-Concussion Syndrome symptoms do your patients most commonly exhibit? Check all that apply.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Concussion Expert</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognitive</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Memory</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>• Concentration</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Fogginess</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Delayed thought processing</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>X</td>
</tr>
<tr>
<td><strong>Difficulty with balance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Difficulty with balance</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td>x</td>
</tr>
<tr>
<td><strong>Ocular/Visual</strong></td>
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<td></td>
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</tr>
<tr>
<td>• Ocular/Visual</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Migraine</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>• Headache</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Nausea and vomiting</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>• Sensitivity to light and sound</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Behavioral</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Anxiety</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>• Depression</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>• Mood swings</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Sleep disturbances</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td><strong>Physical</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Muscular</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>• Cervical/spinal</td>
<td>x</td>
<td>x</td>
<td></td>
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<td></td>
<td>x</td>
</tr>
</tbody>
</table>

Table 3: Survey Results: Symptoms of Patients with Post-Concussion Syndrome, Seen by Concussion Experts
Concussion Experts: Which treatments do you most frequently recommend for your patients who are suffering from Post-Concussion Syndrome? Check all that apply. Note: Treatment does not include preventative steps such as wearing a helmet or rest that should occur at the early stages of a concussion.

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Concussion Expert</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cognitive Therapy (CPT and PE)</td>
<td>x</td>
<td>x-select group</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Neurofeedback</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>• Medication</td>
<td>Does not recommend for cognitive</td>
<td>x-select group</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>• Acupuncture</td>
<td>“Can’t hurt”, But does not have referral network</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Acupressure</td>
<td></td>
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<tr>
<td>Difficulty with Balance</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>• Vestibular therapy</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Therapy for BPPV</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Ocular/Vision</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Vision therapy</td>
<td>x - “Not readily available”</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>• Occipital nerve block</td>
<td></td>
<td>x-select group</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Migraine</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Acupuncture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>• Medication</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>• Neurofeedback</td>
<td>“Probably works but does not</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Treatment Options</td>
<td>Patient 1</td>
<td>Patient 2</td>
<td>Patient 3</td>
<td>Patient 4</td>
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<tr>
<td><strong>Occipital Nerve Block</strong></td>
<td>refer because does not have network”</td>
<td>x</td>
<td>select group</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Botox</strong></td>
<td>x – “for muscle spasms if typical trigger point injections do not work”</td>
<td>x</td>
<td>select group</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Behavioral</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Neurofeedback</strong></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Medication</strong></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Psychologist</strong></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Biofeedback</strong></td>
<td></td>
<td>x- select group</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Physical</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Physical therapy</strong></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Vestibular therapy</strong></td>
<td></td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Chiropractic – Atlas correction</strong></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chiropractic – Active Release Therapy (ART)</strong></td>
<td></td>
<td></td>
<td>x- select group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Monitored physical exertion</strong></td>
<td>x- believes that it does work</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Osteo Manipulation Therapy (OMT)</strong></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Massage</strong></td>
<td>x- “Good for muscle spasms”</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Survey Results: Treatment Options Recommended by Concussion Expert
Including the treatments you typically recommend to your patients, which treatments options are you aware of? Check all that apply.

<table>
<thead>
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</thead>
<tbody>
<tr>
<td><strong>Cognitive</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Cognitive</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Therapy (CPT and PE)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>• Neurofeedback</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Medication</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Acupuncture</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Acupressure</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td><strong>Difficulty with Balance</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Vestibular</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
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<td>• Therapy for</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>BPPV</td>
<td></td>
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<tr>
<td><strong>Ocular/Vision</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>• Vision therapy</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Occipital</td>
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<tr>
<td>nerve block</td>
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<tr>
<td><strong>Migraine</strong></td>
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<tr>
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<td>Chiropractic – Active Release Therapy (ART)</td>
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<td>x</td>
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<td>Monitored physical exertion</td>
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<td>Osteo Manipulation Therapy (OMT)</td>
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<td>x</td>
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<td>Massage</td>
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</table>

Table 5: Survey Results: Treatment Options that Concussion Experts are Aware of
Which Post-Concussion Syndrome symptoms do your patients most commonly exhibit? Check all that apply.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Vision Therapy</th>
<th>Medications, Injections</th>
<th>Neurofeedback</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognitive</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Memory</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Concentration</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Fogginess</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>• Delayed thought processing</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Difficulty with balance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Difficulty with balance</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Ocular/Visual</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Ocular/Visual</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Migraine</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Headache</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Nausea and vomiting</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Sensitivity to light and sound</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Behavioral</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Anxiety</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Depression</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Mood swings</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Sleep disturbances</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>• Hyperactivity</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Physical</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Muscular</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>• Cervical/spinal</td>
<td>x</td>
<td>x</td>
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</tr>
</tbody>
</table>

Table 6: Survey Results: Symptoms of Patients with Post-Concussion Syndrome, Seen by Treatment Providers
The experts and providers were also asked- “what are the gaps/factors that hinder patient recovery?” Below is a compilation of their responses:

- Schools are often missing resources that guide students through the process of management and recovery. School accommodations are also sometimes not followed by the patients.
- There is a lack of awareness of the psychological impact and care following concussions.
- It is difficult to find providers that take new patients and insurance for appointments/treatments. It often takes a long time for patients to get appointments with providers.
- Treatments can often be very expensive and not covered by insurance.
- There is a lack of patient education about the use of CAT Scans and MRIs. Patients often think that because their CAT Scans or MRIs did not show any abnormalities that their brains are not injured. However, this is not often the case as CAT Scans and MRIs only detect hemorrhages, fractures, and neurological damage. But these tests do not detect concussions or change in brain function. EEGs are often useful for this.
- There is a lack of public education about the types of concussion treatments. This partly due to the varying levels of scientific evidence and limited access to information about treatments.
- There is a lack of well-trained behavioral experts to assist with treatment of psychological issues.
- There is a need for better and more well-designed research to find scientific evidence of treatment options.
- There is a lack of education for primary care and Emergency Room physicians to diagnosis and guide concussions patients.
- There is a belief that the only treatment is medication.
- The severity of initial trauma can lead to complex medical issues that causes confusion about management and treatment options.
The experts and providers were then asked: “What resources do you wish existed to help your patients gather information on the management of or deal with Post-Concussion Syndrome?” and “If a website/on-line resource were to be created that focused on concussions and the management of Post-Concussion Syndrome, what specific content would you like the site to contain?”

Below is a compilation of their responses:

- A resource that discusses the efficacy of different treatment options with their levels of scientific evidence. This was a common consensus among most of the experts and providers.
- A resource for providers that is a commonplace of research articles and new findings. It is difficult for providers to stay up to date on all of the research findings that could guide their treatment.
- A resource that has components for families to learn more about how to help their loved ones, since patients may have to limit screen time.
- A resource with an interactive map that identifies therapists and treatment providers in specific areas. This would increase access to providers and allow providers to increase awareness about their resources. Centers should be identified across the United States.
- A resource with a member login/patient portal and symptom tracker to track progress
- A resource with instructions about what to do following a concussion.
- A resource with blogs from families, providers, etc. to share stories and tips. This would also be useful for sharing anecdotes about the experiment treatment options that have less scientific research.
- A resource that highlights major Concussion Centers in the country
- A resource that highlights a risk stratification for re-injury
- A resource that debunks myths about concussions
• A resource that has a feature to chat with a physician and receive online consultant. This would help cut down costs and time to get an appointment. This is a similar model to Amwell’s model of online care.

Current Research on Resources

It is imperative to attain better data, to make more informed decisions about young athletes. The research and clinician community needs to address the knowledge gaps that are currently hindering the progression of treatment. Elizabeth Ahmann suggests many methods to do so, including use of the National Surveillance System to calculate the number of sports-related concussions nationally, better understand the impairments on the brain after a concussive injury, determine the effect of cumulative concussions over an individual’s lifespan, and assess the degree of efficacy of return-to-play rules (Ahmann, 2013).

For the 10-20% of patients whose symptoms persist for much longer than the two weeks following concussive injury, an individualized treatment plan is required. This plan should include physical and mental rest regimens. However, current research does not indicate a standard or universal level or duration of rest needed (Ahmann, 2013).

A research study done to assess the effectiveness of a web-based resource called Brain 101: The Concussion Playbook, includes training in sports concussions for school coaches, educators, parents, and teen athletes. The resource presents guidelines on the formation of a concussion management team and strategies for helping students in the classroom. The study was a randomized control of 25 Oregon high schools that were assigned to Brain 101 intervention and
control groups. In the *Brain 101* treatment group, fall athletes and their parents were required to complete online training and the school administrators were instructed to create concussion management policy and procedures within the schools. The results showed that the athletes and parents who completed the *Brain 101* trainings did significantly better than those at the control schools who were not required to complete training. They specifically outcompeted the control schools on sports concussion knowledge, knowledge application, and behavioral intention to put concussion management practices in place. The students who had concussions at the *Brain 101* schools received more academic accommodations, as guided by the school administrators. This study showed the beneficial use of an online resource in spreading awareness about concussions (Glang, et. al, 2015).

Another research study focused on the current attitudes, beliefs, knowledge, and practice of physical therapists in the treatment of patients with concussions. It was a “55-question electronic survey, divided into 6 sections- demographics, current practice, youth concussion legislation, attitudes and beliefs toward management, concussion knowledge, and clinical decision making”. 1,272 physical therapists were part of the survey, 894 of which had concussion training. Respondents correctly recognized the spectrum of post-concussion symptoms and when a comprehensive exam with neurocognitive assessment, balance testing, and self-reported symptoms was required. However, there were gaps in knowledge. 25% did not realize that normal CT scans and MRIs are quite typical of concussions, but does not mean a concussion did not occur. In addition, individualized treatment plans based on actual clinic exam has recently replaced individualized treatment plans based on concussion severity scales. Yet, still 40% of respondents believed that the severity scales should be used and could guide treatment. Lastly, the current consensus on recovery time is that younger athletes, below 18 years old, require more time for
recovery than older athletes do. Despite this consensus, 33% of the respondents believed that young athlete concussions do not need to be managed more cautiously. This is problematic due to the possibility of Second Impact Syndrome. The research study overall found that Knowledge Translation, introduction of new evidence into practice, was lacking and that future research should assess Knowledge Translation initiatives that attempt to address knowledge gaps (Yorke, et. Al, 2016).

Chapter 6 Discussion

Summary of Study and Findings

The purpose of the study was to understand the treatment options that exist for post-concussion syndrome, compare current resources that focus on management and treatment of concussions, analyze the factors that hinder patient recovery, and gain expert opinions about resources that would benefit future patients. It was found that much research and scientific evidence analysis still needs to be done to prove the efficacy of treatment options. In reviewing current resources and interviewing experts/providers, it was found that there has been a large amount of progress in resource/management creation. However, there is room for many improvements and a crucial need for new features. The research team accepts the hypotheses posed, but realizes that there is much more complexity to the issue at hand.

As seen in Table 3, a spectrum of post-concussion syndrome symptoms were observed by the concussion specialists I interviewed. Cognitive challenges, behavioral problems and migraines were the most common post-concussion symptoms observed by the interviewed specialists among their patients. Cognitive challenges were predominantly related to concentration, fogginess and
delays with thought processing. Anxiety and mood swings were the most common behavioral problems, followed by depression and sleep disturbances.

Physicians also mentioned that many of their patients had difficulty with balance and experienced muscular and/or cervical pain. Though less frequent in incidence, ocular/vision problems were also observed.

In order to provide effective treatment and ensure full recovery, physicians tailor their treatment to the specific post-concussion symptom(s) exhibited by the patient. Based on the interviews I conducted and the results of Table 4, concussion specialists are primarily prescribing tried and true treatments - the most common are summarized below:

- Cognitive challenges: Cognitive Therapy (CPT and PE) and medications
- Balance: vestibular therapy
- Ocular/Vision: vision therapy, although less common itself
- Behavioral issues: psychological counseling/therapy, followed by medication and biofeedback
- Migraines: medications and occipital nerve blocks
- Physical: physical therapy, followed by vestibular therapy, monitored physical exertion, and massage

Overall, awareness of all treatment options included within this research is high among concussion specialists as seen in Table 5. The treatments that were the least well known were acupressure, ART, OMT, and massage. However, consensus on efficacy of treatment options was still unclear among the experts. Education and evidence-based research may be required for all treatment options, especially the alternative treatments.

The span of post-concussion syndrome symptoms observed by the treatment providers in Table 6 is more tailored towards the type of treatment. The interviewed provider who specializes in medications and injections seems to see patients who experience the full spectrum of symptoms. The neurofeedback specialist seems to also cover all symptoms, except the physical symptoms like
muscular or cervical/spinal pain. The interviewed vision therapist sees patients who have a more limited spectrum of symptoms, directly relating to ocular and visual deficiencies that might cause migraines; the provider saw patients with several other symptoms like fogginess, delayed thought processing, anxiety, and cervical/spinal pain.

Using the potential features presented by the concussion experts and treatment providers could lead to the creation of a centralized location for information on treatment options. Having more personalized plans of recovery, research on treatment options, a list of reputable clinics across the US, and education material for all groups would be extremely beneficial for the recovery of future patients. Improvement to current resources or creation of a new resource may help decrease costs associated with scheduling consultations and traveling to remote clinics, dispersal of information across too many websites, limited information on and importance of individualized treatment plans, length of time to get appointment, and inaccessibility to reputable providers.

**Limitations and Future Research**

Originally, the research team planned to conduct interviews with patients and their families, athletic trainers, and primary care providers at Hershey Medical Center, in addition to the concussion experts and providers. However, due to time constraints, this component was unable to be completed. Future research would benefit from hearing directly from all groups. Specifically, patient and family interviews would help to directly understand patients’ struggle with post concussion syndrome, the treatment options they have tried, and the symptoms that seem to be the most persistent. The purpose of the athletic trainer interviews would be to understand the resources that athletic trainers require in managing athletic brain injuries and guiding athletes towards proper
treatment before returning to play. The purpose of the primary care provider (PCP) interviews would be to understand the type of cases that they see and what resources PCPs require to immediately care for patients or refer to specialists. Understanding how educated PCPs are in concussion management and treatment options would be beneficial for the creation of new resources. Future research should include interviews with all groups across the country, instead of concentrated at only one medical center.

It would also be beneficial to further investigate the available scientific evidence surrounding each potential treatment option. Assigning a level of evidence for each treatment option would be helpful in creating an evidence-based treatment guide, tailored to individual symptoms. It would also help guide future research to explore the treatments that have less supporting evidence or not enough research.
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Return to Play Progression. *CDC Heads Up- Managing Return to Activities.*


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Kohl’s Care Scholar
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