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Active Rehabilitation in Sports-Related Concussions: An Educational Intervention for Primary Care Providers

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Active Rehabilitation in Sports-Related Concussions:

An Educational Intervention for Primary Care Providers

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A DNP project submitted in partial fulfillment of the

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Abstract

Background and Review of Literature: Sports-related concussion (SRC) is a form of traumatic brain injury caused by a blow to the head and remains a prevalent issue across the 11-18-year-old age group within the United States. Historically, total physical and cognitive rest has been the preferred method to help individuals recover after suffering a concussion. However, recent data have shown that incorporating active rehabilitation or aerobic exercise therapy as part of acute post-concussion treatment is safe. Further investigation into these methods could provide valuable insight into prognosis as well as promote clinical recovery. Purposes/Goal: This project involved delivering an educational intervention to primary care providers (PCP) about active rehabilitation of SRC in order to collect insights and gauge potential concerns regarding this emerging treatment modality. Additionally, this project updated the providers' current understanding of consensus-based management of SRC. Methods: This was a quality-improvement project with quantitative and qualitative data collection. Implementation/Procedure: This DNP project was delivered at a primary care clinic in the Pacific Northwest region. Results: PCPs recognized the potential benefits of this new treatment modality but expressed concerns over treatment coordination, recovery evaluation, and potential impact on patients. Conclusion: This project educated PCPs on updated treatment guidelines for SRC and created an educational program to introduce active rehabilitation concepts. Though several PCPs recognized the intervention's utility, they expressed potential logistical and safety concerns in relation to implementing such a program in a clinical setting.

Keywords: Sports-related concussions, active rehabilitation, total rest, BCTT, aerobic exercise therapy, clinical recovery, cognitive rest, physical rest, primary care, mild SRC

Introduction and Background

Sport-related concussion (SRC) comprises a growing area of focus both for primary care providers and for public health. It is also a phenomenon significantly more common in younger age groups. Overall, SRC has the potential to cause wide-spread physical, cognitive and behavioral impairment (Feden, 2016). Zhang et al. (2016) reviewed records between 2007 and 2014 of over 8.8 million members of a private payer insurance group in order to quantify concussion incidence among the general population. They identified 43,884 patients diagnosed with a concussion; chief among those diagnosed were adolescents (aged 10-19). This accounted for 32% of all cases, the largest among all age groups. Though this study lacked insight into the mechanism of injury, the higher incidence rate found among adolescents is an important trend to consider when researching SRC treatment. Despite this knowledge, accurate estimation of SRC incidence remains a developing area of focus. This is largely due to a lack of comprehensive, standardized data collection at both national and state levels.

In 2016, Bryan et al. (2016) attempted to better estimate the national incidence of SRC in adolescents younger than 18 using statistics from three separate SRC reporting databases. They estimated that annually between 1.1 and 1.9 million sports and recreation-related concussions occur among adolescents. The majority of these patients were seen at an outpatient clinic rather than the emergency department, while over half were never even evaluated in a healthcare setting. Arbogast et al. (2016) sought to investigate the point of entry for SRC patients, discovering that over 81.9% of 8,083 concussed patients 17 and younger in Philadelphia visited their primary care providers (PCPs) first. These trends are important because they show that PCPs are becoming the first contact for patients with SRC. As a result, it is vital that PCPs remain aware of current evidence-based practice and guidelines when managing SRC.

At the time of this writing, consensus-based recommendation for treatment of mild SRC is total cognitive and physical rest until symptom improvement (McCrory et al., 2017). Only once the patient is fully asymptomatic can they enter a return-to-school and then a return-to-sport protocol, which gradually increases their daily level of mental stimulation and exercise intensity. After completing these two protocols, patients may return to full participation barring any setbacks or recurrence of symptoms. This "total rest" recommendation is in place despite insufficient data supporting exact determination of the most beneficial amount of rest or exercise. Further complicating this determination, SRC tends to affect each individual differently, depending on various factors such as concussion history, age, and sex (Gallagher et al., 2017).

Mandating complete rest and inactivity for all patients presenting with SRC fails to address the unique needs of each individual and research establishes this as a gap in treatment guidelines. Emerging evidence demonstrates that structured aerobic exercise or active rehabilitation may actually be beneficial to SRC recovery. Clinical trials have established that active rehabilitation has the potential to shorten recovery times in SRC patients, as well as provide valuable information on prognosis (Leddy et al., 2018; Leddy et al., 2019). Active rehabilitation utilizes various exercise protocols, the most widely used being the Buffalo Concussion Treadmill Test (BCTT). While consensus guidelines do currently recognize active rehabilitation's safety and potential in improving clinical recovery (McCrory et al., 2017), nevertheless it is also recognized that additional high-quality studies are needed before this body of research can more substantively inform and influence clinical practice.

Active rehabilitation provides a holistic treatment approach that can be customized to each individual. While research continues, practice guidelines still advocate for the traditional "rest is best" approach for managing SRC. Further work is needed to disseminate current

research to PCPs. In addition, collaboration with PCPs is critical to gain insight into how current guidelines may be improved, as well as potential barriers to implementation of new treatment protocols.

Aim of Project

The aim of this DNP project was to educate PCPs about the use of active rehabilitation in SRC via an educational presentation. PCPs completed pre- and post-knowledge tests as well as participated in an audio-recorded focus group to provide qualitative and quantitative information in order to assess active rehabilitation's feasibility and applicability in their practices. In this DNP project, one objective was a better understanding of how PCPs understand the current consensus-based methods of managing SRC in their primary care practices. A second objective was to gain a deeper understanding of PCPs' understanding of the potential benefits of and challenges to utilizing active rehabilitation in the treatment of SRC. It is important to note that this DNP project does not implement active rehabilitation with any group of patients in primary care. Instead, it focuses on the input and education of PCPs regarding this emerging treatment. Despite promising results in randomized control trials, more research must be conducted before implementation of active rehabilitation in clinical practice can occur (Haider et al., 2019; Leddy et al., 2018; Leddy et al., 2019).

The DNP project question is thus: *What is the effect of an educational intervention on the primary care provider's knowledge of and openness towards inclusion of active rehabilitation during treatment of mild sports-related concussions?* In order to assess this question, pre-existing and resultant knowledge will be evaluated through Likert scale response and short answer, as well as a focus group.

Review of the Literature

Google Scholar and PubMed were the initial databases searched to identify relevant articles for the literature review. Google was also utilized as this provided a wider array of non-indexed studies. The following parameters were specified in the database searches: English language only, human subjects, years 2008-2019. The following keywords were utilized: sports-related concussions, active rehabilitation, total rest, BCTT, aerobic exercise therapy, clinical recovery, cognitive rest, physical rest, primary care and mild SRC. A total of 525 articles were found via PubMed utilizing these keywords. In addition, several articles were found through a Google Scholar search. Twenty-one studies were ultimately selected as relevant to this project.

Concussion Symptom Presentation and Recovery

The acute symptoms of concussions are well documented, including physical, cognitive, and behavioral impairment (Feden, 2016). Symptoms can include headache, impaired balance, fatigue, insomnia, fogginess, depression, memory problems, and irritability, as well as many others. The majority (80 to 90 percent) of SRCs in adults resolve within seven to ten days. When concussion-related symptoms do not subside within ten days, it is typically defined as “post-concussion syndrome” (PCS), describing a condition that is more serious than an acute, mild SRC (Leddy et al., 2018). Unfortunately, research has identified a pattern of much slower recovery time for patients younger than 18 (Leddy, Baker, & Willer, 2016). Though this represents a clear health disparity, current consensus-based methods lack the holistic approach necessary to effectively accommodate for this trend in younger patients.

Though a brief loss of consciousness (LOC) was once thought to correlate positively with concussion severity, research has since identified retrograde amnesia to be a more predictive symptom (Dougan, Horswill & Geffen, 2013). In addition to retrograde amnesia, there are other

red flag symptoms that indicate emergent medical evaluation is necessary. These include severe headache, neck pain, seizure, vomiting, double vision, numbness or tingling in arms or legs, and other focal neurological symptoms (Muth, 2018). Imaging and emergent medical evaluation are not required for acute SRC management unless any of these red flag symptoms are present.

Varying Presentation in Patient Populations

Symptom presentation in acute SRC varies greatly depending on the patient's genetic makeup, as well as other modifiable and non-modifiable risk factors. Data demonstrate that patients younger than 18 typically take longer to recover from SRC than adults (Covassin, Elbin, Larson & Kontos, 2012). Additionally, those who have sustained a previous concussion typically suffer from longer recovery times and have more severe symptoms with each subsequent SRC (Ellis, Krisko, Selci & Russell, 2018). The biomechanics of the injury critically influence the severity of SRC due to the complexity and variation of the body's physical response to trauma (Graham, Rivara, Ford & Spicer, 2014). These biomechanics include the force and impact of trauma and their relationship with head and neck movements, as well as the biological response to the insult that follows.

The athlete's sex is one of the biggest factors determining the severity, range of symptoms and overall recovery time for concussions. Gallagher et al. (2018) explored this disparity further, investigating the effect of sex differences and hormonal contraceptive usage among collegiate athletes who suffered SRC. On average, this study found that after concussion females experienced a longer recovery time compared to males regardless of their hormonal contraceptive usage. Among females, those not using hormonal contraceptives also reported higher symptom severity. No statistically significant difference was reported in length of recovery between female hormonal contraceptive users and non-hormonal contraceptive users.

These trends are important to contemplate as they call into greater question the impact of different sex hormones on the SRC recovery process.

Traditional Management of Acute Mild Sports-Related Concussions

The Concussion in Sports Group (CISG) is a consensus statement issued by experts to healthcare providers in the management of concussions (McCrory et al., 2017). The statement is released every four years and provides consensus-based guidelines on how to approach diagnosing and treating SRC. The CISG recommends a two-step strategy: first, a return-to-school (if applicable), and only then a return-to-sports. This two-step process allows for a gradual reintroduction of mental and physical activity. These guidelines are specifically designed to limit exacerbation of concussion-related symptoms. Both strategies require athletes to achieve incremental milestones while remaining asymptomatic before graduating to the next stage within the protocol. According to the CISG protocol, an athlete must remain in each stage for at least 24 hours, but this timeframe can be extended depending on the athlete's symptom presentation and trend. If at any time the athlete redevelops symptoms, they must return to the previous stage of the protocol.

The Return-to-School Protocol

The incremental return-to-school protocol consists of four stages (McCrory et al., 2017). The first stage allows the athlete to engage in cognitive activities at home that do not aggravate symptoms. Acceptable activities include reading, texting, or screen time. Athletes start participating in these activities roughly ten minutes at a time, gradually increasing tolerance. Next, school activities may be re-introduced such as homework, critical reading and similar, slightly more demanding cognitive challenges. The next stage allows the athlete to return to school on a part-time basis, gradually re-introducing more challenging types of schoolwork.

Finally, the athlete is permitted to return to school on a full-time basis with no restrictions on school-related activities. Appendix A has a more complete presentation of this information.

The Return-to-Sports Protocol

The return-to-sports strategy involves six stages of graduated physical activity (McCrory et al., 2017). They are as follows: 1) basic symptom-limited activity that does not exacerbate symptoms; 2) light aerobic exercise such as walking or stationary cycling that increases heart rate (HR); 3) sport-specific exercise such as running to add movement; 4) non-contact training drills to allow for increased exercise, concentration, and thinking; 5) full-contact practice and participation in normal training activities following medical clearance; and 6) full return to sport and normal gameplay. Both the return-to-school and the return-to-sports protocols require the athlete remain symptom free when progressing between stages. See Appendix B for a breakdown of this information.

Impact of Rest on Concussion Recovery & Symptomatology

As stated previously, the exact amount of rest time the patient should be prescribed remains unknown (McCrory et al., 2017). Retrospective studies and animal models have demonstrated that premature mental or physical activity could impair recovery; however, human based studies are limited (Thomas et al., 2014). Typically, a 24 to 48-hour rest period is prescribed before allowing the athlete to begin a stepwise return to activity, although some clinicians recommend an even longer resting period before resuming activity (McCrory et al., 2017). Further research is necessary before a method can be determined to measure with best evidence how much rest is needed for each individual patient.

In 2014, Thomas et al. studied the impact of two separate rest durations on concussion symptom severity in patients aged 11-22 years. The first group maintained five days of strict rest

while the second group rested 24-48 hours per consensus guidelines, followed by a gradual return to activity. This experiment assessed concussion recovery in three primary ways. Participants self-reported symptom presence and severity using a post-concussive symptom scale. They also completed the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT), a neurocognitive computer-based assessment. Finally, participants completed the Standard Assessment of Concussions (SAC) scale. Overall, these results provided valuable information on neurocognitive deficits using sensitive, reliable, and valid scales.

The study by Thomas et al. (2014) established that strict rest ultimately did not improve symptom, neuro-cognitive, and balance outcomes in subjects' post-concussion assessments. Over 60 percent of patients in both groups experienced symptom resolution during the ten-day follow-up period. However, it took approximately three days longer for 50 percent of the strict rest group to report symptom resolution compared to the group that was allowed to return to activity more quickly. Overall, the strict rest group reported a higher symptom presence over the course of the study than the group that returned to exercise earlier. The study concluded that complete rest until the abatement of all concussion symptoms could have an overall negative impact on patient recovery.

This raises the possibility that the faster recovery in the second group was due to its shorter strict best rest period. Researchers are also discovering that extended periods of strict, total rest can contribute to situational depression and lengthier recovery times as a result of social isolation and physical deconditioning (Thomas et al., 2014). One systematic review found incremental increases in depressive symptoms after three days, one week, and two weeks of exercise withdrawal (Morgan, Olagunju, Corrigan & Buane, 2018). Prolonged exercise withdrawal leads to physical deconditioning, resulting in a negative impact on cerebral blood

flow (CBF) regulation, autonomic nervous system (ANS) functioning, and sleep quality (Clausen, Pendergast, Willer & Leddy, 2016; Esterov & Greenwald, 2017; Feden, 2016). Conversely, research has established that regular exercise improves both CBF regulation and ANS functioning (Clausen et al., 2016; Guiney, Lucas, Cotter & Machado, 2015). Staying active has positive effects on mental health, elevating both mood and self-esteem, while also improving sleep quality (Fu & Levine, 2013).

Active Rehabilitation & Sports-Related Concussion

The CISG guidelines recognize that exact duration and type of rest must be researched further, while at the same time noting that structured aerobic exercise therapy after an initial rest period could provide better outcomes for patients suffering from SRC when compared to total rest alone. As previously established in multiple studies, active rehabilitation has the potential to speed up recovery from concussion, reduce incidence of delayed recovery, and provide important data on prognosis (Leddy et al., 2018; Leddy et al., 2019). The CISG also reaffirms the safety of this emerging treatment modality but concedes certain aspects must be studied further (McCrory et al., 2017). The CISG guidelines further assert that future studies should assess timing, length, intensity, and frequency of active rehabilitation treatment during the acute recovery stage.

Research utilizing structured aerobic exercise to treat SRC has been conducted over the last decade, with the exercise bike and treadmill representing two of the most popular vehicles for carrying out this theory (Leddy et al., 2019; Maerlender, Rieman, Lichtenstein & Condiracci, 2015). The BCTT is one protocol primarily researched within the pediatric (11-18 years) population. Originally designed for treatment of post-concussive syndrome, the research focus with BCCT has since shifted toward acutely concussed patients. This treadmill test utilizes elements of active rehabilitation to create personalized aerobic exercise treatment plans for

patients (Leddy et al., 2019). The theory is that exercise intolerance can be determined based on the heart rate (HR) of the patient at the time SRC symptoms become exacerbated. Research has demonstrated that isolating the patient's level of exercise intolerance can provide valuable data on prognosis and potential for delayed recovery (Leddy et al., 2018).

There are contraindications to the BCTT, however. Some of these include a focal neurological deficit, significant balance issues, a history of moderate to severe traumatic brain injury, or concurrent beta blocker usage. Beta blockers artificially suppress the heart's ability to increase its rate as a response to stress, and therefore are to be avoided prior to and during the test (Leddy & Willer, 2013). The goal for patients during BCCT is to report symptoms as they appear during exercise, rather than pushing through those symptoms to reach complete physical exhaustion (Leddy & Willer, 2013). The patient "passes" the BCTT in one of two ways. Either the patient exercises to the point of physical exhaustion, or exercises for 20 minutes. Whichever modality is chosen, no SRC symptoms can be present for a successful test (Leddy et al., 2018). Based on previous research, twenty minutes is the accepted duration of the test. The BCTT is conducted by two personnel, both of whom must be CPR certified. One person coaches the patient through the test while the other observes the patient and records specific values (Leddy et al., 2018).

During BCCT, the patient begins by rating symptoms using the Visual Analog Scale (VAS). This provides a pre-exercise symptom baseline objective score (Leddy et al., 2018). The treadmill then begins at 3.6 miles per hour (mph) and at zero percent incline (Leddy et al., 2018). The incline is then increased by one degree every minute for the initial 15 minutes. At this elevation of 15 degrees, the speed is increased by 0.4 mph each minute for the remaining time (Leddy & Willer, 2018). The patient's HR is constantly monitored, taking a reading at each one-

minute interval. In addition, the VAS and Borg Rating of Perceived Exertion (RPE) are re-administered until the completion of the test or the time at which the patient begins reporting symptoms (Leddy et al., 2018). Based on the results of one study, researchers defined voluntary exhaustion as score of less than 17 on the RPE scale, while symptom exacerbation was described as an increase of three or more points compared to the patient's pre-exercise VAS baseline score (Leddy et al., 2018).

The purpose of this intervention is to isolate the heart rate threshold (HRt) value, which indicates the HR during exercise at which symptom exacerbation occurs. A "low" HRt is below 135 beats per minute (bpm) and correlates with delayed recovery, while a "high" HRt (greater than 135bpm) is associated with quicker recovery and less symptom presence (Leddy et al., 2018). Again, this explains by beta antagonists are contraindicated; they would artificially depress the HR. Once the HRt value is established, a personalized exercise regimen is prescribed to the patient. The patient performs supervised, daily aerobic exercise with the explicit recommendation not to exceed 80 percent of their recorded HRt. Patients are instructed to walk, jog, or stationary cycle for 20 minutes each day, including a warm-up and cool-down period of five to ten minutes.

An example of this regimen is the following: *Patient A* has a resting heart rate of 55 bpm and reaches HRt of 145 bpm on the BCTT. The patient is given instructions to exercise daily for 20 minutes without surpassing 116 bpm (80 percent of 145), including the warm-up and cool-down period. Ideally, patients are encouraged to increase their HR goal by 5-10% each day as long as they remain asymptomatic during the prescribed aerobic exercise (Leddy et al., 2018). If symptoms worsen or the 20-minute threshold is reached, the patient has instructions to stop exercising. The BCCT can be re-administered on a weekly basis to provide a new HRt value for

the patient. Once the patient completes the BCCT protocol, they begin the seven-day return-to-sport protocol outlined by the CISG (Leddy et al., 2018).

Summary of Current Active Rehabilitation Research

Safety and Prognostic Utility of Exercise Testing in Acutely Concussed Adolescents

In a randomized controlled trial (RCT) by Leddy et al. (2018), 54 adolescent males (13-18 years of age) with acute SRC were prescribed either BCTT or standard total rest. This study examined the impact of BCTT on two primary variables: symptom presence, and length of recovery. Normal recovery was defined as less than 21 days, and delayed recovery was 21 days or more. Researchers found clinical recovery outcomes were very similar between the two interventions, indicating no discernable negative effect from sub-symptom aerobic exercise. This study also discovered prognostic value in assessing HRt in patients; specifically, researchers identified a positive correlation between lower HRt (less than 135 bpm) and delayed recovery from SRC. Table 1 presents these data, which were statistically significant (Leddy et al., 2018).

Table 1 - Instances of Normal and Delayed Recovery Based on HRt of First BCTT Visit

	Low HR Threshold (<135BPM) *n* = 8	High HR Threshold (>135bpm) *n* = 19
Normal Recovery (<21d)	1	17
Delayed Recovery (>21d)	7	2

Effects of Early Aerobic Exercise on Daily Symptom Reporting after SRC in Adolescent Males

A different arm of the above study by Leddy et al. (2018) separated participants into two groups. Twenty-four underwent BCTT protocol while the remaining 30 received total bed rest. The exercise group had a faster total recovery time compared to the total rest group, but the results were not statistically significant. A complication to this study was that none of the

exercise group participants had delayed recovery, whereas four adolescents in the total bed rest group did experience delayed recovery. The study defined delayed recovery as showing symptoms beyond 30 days. The results of this research supported that light, structured aerobic exercise after acute SRC could aid in improving recovery and reducing total symptoms. Though these results provided an important contribution, researchers emphasized their preliminary nature. Higher quality studies are still needed to overcome the deficits of small sample sizes, failure to randomize, and lack of female participants.

Early Subthreshold Aerobic Exercise for SRC

A separate RCT of those with acute SRC prescribed BCTT to 52 adolescents, while another group of 51 received stretching exercises alone (Leddy et al., 2019). Those in the BCTT exercise group recovered in a median of 13 days while those in the stretching group recovered in a median of 17 days. In fact, participants who exclusively stretched saw a recovery delay, compared to those in the BCTT group though it was not statistically significant. Likewise, total symptom scores seemed to decrease quicker within the BCTT group, but this also was not statistically significant. These data trends however indicate that stretching is not physically rigorous enough to share the similar positive effects that a process like active rehabilitation could provide. The preliminary data presented by both of these studies reaffirm the safety and benefits of early exposure to exercise regimens in the treatment of SRC while also making it clear that further research is necessary.

Predictive Capacity of the BCTT After SRC in Adolescents

A study by Haider et al. (2019) sought to evaluate the predictive capacity of exercise (via the BCTT) in recovery from SRC. More specifically, this study's goal was to identify the change in heart rate (ΔHR) and its relationship with clinical recovery of acute SRC. Measuring ΔHR was

obtained by subtracting the resting heart rate from the HRt. The study measured ΔHR in a total of 130 male and female participants. Rest was prescribed for 27, stretching exercises for 51, and BCTT for 52 participants. Regression analysis demonstrated that ΔHR correlated positively with clinical recovery for both rest and stretching groups, but not with the exercise group (Haider et al., 2019). Researchers found that the ΔHR value was considerably lower in participants who displayed prolonged recovery (>30 days) within both the rest and stretching groups (Haider et al., 2019). Ultimately, a ΔHR of <50 bpm via the BCTT test was found to be 78% specific and 73% sensitive in predicting a prolonged recovery timeline for adolescents with concussion who were treated with standard total physical and cognitive rest (Haider et al., 2019).

Active Rehabilitation in Sports-Related Concussions: An Educational Intervention for Primary Care Providers

Sports-related concussions affect each patient differently, yet current consensus recommendations and management guidelines do not incorporate any individualized care regimens. As described previously, prolonged rest may actually lead to negative physiological and psychological outcomes for athletes with SRC. The reliance on symptom self-reporting further complicates the quality of this treatment process, as the athlete could choose to hide symptoms in an effort to return to activity quicker. Though most people are familiar with the "rest is best" approach outlined by the CISG, many providers and athletes remain unaware of emerging SRC treatment concepts. Total rest has been the mainstay of treatment for many years, making a treatment that utilizes a completely opposite approach difficult to introduce to practitioners.

The assessment of exercise intolerance via BCTT provides clinicians with the first ever biomarker while interpreting concussion recovery. Despite this objective advancement, much of

the evidentiary data remains preliminary. Researchers must continue to explore active rehabilitation in treatment of SRC in higher quality research studies before clinical practice guidelines can be modified.

The future of SRC treatment depends on how practitioners respond to this pivotal moment. This DNP project is founded on this reality and seeks to investigate how best to communicate these new opportunities to PCPs. Though active rehabilitation is not ready for dissemination into clinical practice, introducing this research to PCPs is an integral step in laying the groundwork for future implementation. Moreover, provider input will be critical to identifying concerns and incorporating new opportunities into active rehabilitation in SRC treatment.

Theoretical Frameworks

The multidimensional impact of SRC requires the use of a more holistic therapeutic intervention. Prolonged total rest fails to provide a treatment that promotes well-being of the patient and can sometimes contribute to negative health outcomes. Active rehabilitation has the potential to avoid these pitfalls by utilizing structured exercise as its primary intervention. Nevertheless, variations in the way SRC presents in patients requires the utilization of a theoretical framework that provides a multi-level system view of concussion management. This is because SRC, as noted above, has demonstrated its tendency to impact both the physical and affective aspects of the athlete.

The Multi-Scale conceptual framework was created by researchers to help provide a comprehensive approach to understanding the pathophysiology, classification, and treatment of concussion (Kenzie et al., 2017). This conceptualization is necessary in order to understand more completely the widespread impact that SRC can have on a patient, as well as the holistic effect

that a treatment such as active rehabilitation offers. The framework describes four major scales – cellular, network, experiential, and social – representing domains present throughout SRC recovery (see Appendix C). These domains represent levels at which both impacts of SRC and effects of therapeutic interventions are observed. Domains intersect via the context of the injury, personal characteristics (genetics, age, sex, prior concussion history), and injury biomechanics. The Multi-Scale structurally demonstrates the ways SRC can result in drastic variations in symptoms seen among individuals with concussion (Kenzie et al., 2017). Additionally, it offers a structured discourse regarding the impact of various interventions across each of the domains from injury to recovery. The model implies that existing SRC treatment fails to provide a holistic impact that addresses more than one domain at a time. Active rehabilitation, or aerobic exercise therapy, has the potential to provide positive impact within and across all four individual domains simultaneously, offering the most comprehensive therapeutic intervention currently achievable for SRC.

A key objective of this project focused on creating a standardized process of integrating provider feedback. The Theory of Planned Behavior by Icek Ajzen (1991) is a conceptual framework for understanding human social action. A person's attitude towards a behavior, subjective norms, and behavioral control all constitute beliefs that contribute to the formation of an intention. This intention inevitably leads to a behavior or practice change within the individual. Understanding intention and the underlying factors that inform an individual's decisions are key to effecting behavioral change in that individual. First, subjective norms refer to an individual's perception of behavior, as well as the associated social pressure. Second, one must consider how a person weighs the potential positive or negative outcomes of any given behavioral change. This calculus results in a favorable or unfavorable attitude towards the

decision to change. Finally, behavioral control can be understood as the presence of external factors that hinder or facilitate the aforementioned change. This results in an evaluation of a subject's self-efficacy, or ability to perform a task at the given knowledge and skill level.

Ajzen (1991) asserted that individuals are more likely to adopt a behavioral change if supported by subjective norms and if they feel they are capable of performing the required tasks. This project developed questions to postulate these primary principles of Ajzen's theory – subjective norms, attitude, and behavioral control (see Appendix D).

Methodology

Project Design

This DNP project was a quality improvement venture using a convenience sample of PCPs in the Pacific Northwest. It used a mixed method approach that included a pre- and post-knowledge test with item responses via Likert-scale, as well as a focus group that provided qualitative data. As a result, this project required collection of both quantitative and qualitative data to accurately answer project aims. No protected health information or demographics of study participants were collected during the course of this study. As a result, informed consent was provided to participants but was not collected for storage, per Institutional Review Board (IRB) recommendation. The security and plan for the collected data were discussed with participants prior to beginning the educational presentation. This DNP project was designated exempt by Seattle University's IRB, and the clinic's Research Steering Committee provided approval for this project to take place.

Project Site and Subject Recruitment

The intervention for this DNP project was delivered at a primary care site in the Pacific Northwest. Recruitment flyers were given to the clinic manager for distribution to PCPs. A fruit

and vegetable platter were provided to PCPs for consumption during the project presentation. There was no financial incentive involved with completion of this project. Participants involved were PCPs (MD, DO, ARNP, PA) present at a staff provider meeting where the educational presentation was delivered. A total of six PCPs took part in the initial phase of data collection for this project.

Intervention Description

The intervention was conducted by the principal investigator (PI). The PI collaborated with the clinic manager to help recruit participants and schedule the educational intervention during the clinic's provider meeting, which was held on October 23rd, 2019. The meeting began with the PI explaining the project, obtaining consent, and then introducing the objectives of the DNP project and lesson plan to the participants. The PI then administered a pre-test to participants, asking them questions concerning their knowledge about SRC identification, active rehabilitation, and current practice guidelines. The survey also invited the participant to offer via free text any concerns they had about implementing an aerobic exercise therapy plan for SRC treatment into their clinical practice.

Following the pre-test, an educational handout was distributed to providers. The PI then provided a ten-minute presentation regarding the information provided in the educational handout. This included information regarding SRC epidemiology as well as patterns in clinical presentation. Using the Multi-Scale theoretical framework, the PI then presented current management guidelines as well as a short session on active rehabilitation of SRC. After the presentation, a post-test was administered to providers using the same pre-test questions. Following the post-test, a five-minute focus group was held during which provider commentary

regarding four open-ended questions was audio-recorded. Finally, a 30-day post-test was delivered to participants online via Qualtrics. The timeline for the project is presented in Table 2.

Table 2 - Timeline for the DNP Project

	10/23/2019	11/23/2019
Pre-Test Survey	X	
Post-Test Survey	X	
Focus Group	X	
30-Day Post-Test Follow-Up		X

Data Collection Methods

The data collection plan primarily centered on the immediate collection of quantitative and qualitative data. The focus was on short-term instead of long-term outcomes, since the PI wanted to find out providers' initial knowledge as well as immediate reactions to concepts presented during the intervention. A 30-day post-test provided an opportunity for providers to express insight into how their beliefs about SRC management changed as a result of the educational presentation; this gave some indication of the DNP Project persistence effect.

Assessment Instruments and Materials

Measurement for this project included two author-constructed tools. The first tool was a pre- & post-test survey instrument containing eight questions answered via a Likert-scale with five response options from "strongly agree" to "strongly disagree", and one open-ended question that focused on areas covered within the educational presentation. Study participants were asked to rate how much they agreed or disagreed with any given statement, thus providing ordinal data. The second tool was a four-question interview guide for a focus group. The focus group provided extra time for providers to elaborate on their opinions and concerns regarding use of active rehabilitation in SRC. Table 3 illustrates a crosswalk of project aims, examples of items that

measured each aim, and the relationship of each to various constructs within the Theory of Planned Behavior.

Table 3 - Crosswalk of Project Aims, Items, and Framework Domains

Project Aims	Instrument Items	Theoretical Framework
	PRE/POST-TEST SURVEY:	
#1: Increasing knowledge of current consensus-based management of SRC	Item 2: An initial total rest period of 24-48 hours is recommended for all patients directly after suffering a mild sports-related concussion. Likert style: 1 Strongly disagree, 2 Disagree, 3 Neutral, 4 agree, 5 Strongly agree	Self-efficacy
	Item 5: Structured aerobic exercise within the first week of sustaining a sports-related concussion could be beneficial for recovery. Likert style: 1 Strongly disagree, 2 Disagree, 3 Neutral, 4 agree, 5 Strongly agree	Attitude
	FOCUS GROUP:	
#2: Collecting insights and concerns regarding active rehabilitation of SRC	Item 1: Describe your primary concerns about active rehabilitation of SRC?	Attitude
	Item 2: What barriers do you envision if you were to try and implement active rehabilitation into your current practice?	Attitude
	Item 3: What aspects of active rehabilitation would you like to see researched further?	Self-efficacy

Pre- and post-test surveys were designed specifically for use in this research study. Given their first-time use, the author was unable to assess their reliability or validity. In terms of qualitative research however, there are a number of strategies that can be employed to ensure trustworthiness of data. The first strategy involves affirming credibility, which was done by analysis and identification of concepts and core categories, as well as development of themes relevant to the topic at hand. Secondly, when describing transferability, although specific identifying information about participants was not collected, enough information about the setting and participants was obtained to help make information more applicable to those reading the study. Lastly, the PI attempted to create an audit trail by documenting analysis and coding of the qualitative data. This was done in an effort to help ensure dependability and confirmability, two other important criteria to consider when evaluating qualitative data (Lincoln & Guba, 1986).

Data Analysis Plan

Quantitative data was collected and entered into Statistical Package for the Social Sciences (SPSS) version 25 (IBM, 2017). Descriptive statistics were generated. Qualitative data was collected and transferred to a WORD document, from which identification and analysis of key items from recorded and written responses from providers occurred. Audio recordings were then securely erased. The narrative thus produced was analyzed in a three-step process to identify categories, codes, and then major themes (Bradley et al., 2007).

Results

Quantitative Data Introduction

In total, six providers participated in this project. Demographic information of participants was not collected because the sample size was considered too small. Question two was skipped on both the pre- and post-test, while question three was skipped on just the post-test. Only one post-test was returned for the 30-day follow-up. Due to the lack of comparable data, no statistics were run on the 30-day post-test. Numbers were assigned to Likert scale responses as follows: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. See Appendix E for breakdown of quantitative data. No statistical analysis was performed due to the small sample size.

Qualitative Data Analysis - Themes

Both the pre- and post-test surveys contained one qualitative question. Additionally, a short focus group session was conducted with four guiding open-ended questions (see Appendix F). Ultimately, a total of 42 codes were identified from the qualitative data available. Four categories and three primary themes emerged after analyzing the available codes (see Appendix G, H, and I).

Theme One: Concern Over Coordinating Treatment

Though the providers expressed interest in learning more about active rehabilitation and BCTT protocol, concern was expressed around the difficulties that could come with utilizing this therapy in their clinical practice. As a result, a number of implementation barriers were identified from provider responses.

There was concern expressed over the procedure's insistence on using a treadmill, as well as the need for direct supervision by two healthcare personnel. Providers were worried about the

"cost to patients" that such a procedure would entail. One participant verbalized the potential of such treatment discriminating against "[poorer] socioeconomic groups," again highlighting the need for cost effectiveness. Providers also discussed how the daily exercise requirement in SRC would impose significant time demands on both the patient and the family. One provider felt that there must be some "manageable way to do [aerobic exercise] at home without someone present."

Providers also wanted more information about the extent to which the procedure was "accepted" within the medical community. To that point, the legal exposure to providers was also something that was brought up, with one participant wondering to what degree this procedure could be "defensible in court." Lastly, some providers indicated a desire to see the treatment modality replicated with research among different age groups. One individual mentioned that many of their patients were older adults, and while such a treatment could be beneficial, the potential "risk for falls" could be too great.

Theme Two: Concern Regarding the Evaluation of Recovery

A primary concern of study participants concerned the process of evaluating patient recovery using this treatment method. Of specific concern was that, although the HRt represented an objective clinical biomarker for recovery, the over-reliance on symptom reporting remained the same. One provider mentioned the likelihood of consistency in reporting bias when assessing symptom presence, *e.g.*, "the athlete who comes in and tells me he is not having headaches is going to tell me the same thing on the treadmill." In addition to worry over dependability, there was much concern over patient compliance with the exercise prescription. Fundamentally, there is at present no way for providers to verify that a patient has followed the exercise prescription properly. Lastly, participants expressed wanting more "objective testing"

available in clinical settings. These included such things as computerized testing tools in an attempt to provide a more complete picture to aid in assessment and treatment.

Theme Three: Impact on Patients

Due to the novelty of this treatment, much of the provider discussion centered around treatment efficacy and its impact on patient outcomes. More than one provider expressed interest in implementing such a protocol but mentioned apprehension without more data being available. One provider remarked: “I’m excited to implement this, as soon as long term data is published.” Another remarked they were “ready to adopt as soon as [they] see more published data and guidelines.” This was not the only request for more data, as multiple providers commented wanting more “data on [the] exercise effect” as well as “more information on statistical power.”

Despite their interest in this emerging protocol, concern persisted among this group of providers regarding the potential risk for patients. The “change from previously researched methods” as well as potentially “lengthening recovery time and worsening symptoms” were among the chief worries voiced by the group. Providers again expressed unease over the “risk for falls” and strongly desired more information on “long term effects and outcomes.” It was apparent that providers wanted to clarify if the therapy was “low risk” and “accepted.”

Discussion

The results of this study provide unique insight into concerns over implementing active rehabilitation in the treatment of SRC, as well as current opinions on the impact of both exercise and rest within the concussion recovery period. Furthermore, viewing study results through the lens of the Theory of Planned Behavior brings into focus critical information about current provider attitudes concerning SRC management. In order to implement successful behavior change, the primary tenets of this theory demonstrate steps that must be taken. One must

consider an individual's attitude towards the behavior, subjective norms, and behavioral control when attempting a change in behavior or practice.

In the context of medicine, being one of the first to adopt any practice change represents a significant risk. As a result, the implementation of change often occurs in medicine at a glacial pace, particularly when the change directly impacts patient safety. In 1979, social psychologists Daniel Kahneman and Amos Tversky posited that "loss looms larger than gain" when describing loss aversion within the context of economics. This is particularly evident when assessing the potential consequences of loss in healthcare, as providers must consider the possibility of malpractice, loss of reputation, loss of license, and the potential of negative consequences for patients when weighing a prospective practice or behavior change. Active rehabilitation seems to complicate this matter further as it represents a treatment modality with principles antithetical to traditional management beliefs. This makes practice change that much harder.

This treatment modality sparked equal amounts of excitement and concern in participants. This became clear with the very first survey assertion, "Sports-related concussions have the potential to cause physical, behavioral, and cognitive changes in patients." Responses revealed that providers appeared to have a strong comprehension of the profound, widespread impact concussions can have on an individual. Five providers selected "strongly agree" with a final individual selecting "agree." All six providers responded to the first question with "strongly agree" on the post-test. A major point within the educational intervention was to express the lack of holistic qualities that total rest presents as a treatment modality. This result was important as the variation in symptom presentation calls for a treatment that is more holistic and individualized in response. Ultimately, this question's responses resulted in one of the lowest variances among all; providers seemed to be in consensus that SRC could have a profoundly

negative impact on patients.

Prior to the intervention, provider's responses indicated uncertainty regarding how to describe the most current guidelines for managing acute SRC. Responses to Item Two ("I can describe the most current guidelines and/or official recommendations for managing acute, mild sports-related concussion") resulted in one of the highest variances among all survey questions. The pre-test responses resulted in one provider selecting "disagree," two picking "neutral," and two selecting "agree." The mean and median of these pre-test responses equaled "neutral." After the intervention, variance decreased with two providers shifting their response to "agree" and three to "strongly agree." At this point, the mean response to this question shifted to "agree", while the median became "strongly agree."

Both Items One and Two relate to behavioral control, or the self-efficacy branch of Ajzen's Theory of Planned Behavior (1991). As stated previously, when adopting a behavior change subjects must assess their ability to perform a task at their given knowledge or skill level. Both these items encourage providers to reflect on their knowledge of clinical presentation as well as consensus guidelines related to management of acute SRC. While providers indicated they had sufficient understanding of the extensive impact that SRC can have on an individual, the high variation in scores related to describing consensus guidelines elucidated a possible gap in knowledge.

Another assertion that appeared to also divide survey respondents was Item Six, "Total rest until a patient feels no symptoms remains the most accepted treatment of sports-related concussions." In this case, variance among provider responses actually increased after the educational intervention was provided. This item asked respondents to respond whether total rest until a patient felt no symptoms was the most accepted form of SRC treatment. In the pre-test,

the mean and median response was “neutral,” revealing that there was some confusion as to the exact timeframe that total rest should be prescribed to patients. Overall, one individual chose “disagree,” two chose “neutral,” and three selected “agree.” After the intervention, while the mean and median remained the same, variance greatly increased as the number of unique responses rose. Providers appeared to be more split on this topic, as two individuals responded with “disagree” and another two “neutral,” while another chose “agree” and the final individual selected “strongly agree.” This variation indicated that providers were at the very least open to considering alternative treatments other than total rest. Importantly, these data showed that providers were already considering the outcomes of a potential practice change.

Item Four (“Total rest as treatment of sports-related concussion could have negative health outcomes for some patients if continued past the recommended period”) sought further provider opinion on the most optimal length of rest for patients, specifically exploring whether total rest could have negative health outcomes if continued past the recommended 24-48-hour period. While total rest is effective for those patients whose symptoms dissipate within a few days, there are those whose symptoms persist past the initial recommended 24-48-hour total rest period. As a result, total rest is frequently continued past this period until the patient is asymptomatic. While the median response for the pre-test was “neutral-agree,” this changed to “agree” for the post-test. It is clear from these responses that there were some pre-existing beliefs among these providers that prolonged total rest could result in negative impacts for patients. In two instances, providers appeared already to be questioning the health outcomes of current practice, signaling a potential openness toward implementing a change in practice.

Item Five asked respondents to rate their agreement concerning whether they felt some structured aerobic exercise could promote recovery in patients. The median response for both the

pre- and post-test was “agree.” The mean response was “neutral” on the pre-test and “agree” on the post-test. These results indicate that providers had already thought that exercise earlier within the recovery process could actually be beneficial for patients. Item Seven asked providers to rate their thoughts on whether or not it was safe to participate in aerobic exercise directly after the initial recommended 24-48-hour rest period. The median response for both the pre- and post-test was “agree.” The mean response was “neutral” on the pre-test and “agree” on the post-test. Similar to Item Five, providers appeared already to possess some openness toward the inclusion of early exercise within the recovery period. It was important that this educational presentation re-frame exercise as a form of medicine, as opposed to simply something that must be entirely avoided in order to promote the recovery process.

Though the providers appeared to express support toward early inclusion of exercise, it was clear from the qualitative data that there was still a fair amount of concern regarding the potential risk to patients. Specifically, providers wanted more information on long-term health outcomes, and they expressed concern over short-term exacerbation of symptoms resulting in a lengthening of the recovery process. Frequently, providers mentioned wanting to see a larger quantity of higher quality research data about active rehabilitation in SRC. Despite this concern, the principal understanding of the benefits of exercise as opposed to total rest appeared at the very least to intrigue these providers enough that they requested more information.

Item Three asked the respondents their thoughts in regard to recommending an initial total rest period of 24-48 hours to all post-SRC patients. The mean and median for the pre-test was “agree,” and both changed to “strongly agree” for the post-test. This question was important, as this initial rest period is strongly recommended for all patients. Item Eight also dealt with proper SRC management, as it asked providers whether diagnostic imaging was required in the

absence of red flag symptoms. The mean and median for the pre-test was "agree," which did not change for the post-test. Ultimately, variance for both these questions was relatively unaffected after the delivery of the educational intervention, implying that this information was already known to study participants. Both of these questions represent examples of subjective norms; in medicine, there is an expectation that current consensus and evidence-based methods are followed. This creates a pseudo-form of perceived social or peer pressure among providers. As a result, implementing a protocol that is drastically different than precedent can create a host of issues.

Conclusions

The aim of this DNP Project was to present findings that can inform the next steps in researching SRC treatment. It was not the purpose of this project to propose policy or practice changes, nor can they be recommended as a result of the data collected by this DNP project. More research and data are required to investigate active rehabilitation in SRC before this practice can be disseminated into the clinic setting. However, quantitative results in this project support the conclusion that providers in this study could benefit from a renewed examination of current consensus-based guidelines for SRC management. Additionally, providers requested to see more robust data and information on long-term health outcomes for patients undergoing active rehabilitation. Many appeared interested in the flexibility of prescribing a structured exercise program instead of simply total rest. Though providers appeared to recognize total rest as an important principle of initial SRC treatment, they expressed concern over lengthening the total rest period past 48 hours. Providers were also unsure if total rest was the most appropriate treatment for SRC patients after 48 hours. Beyond the mechanics of instituting treatment guidelines however, participants in this project expressed concerns that fell into three themes.

The first was concern regarding the actual coordination of active rehabilitation in SRC. The second was how actual evaluation of recovery was to occur. The third and final theme was how active rehabilitation would impact their patients; specifically, how its effects would differ from what they had grown to expect with strict bed rest.

Limitations

If this project is to be replicated and improved upon, there are some limitations that must be addressed. First is the sample size in the current study; it was not large enough to draw more than initial conclusions. A larger sample size would provide a more complete picture of provider opinion on SRC management. In addition, a wider variety of provider type could provide higher quality data, as viewpoints may differ among medical doctors, nurse practitioners, and physician assistants. If both the sample size and provider variety were increased, collecting demographic information could become more useful in understanding and evaluating provider-specific opinions. Additionally, performing this intervention at multiple primary care clinic locations would also provide a broader selection of data.

Another limitation is the general lack of data regarding how many concussions are evaluated on a per-clinic basis. As a result, it is harder to identify which providers or clinics might benefit more from this education; one simply lacks local- or state-level epidemiological data on concussions. Lastly, this project was a one-time presentation and offered no significant incentive for providers to complete the 30-day survey. There also ended up being a reduced amount of time to provide the educational intervention due circumstances outside of the PI's control.

Implications for Practice

Providers in this study expressed a desire to see higher quality RCT studies as well as more compelling, statistically significant data. Additionally, more information is needed from providers regarding their opinions and concerns about the implementation of active rehabilitation. The author considers both to be critical before implementing active rehabilitation into primary care practice. Ideally, researchers would also begin utilizing this treatment modality in other age groups besides pediatrics. Research into the effects of active rehabilitation in the young adult (18-24) age group in larger sample sizes would seem to represent a logical next step.

The medical community strives to provide high quality, holistic care to all patients. Accordingly, providers must apply those same rigorous standards and consideration to the types of therapies we prescribe. At the current time however, the application of total rest for all individuals with acute concussion remains a uniform approach for a medical issue that presents with extreme variation among patients.

This health disparity demands an intervention that is individualized, holistic, and above all, founded on evidence. Medicine relies on evidence-based recommendations when prescribing therapeutic interventions. It is critical to note that at the current time, total rest after concussion represents continued use of expert opinion, a consensus-based conclusion that lacks a clear foundation in evidence. It is imperative that we continue to evaluate and improve the quality of existing guidelines to ensure everything we do is both comprehensive in approach and grounded in evidence. Active rehabilitation promises both a logical and innovative step forward in acute SRC research. As this treatment protocol continues to develop, we must challenge the “rest is best” paradigm with sound research and encourage exercise-based rehabilitation strategies in SRC treatment in order to further the advancement of medicine.

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Appendix A: Graduated Return-To-School Strategy

Stage	Aim	Activity	Goal of each step
1	Daily activities at home that do not give the child symptoms	Typical activities of the child during the day as long as they do not increase symptoms (eg, reading, texting, screen time). Start with 5–15 min at a time and gradually build up	Gradual return to typical activities
2	School activities	Homework, reading or other cognitive activities outside of the classroom	Increase tolerance to cognitive work
3	Return to school part-time	Gradual introduction of schoolwork. May need to start with a partial school day or with increased breaks during the day	Increase academic activities
4	Return to school full time	Gradually progress school activities until a full day can be tolerated	Return to full academic activities and catch up on missed work

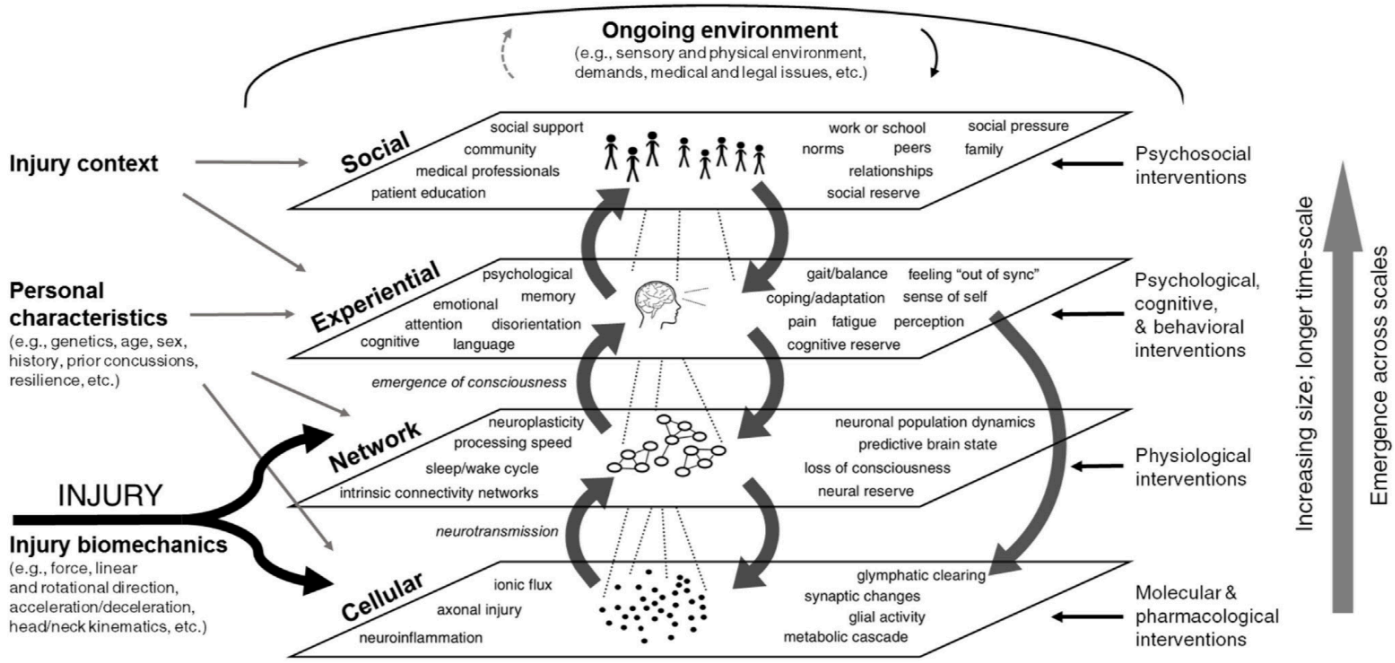
(McCrory et al., 2017)

Appendix B: Graduated Return-To-Sport Strategy

1	Symptom-limited activity	Daily activities that do not provoke symptoms	Gradual reintroduction of work/school activities
2	Light aerobic exercise	Walking or stationary cycling at slow to medium pace. No resistance training	Increase heart rate
3	Sport-specific exercise	Running or skating drills. No head impact activities	Add movement
4	Non-contact training drills	Harder training drills, eg, passing drills. May start progressive resistance training	Exercise, coordination and increased thinking
5	Full contact practice	Following medical clearance, participate in normal training activities	Restore confidence and assess functional skills by coaching staff
6	Return to sport	Normal game play	

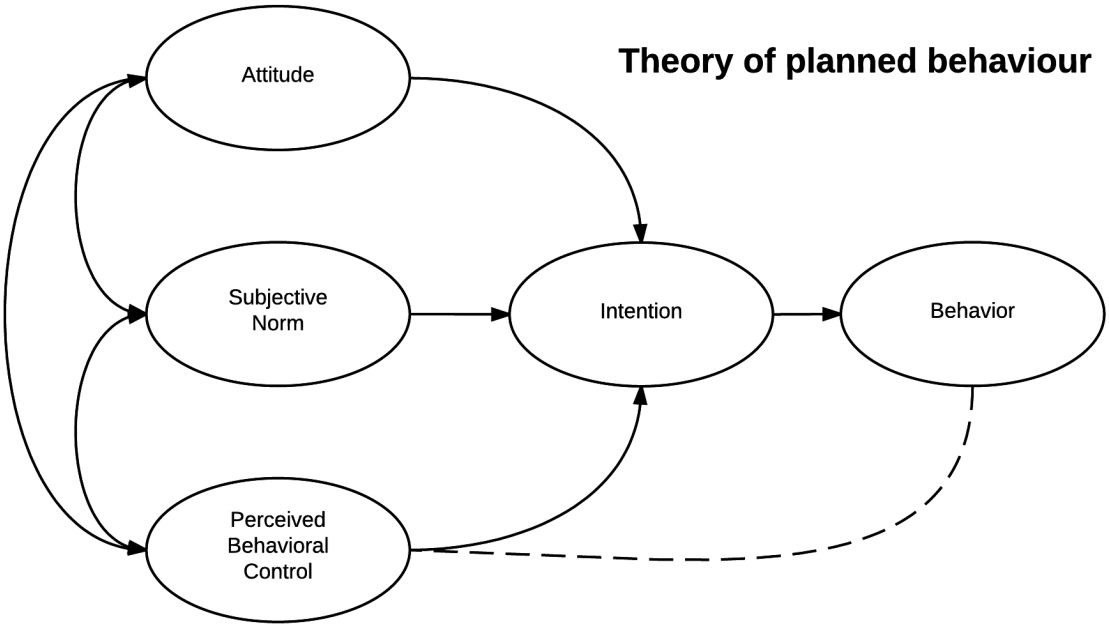
(McCrory et al., 2017)

Appendix C: Factors Related to Injury Recovery



(Kenzie et al., 2017)

Appendix D: Theory of Planned Behavior Framework



(Ajzen, 1991)

Appendix E: Assessment Questions and Responses

Q1) Sports-related concussions have the potential to cause physical, behavioral, and cognitive changes in patients.

	PRE-TEST	POST-TEST
# OF RESPONSES PER ANSWER	AGREE: (1) STRONGLY AGREE: (5)	STRONGLY AGREE: (6)
MISSING RESPONSES	0	0

Q2) I can describe the most current guidelines and/or official recommendations for managing acute, mild sports-related concussion.

	PRE-TEST	POST-TEST
# OF RESPONSES PER ANSWER	DISAGREE: (1) NEUTRAL: (2) AGREE: (2)	AGREE: (2) STRONGLY AGREE: (3)
MISSING RESPONSES	1	1

Q3) An initial total rest period of 24-48 hours is recommended for all patients directly after suffering a mild sports-related concussion.

	PRE-TEST	POST-TEST
# OF RESPONSES PER ANSWER	NEUTRAL: (2) AGREE: (4)	AGREE: (1) STRONGLY AGREE: (4)
MISSING RESPONSES	0	1

Q4) Total rest as treatment of sports-related concussion could have negative health outcomes for some patients if continued past the recommended period.

	PRE-TEST	POST-TEST
# OF RESPONSES PER ANSWER	NEUTRAL: (3) AGREE: (3)	AGREE: (4) STRONGLY AGREE: (2)
MISSING RESPONSES	0	0

Q5) Structured aerobic exercise within the first week of sustaining a sports-related concussion could be beneficial for recovery.

	PRE-TEST	POST-TEST
# OF RESPONSES PER ANSWER	NEUTRAL: (2) AGREE: (4)	AGREE: (4) STRONGLY AGREE: (2)
MISSING RESPONSES	0	0

Q6) Total rest until a patient feels no symptoms remains the most accepted treatment of sports-related concussions.

	PRE-TEST	POST-TEST
# OF RESPONSES PER ANSWER	DISAGREE: (1) NEUTRAL: (2) AGREE: (3)	DISAGREE: 2 NEUTRAL: 2 AGREE: 1 STRONGLY AGREE: 1
MISSING RESPONSES	0	0

Q7) In patients with sports-related concussions, participating in structured aerobic exercise is safe as long as they are asymptomatic after the initial recommended rest period.

	PRE-TEST	POST-TEST
# OF RESPONSES PER ANSWER	NEUTRAL: (2) AGREE: (4)	AGREE: (5) STRONGLY AGREE: (1)
MISSING RESPONSES	0	0

Q8) Diagnostic imaging of an acute sports-related concussion is not typically required unless red flag or focal neurological symptoms are present.

	PRE-TEST	POST-TEST
# OF RESPONSES PER ANSWER	AGREE: (4) STRONGLY AGREE: (2)	AGREE: (1) STRONGLY AGREE: (5)
MISSING RESPONSES	0	0

Appendix F: Focus Group Questions

- Briefly list your primary concerns about implementing an aerobic exercise therapy plan for treatment of sports-related concussions into your clinical practice.
- Describe your primary concerns about active rehabilitation of SRC?
- What barriers do you envision if you were to try and implement active rehabilitation into your current practice?
- What aspects of active rehabilitation would you like to see researched further?
- Where do you feel your knowledge base currently is lacking most in terms of understanding how to best manage SRC?

Appendix G: Qualitative Analysis - Codes

Access (to resources)
Access (to PTs)
Accepted
Assessment
Barriers (to implementation)
Change (from norm)
Clinical assessment
Computerized (testing)
Concern
Cost
Cost-effective
Court
Compliance
Dependability
Data
Dependability
Defensible
Effect of exercise
Elderly
Falls
Incongruent answers
Longer recovery
Long term (data availability)
Long term (effects)
Long term (outcomes)
Lengthening recovery
Low risk
Manageable
Monitoring
Objective testing
Patient compliance
Published (data)
Published (guidelines)
Reporting bias
Self-reporting
Socioeconomic groups
Statistical power
Spotter
Time
Time (for family)
Tech
Worsening symptoms

Appendix H: Qualitative Analysis - Categories

Implementation Barriers:
Access (to resources)
Access (to PTs)
Accepted
Barriers (to implementation)
Cost
Cost-effective
Court
Defensible
Elderly
Manageable
Monitoring
Socioeconomic groups
Spotter
Time
Time (for family)
Tech

Treatment Evaluation:
Assessment
Clinical assessment
Computerized (testing)
Compliance
Dependability
Incongruent answers
Monitoring
Objective testing
Patient compliance
Reporting bias
Self-reporting

Patient Outcomes:
Concerns
Change (from norm)
Falls
Risk
Worsening symptoms
Lengthening recovery
Longer recovery
Long term (effects)
Long term (outcomes)

Treatment Efficacy:
Data
Effect of exercise
Published (data)
Published (guidelines)
Statistical power
Long term (data availability)
Low risk

Appendix I: Qualitative Analysis - Themes

Concern Over Coordinating Treatment (implementation barriers)

Concern Regarding the Evaluation of Recovery (treatment evaluation)

Impact on Patients (patient outcomes, treatment efficacy)