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Potential Influences of Compliance for Short-Term Recovery from Sports-Related Concussion

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RECOVERY FROM SPORTS-RELATED

CONCUSSION

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by

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Abstract

Currently, treatment of sports-related concussion dictates the prescription of physical and cognitive rest to allow the injured brain to recover and for concussion-related symptoms to subside. However, clinicians who prescribe rest are often met with resistance from athletes who do not recognize its therapeutic value in the recovery process. Research has shown that athletes often fail to comply with rest recommendations, resulting in protracted recovery and the persistence of symptoms. *Method:* This study employed a three-group pretest-posttest experimental design to compare the effects of three different concussion management protocols. Participants were recently concussed collegiate or semi-professional athletes ages 18-25 seen in the UTEP CMC. *Purpose*: This study sought to determine whether supplementary attempts to encourage athletes' compliance with rest recommendations following concussion would benefit their recovery. The researchers addressed the experimental question: *Which of the following treatment protocols will best facilitate recovery from a sports-related concussion: (a) standard of care, (b) standard of care + a self-monitoring component, or (c) standard of care + a therapeutic alliance component? Results*: Statistical tests revealed that Groups B and C demonstrated significantly faster recovery times than Group A, being returned to play sooner. Statistical analyses revealed no significant differences across groups in ImPACT scores from PC1 to PC2, but Groups B and C improved in more variables when qualitatively compared to ImPACT normative data. Participants in Groups B and C demonstrated varying levels of compliance with the rest protocol as measured by self-reports. *Conclusion:* These results suggest that participants who receive the standard of care combined with either a self-monitoring or therapeutic alliance component may demonstrate more significant gains in recovery.

KEY WORDS: Concussion, mTBI, sports-related, compliance, rest, recovery, ImPACT, self-monitoring, therapeutic alliance, return to play

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Chapter 1: Introduction

Over recent years, sports-related concussions have received an increasing amount of attention and become a growing public health concern. Up to 3.8 million sports-related concussions occur annually in the United States (CDC, 2013). Current best practice mandates the prescription of physical and cognitive rest for treatment of concussion until resolution of concussion-related symptoms. The goal is to allow the concussed brain to return to metabolic homeostasis prior to the individual engaging in regular physical/cognitive activities. While most concussions resolve within 7-10 days, research shows that many athletes fail to comply with these recommendations, resulting in prolonged duration of symptoms and cognitive impairments. This study evaluated potential treatment components (i.e., *self-monitoring; therapeutic alliance*) which may positively influence athletes' compliance with rest recommendations following concussive injury, thus resulting in quicker recovery times.

1.1 Concussion

The term *concussion*, often used interchangeably with *mild traumatic brain injury (mTBI)*, is broadly defined as "a trauma-induced physiologic disruption of brain function" (Zuckerman, Lee, Odom, Solomon, Forbes, et al., 2012). Concussion may result from a bump, hit, or jolt to the head or body which forces the head to shake back and forth. This violent shaking of the head causes the brain to shift abruptly, striking the skull, which may in turn result in neuronal dysfunction. This neuronal dysfunction is due to a cascade of neurochemical, ionic, and metabolic changes which cause altered cerebral glucose metabolism and reduced cerebral blood flow (Laddy, Sandhu, Sodhi, Baker, & Willer, 2012). While it is minimally detectable anatomically, it often manifests itself symptomatically throughout the body. Among others, symptoms may include headache, confusion, disorientation, unsteadiness, and emotional, visual, or sleep disturbances (Giza & Hovda, 2001).

1.2 Concussion Assessment

Computerized neurocognitive testing is increasingly being used for assessment of concussions in combination with subjective evaluation. The athlete's subjective self-reported symptoms are best supported by their performance on objective computerized neurocognitive assessments, which can be administered serially to track recovery (Broglio, Macciocchi, & Ferrara, 2007). Fazio, Lovell, Pardini, and Collins (2007) and Broglio et al. (2007) underscored the importance of objective neurocognitive testing when they found that athletes may tend to underreport concussion-related symptoms during subjective measures in an effort to expedite return to play. Athletes' self-reported data coupled with their performance on neurocognitive assessments produces a more accurate assessment of the patient's recovery (Lovell et. al, 2004).

One such computerized neurocognitive assessment utilized in the UTEP CMC, the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT), was specifically designed for assessment of sports-related concussion. It is available in 21 languages and takes approximately 30 minutes to complete. It consists of six individual test modules which measure aspects of cognitive functioning and a Post Concussion Scale (*PCS*; a symptom questionnaire) in which the athlete rates the severity of 22 concussion-related symptoms using a 6-point Likert scale. Results of the test yield a total symptom composite score and four more composite scores for verbal memory, visual memory, processing speed (also termed *visual motor speed*), and reaction time (Iverson, Brooks, Collins & Lovell, 2006). The ImPACT is inclusive of a demographic questionnaire that requires the athlete to document relevant educational, sports participation, and personal medical history. Through the use of several alternate forms, the

ImPACT was designed to minimize practice effects (Broglio et al., 2007). Recent research has shown ImPACT to be sensitive to detecting mild effects of sport-related concussion and has documented reliability of ImPACT's composite scores (McClincy et al., 2006; Iverson, et al. 2006; Shatz, Pardini, Lovell, Collins, & Podell, 2006). Schatz and colleagues (2006) found the ImPACT's sensitivity to be 81.9% and specificity to be 89.4%, suggesting that the test is a useful neurocognitive assessment tool that can provide valuable post-concussion cognitive and symptom data that can assist practitioners in making safer return-to-play decisions. The internal consistency reliability of the PCS for concussed athletes has been demonstrated to be very high ($r = .93$) (Lovell et al., 2010). Overall reliability of the ImPACT tool has been examined in a number of studies, having been found to range from .54 to .76 (Broglio et al., 2007).

The profession of clinical neuropsychology has a long history of over-pathologizing test scores, particularly in the use of the term "impairment" (Lovell & Collins, 2003). Lovell and Collins (2003) noted it is often the case that when test scores fall below average, the test taker is deemed as *impaired* when in fact they may still be within average or low average range. In their research, they have compiled normative data for each of the ImPACT composite scores as well as the postconcussion scale for male/female university/high school students. They utilized the following classification ranges and percentile rank ranges: Mildly Impaired < 2nd percentile; Borderline 3rd – 9th percentile; Low Average 10th – 24th percentile; Average 25th – 75th percentile; High Average 76th – 90th percentile; Superior 91st – 98th; Very Superior > 99th percentile (Lovell & Collins, 2003). This normative data is often helpful in classifying the severity of impairment for those sustaining a concussion as well as monitoring their recovery.

Supported by neurocognitive assessment and the athlete's self-reports, clinical observation plays a crucial role in the assessment of sports-related concussion. Particularly without baseline information, the diagnosis, prognosis, and treatment of an injured athlete are much more subjective (Salvatore & Fjordbak, 2011). Acute signs and symptoms following concussive injury are key indicators of concussion and are essential for evaluation. Salvatore and Fjordbak (2011) differentiate that whereas symptoms are a subjective experience described by the patient, signs are objective indicators noted by a trained observer or clinician. Signs of a concussion may occur as changes in cognitive-communicative function (e.g. slowed reaction times or word fluency), physical manifestations (e.g. balance issues), or behavioral changes (e.g. irritability). At present, there is no perfect diagnostic test or marker that clinicians can rely on for an immediate diagnosis of concussion in the sporting environment (McCrory, Meeuwis, Aubry, Cantu, Dvorak, Echemendia, et al., 2013). Thus, concussion is best assessed through evaluation of a range of domains including neurocognitive function via objective testing, symptoms via self-reports, and signs via clinical observation.

1.3 Concussion Management

According to the 2012 consensus statement on concussion in sport, the cornerstone of concussion management is physical and cognitive rest until symptoms resolve, and then symptom-free completion of a stepwise progression exercise program prior to returning to play. The first level of protocol, total rest, demands the cessation of physical and cognitive stimulation, including activities such as texting, schoolwork, and video games which all involve the cognitive load of attention and concentration. Recommended activities include: rest and breaks from sports and school, avoidance of exposure to bright lights, noise, computers, and television (McCrory et al., 2013).

The theoretical basis for cognitive and physical rest following concussion is evident in the research base. During the past decade, animal models and human data have helped develop a better understanding of the metabolic and functional effects associated with concussions. After an injury, the brain should increase cerebral blood flow to speed the delivery of nutrients, including glucose, to the injured cells. However, the cellular response in the concussed brain restricts cerebral blood flow by up to 50% - the mismatch in the supply and demand for glucose results in an energy crisis at the cellular level (Giza & Hovda, 2012). During the early phase of brain healing, equilibrium begins to develop between this supply and demand of the brain's energy needs and energy production. If given sufficient time and energy to recover, the neurons will restore intracellular function and remain viable (Grady, Master, & Gioia, 2012).

Animal models have demonstrated that exercise has a harmful effect on brain recovery immediately following an injury. Similarly, cognitive work early after a concussion may also increase the metabolic demands of the cells at a time when the cells are particularly vulnerable (Grady et al., 2012). In human models, studies have found that high levels of cognitive and/or physical activity in the early post-concussive phase had a negative impact on cognitive function, both in symptoms and in cognitive testing. For example, Gioia and colleagues reported that more than 80% of students with concussion had a significant increase in symptom severity during school throughout the first 2 weeks post-injury (2010). The implication is that premature neuronal activation in the absence of re-injury could in and of itself have a negative effect on recovery (Grady, Master, & Gioia, 2012)

While the research base evaluating the efficacy of rest for treatment of concussion is sparse, some evidence documenting the positive effects of rest exists. Moser, Glatts, and Schatz (2012) and Moser and Schatz (2012) concluded that a period of cognitive and physical rest may be a useful means of treating concussion-related symptoms, regardless of whether rest was prescribed in the early or prolonged stages of recovery. In a systematic review of the literature, Schneider and colleagues also suggested that rest may be of benefit in regards to the resolution of concussion (Schneider, Iverson, Emery, McCrory, Herring, Meeuwisse, 2013).

The concepts of physical and cognitive exertion can be represented on a continuum that ranges from no activity (i.e., full rest) to full activity (i.e., no rest). It is not realistic to achieve a state of no activity – a conscious patient must engage in some degree of physical and cognitive activity. The therapeutic goal of concussion management is to limit physical and cognitive exertion to a level that is tolerable in order to give the brain a better opportunity to return to homeostasis (McLeod, 2010). Data collected by Bederman (2013) suggested the possibility that there may exist a 7-10 day window immediately following concussive injury in which physical and cognitive rest may drastically improve the future clinical course of the injury.

1.4 Compliance Issues with Rest Protocols

Patient compliance is vital to the effectiveness of therapeutic regimens. Therapeutic goals cannot be achieved without patient compliance, resulting in poorer patient outcomes (Cameron, 1996). Historically, compliance with therapeutic and medical recommendations has been a difficult feat for patients. In a quantitative review of patients' adherence to medical recommendations, DiMatteo found an average non-adherence rate of 24.8% (2004). Concerning sports-related concussion, several studies have documented failed compliance with return-to-play guidelines in which student-athletes have returned to play prematurely (Yard & Comstock, 2009; Ackery, Provvidenza, & Tator, 2009). Consequently, the overwhelming majority of these non-compliant athletes who returned to play prematurely continued to suffer from post-concussion symptoms (Ackery et al., 2009; Bederman, 2013).

Specific to level one of the return-to-play stepwise progression program, physical and cognitive rest, very few studies have evaluated athlete compliance. Recently, in a study comparing the physical and cognitive activities of two concussed collegiate athletes with those of a control group, Bederman (2013) found that both athletes demonstrated a high level of noncompliance, showing similar levels of activity as the control group. It is not surprising that these athletes continued to experience concussion-related symptoms throughout and after the critical recovery period (7-10 days post). In another study examining compliance in a younger population, children were asked to keep activity diaries following concussion in which only 67% of the children remained compliant with activity restrictions (Gagnon, Swaine, & Forget, 2009). In addition to these studies, there is much anecdotal evidence to suggest that many concussed patients of all ages do not comply with rest recommendations.

It has been suggested that rest protocol compliance may be complicated by a general lack of knowledge about the consequences of head injury (Gouvier, Prestholdt, & Warner, 1988). Unfortunately, clinicians who prescribe rest are often met with resistance from athletes, parents, and school/athletic officials who do not see the therapeutic value of missing school or sports for multiple days or possibly weeks. Athletes, parents, and coaches may recoil at the need for, or effectiveness of, rest and inactivity (Moser et al., 2012a).

1.5 Potential Influences of Compliance

Ponsford and colleagues found that the provision of a concussion informational pamphlet to individuals sustaining a concussion contributed to the resolution of concussion-related symptoms at follow-up evaluation. Their control group, who did not receive the pamphlet, continued to report symptoms three months post-concussion, particularly those of sleep disturbances and anxiety (Ponsford, Willmott, Rothwell, Cameron, Kelly, et al., 2002). Results of this study suggest that the provision of information to concussed individuals may influence compliance with concussion management rest protocols. Several concussion management clinics, including UTEP's, have implemented the provision of printed informational resources as part of the course of treatment. Still, a number of athletes may be unwilling to comply with recommendations for physical rest despite this provision of information (Bederman, 2013; Moser et al, 2012a). Identification of other treatment components that could influence compliance in the realm of concussion management would benefit both the clinicians implementing treatment and the clients recovering from concussion.

Since the early 1970s, *self-monitoring* (also termed *self-regulation, self-evaluation, or self-reinforcement*) has been consistently demonstrated as an effective treatment component for altering an individual's behavior across a variety of settings, including clinical, academic, and home environmental (Kanfer, 1970; Mahoney, Moore, Wade, & Moura, 1971; DiGangi, Maag, & Rutherford, 1991; Boutelle& Kirschebaum, 2012). Positive results have been found to occur when behavior therapy is applied to cases in which the patient is an active participant in data collection. Research in the area of self monitoring has shown that the act of observing and recording one's own behavior which is attached with aversive consequences (e.g. persistence of concussion-related symptoms) can dramatically alter that behavior (Mahoney, 1971). In implementing a self-monitoring component, treatment methods are initiated during a session and are carried out by the patient in their everyday environment. Thus, behavior change is instigated by the clinician but carried out by the patient, who assumes the therapist's role of observing and monitoring their own behavior (Kanfer, 1970). Furthermore, self-monitoring helps to clarify and bolster the rationale and goals for treatment (Cohen, Edmunds, Brodman, Benjamin, & Kendall, 2012). This type of treatment component may particularly fitting in the area of concussion management because patients are typically assessed and counseled once a week until they have recovered from their injury – their recovery may greatly depend on the cognitive and physical activities in which they take part in outside of the clinician's domain. After the provision of information and recommendations for total rest by the clinician, it is up to the patient to follow through with those recommendations in their everyday environment and temporarily change their behaviors to allow for full recovery.

Another favorable treatment approach in the literature proven to be effective in altering patient behavior by encouraging treatment compliance incorporates a *therapeutic alliance,* the positive relationship between patient and health care professional (Barofsky, 1978; Madden, 1990). This alliance is an emergent quality of partnership and mutual collaboration between patient and provider, and is one of the strongest validated factors influencing therapy success (Wampold, 2001). This patient-provider relationship has also been recognized by many researchers as a key factor for compliance. The behavior and attitudes of the provider can have a profound impact on patient compliance. By showing sensitivity, empathy, and understanding toward the patient, the provider may facilitate a patient-provider relationship of mutual respect which in turn will promote compliance as well as satisfaction with care (Cameron, 1996). A meta-analysis of several studies regarding patient compliance found that inadequate supervision by health care providers correlated with reduced patient compliance rates (Haynes et al., 1976). Schapira and colleagues evaluated the extension of clinician supervision within a therapeutic alliance, concluding that reminders such as telephone calls concerning the treatment regimen are simple but useful ways for clinicians to promote patient compliance (1992). This particular approach may be effective in encouraging patient compliance within the realm of concussion management. Again, patients are typically assessed and counseled once a week until they have recovered from their injury and their recovery may greatly depend on the cognitive and physical activities in which they take part in outside of the clinician's domain. Periodic phone calls from the clinician during the critical recovery period may not only serve as reminders for compliance, but may also help establish a therapeutic alliance by conveying the fact that the clinician cares about the patient's recovery. In turn, athletes may be more willing to comply with rest recommendations when a positive patient-provider relationship of mutual respect exists.

1.6 Purpose

Concussed athletes' noncompliance with physical and cognitive rest recommendations remains an important hurdle to concussion management and recovery. To date, no studies in the literature base have attempted to encourage compliance with rest recommendations to facilitate recovery. Furthermore, no studies have examined the relationship between levels of compliance and measures of recovery. Only one study by Bederman (2013) has examined collegiate student-athlete's compliance with rest recommendations following concussion, and this study had a concussed sample size of only two individuals. There is a dire need for this type of research considering the documented levels of noncompliance with medical recommendations and the prevalence of sports-related concussions.

The purpose of this study was to determine whether additional attempts to encourage athletes' compliance with rest protocols following concussion would result in more significant improvement within the 7-10 day critical recovery period when compared to those receiving only the standard of care. The researchers sought to determine whether these additional attempts would result in faster return-to-play times of concussed student-athletes and/or more significant improvement in neurocognitive test scores. Another goal within the study was to gain some insight into how concussed athletes comply with rest recommendations according to self reports, as well as how their compliance may have or have not impacted their recovery. This information would be a novel addition to the literature base and may profoundly impact our understanding of and treatment for concussions.

Within the domain of the UTEP Concussion Management Clinic, this study sought to address the experimental question, *Which of the following treatment protocols will best facilitate recovery from a sports-related concussion: (a) standard of care, (b) standard of care + a self-monitoring component, or (c) standard of care + a therapeutic alliance component?* It was hypothesized that participants in either treatment group B or C would be more likely to comply with rest recommendations. Thus, they would exhibit faster recovery times and be returned to play sooner, as well as demonstrate more significant gains in ImPACT neurocognitive assessment scores from the initial post-concussion evaluation to the follow-up evaluation.

Chapter 2: Methods

2.1 Design

This study employed an experimental three-group pretest-posttest design to evaluate the effectiveness of three different treatments on the recovery of concussed athletes. The independent variables of interest were the following three treatments: *(A) standard of care, (B) standard of care + a self-monitoring component,* and *(C) standard of care + a therapeutic alliance component.* For ethicality purposes, a control group receiving no treatment was not utilized. Instead, comparisons in treatment gains of Groups B and C were made against those of Group A. Dependent variables of interest were the participants' performance on the ImPACT assessment tool as measured by the five ImPACT composite scores (i.e. verbal memory, visual memory, processing speed, reaction time, total symptom score) as well as the length of recovery time as measured by the time from concussion until the time the stepwise progression program was initiated. For further descriptive measures, ImPACT normative data was used to classify severity rankings for each group based on the groups' mean performance on the ImPACT. The researchers also utilized descriptive statistics to examine the extent to which athletes complied with rest recommendations for Groups B and C.

2.2 Participants

A total of 10 recently concussed athletes (6 males) were recruited for participation in this study. They played either at the collegiate or semi-professional level. Participants were selected from the Concussion Management Clinic (CMC) at the University of Texas at El Paso (UTEP). Involvement in this study required that each participant be between the ages of 18-25 with no history of attention deficit disorder, learning disorders, brain surgery, meningitis, seizure/epilepsy, substance abuse, or concussive injury within the last 12 months. It was also required that all participants have had a valid initial post-concussion assessment (PC1) following concussive injury and a valid follow-up post-concussion assessment (PC2). Participants were distributed across a variety of sports, represented in Figure 2.1.

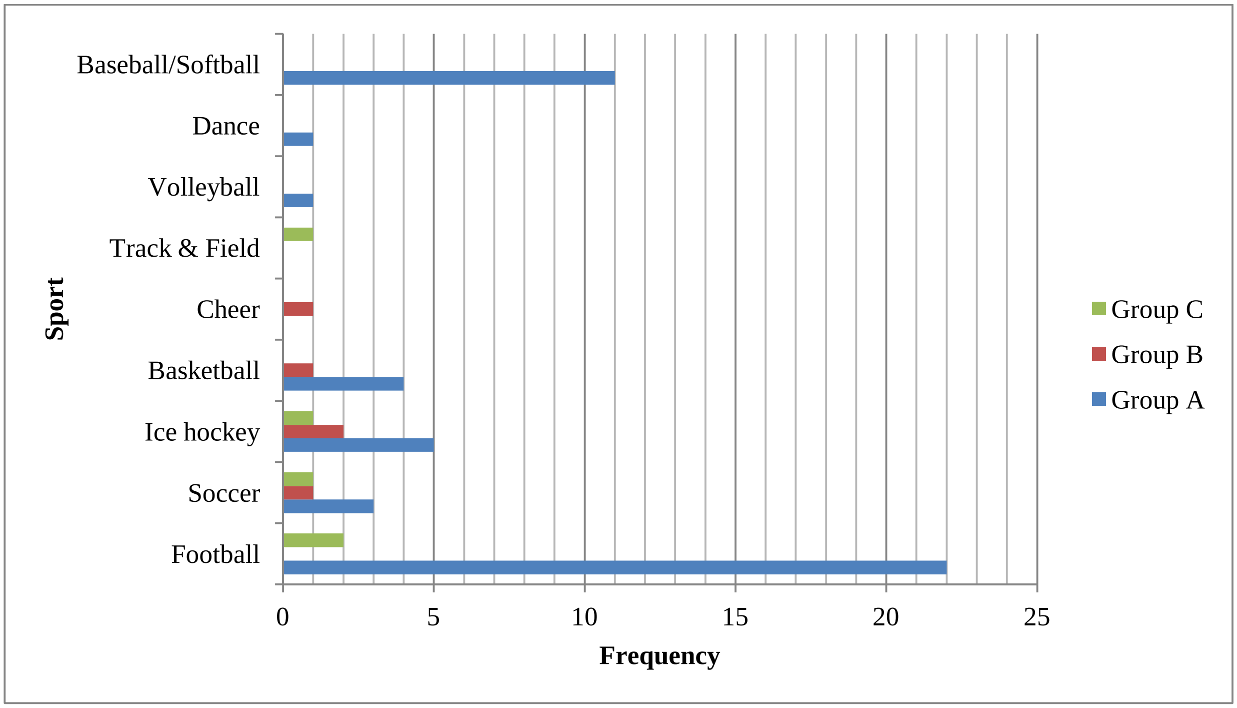

Figure 2.1 represents the participants' distribution across sports for Groups A, B, and C.

This study employed alternating assignment to treatment groups. Participants who met the criteria for involvement and were willing to take part in this study were alternately assigned to treatment Groups B (n=5) and C (n = 5), beginning with Group B. Existing data obtained from the UTEP CMC within the last four years was used to select participants for Group A. The primary investigator conducted an electronic records search specifying the inclusion and exclusion criteria for this study. The search results yielded 60 participants who were selected for assignment to Group A. Table 2.2 displays the demographic data for each group.

Table 2.2 provides demographic data of participants by treatment group.

Treatment Group	Participants (n)	Gender Male/Female	Age (*M/SD*)
A	60	41/19	19.57(1.32)
B	5	3/2	20.2(0.83)
C	5	3/2	20.0(1.87)

Institutional Review Board approval was obtained prior to data collection. To recruit participants for Groups B and C, recently concussed athletes visiting the UTEP CMC for initial post-concussion assessment were asked to participate in this study. Each willing participant was informed that participation was strictly voluntary and asked to read and sign a written consent form prior to involvement. Participants were made aware that their involvement in this study and any information they reported as part of being involved in this study would remain confidential and not affect any return-to-play recommendations made on behalf of the UTEP CMC. All data, both hard copies and electronic copies, were securely kept in the UTEP CMC under physical lock and key or electronic password protection. Hard copies of consent forms, survey results, and test results were kept in a file cabinet which remained locked when not in use. ImPACT scores and demographic data for each participant were entered into and stored in a computer database for analysis on a password-protected computer.

2.3 Materials/Procedures

Each newly recruited participant was assessed in the UTEP CMC as soon as possible following concussive injury. Evaluation began with a participant interview and then participants underwent a neurocognitive-linguistic assessment battery. Components of the battery included computerized neurocognitive-linguistic testing (ImPACT and a module from the Revised Token

Test), 3-dimenstional picture copying tasks, and a rapid naming word fluency task. The assessments were carried out by CMC student clinicians (volunteers from the department of speech-language pathology) who were trained in conducting the assessments. The primary investigator, also a CMC student clinician, did not partake in these assessments and spoke to the participants recruited for Groups B and C regarding treatment and this study after they were assessed. Following completion of the assessment battery, results of the participants' performance were reviewed by the CMC clinician(s) and the clinic director (Ph.D, CCC-SLP & ANCDS certified). Following review, one of the following treatments was initiated.

2.3.1 Group A

Group A received the standard of care treatment. This consisted of direct counseling with the participant, providing information regarding the nature of concussions, the rationale for physical and cognitive rest, the dangers of returning to play too soon, and rest recommendations with suggested activity restrictions. Any questions posed by the participant were answered and they were provided with written information reiterating what was discussed during counseling. Group A received only this treatment with no additional treatment components.

2.3.2 Group B

Group B received the standard of care treatment with the added component of a self-monitoring tool. This self-monitoring tool was in the form of an electronic survey known as the Survey of Concussed University Lads and Ladies (SCULL). The SCULL, an internet-based survey created by the primary investigator on www.surveymonkey.com, consisted of nine simply-worded questions concerning the experience of concussion-related symptoms and levels of physical/cognitive activity. In responding to each question, the participants were to compare their daily symptoms/activities to those of a typical day pre-concussion. Comparisons were made using 5-point Likert scale ranging from *much* less to *much more.* The survey was designed to take less than 3 minutes to complete. Upon completion and submission of the survey, the response forms were made anonymous and sent to a password-protected online account and made available for analysis by the investigators. Survey questions and answer choices can be found in Appendix A.

When enrolling these participants into the study, the primary investigator counseled them with information specific to their Group B assignment. The investigator reminded the participants of the provided rest recommendations and instructed them to use the SCULL as a self-monitoring tool. The participants were encouraged to be honest in responding to the questions and assured that their responses would remain anonymous and not factor into any return-to-play recommendations made on behalf of the UTEP CMC. The investigator informed the participants that on a periodic schedule, every two days from PC1 to PC2, they would receive a web link to the survey and should complete the survey by end of day. The web link was sent via text message or email, depending on each participant's preference.

2.3.3 Group C

Group C received the standard of care treatment with the added component of a therapeutic alliance. This therapeutic alliance was fostered during initial contact with the participant and through periodic phone calls from the primary investigator. A phone call script, created by the primary investigator, was utilized which consisted of between 7-8 sentences and employed principles of supportive therapy. Depending on participant responses, the script was designed to elicit a ~3 minute dialogue between the clinician and participant. The CMC clinician initiated the dialogue by asking how the participant was feeling and later offered subtle reference to the rest recommendations, gaining information on their compliance. During the call the investigator did not offer any direct advice, only offered a reminder of the rest recommendations and attempted to convey support and positive regard. Phone calls were audio recorded and then transcribed. The phone call script can be found in Appendix B.

When enrolling these participants into the study, the primary investigator counseled them with information specific to their Group C assignment. The primary investigator reminded the participants of the provided rest recommendations and informed them of the investigator's interest in their recovery. The investigator explained that the phone calls would serve as the method to stay in contact with them to ensure they are recovering well and answer any possible questions. They were assured that their responses would remain anonymous and not factor into any return-to-play recommendations made on behalf of the UTEP CMC, thus they could feel free to be open and honest during the phone dialogue. The investigator informed the participants that on a periodic schedule, every two days from PC1 to PC2, they would receive a phone call. If they failed to answer the call, one more call would be made later in the day. They were advised to return any missed calls if they felt comfortable doing so. The investigator collected information on each participant's contact information and the best times for contact.

2.4 Assessment Measures

Each participant completed a comprehensive assessment battery twice at the UTEP CMC. Initial assessment (PC1) was completed approximately 2-3 days after concussive injury and followup assessment (PC2) was completed approximately 5-7 days after PC1. The primary assessment tool was version 2.0 of the Immediate Post-Concussion Assessment and Cognitive

Testing (ImPACT, Applications, Inc., Pittsburgh, PA). This assessment tool, shown to be effective at detecting mild effects of concussion (McClincy et al., 2006; Iverson, et al. 2006; Shatz, Pardini, Lovell, Collins, & Podell, 2006), yields 5 composite scores: verbal memory, visual memory, processing speed, reaction time, and total symptom score. The ImPACT provides objective information on a concussed athlete's neurocognitive performance, as well as subjective information on their symptoms via the inclusion of the Post Concussion Symptom Scale questionnaire.

Coupled with data the ImPACT tool provided, clinical observation of signs/symptoms played an important role in assessing participants during assessment interviews. The clinic director, an experienced clinician with expertise in the area of concussion, made the ultimate recommendation of whether or not an athlete should adhere to the rest protocol for recovery or whether they could be returned to play via the initiation of the stepwise progression program. Initiation of the progression program required that the following criteria be met: 1) asymptomatic at rest and with exertion; 2) within normal range of baseline on ImPACT testing.

2.5 Analyses

Mann-Whitney U Tests were conducted to compare differences across groups in regards to recovery durations. Using ImPACT composite scores from PC1 to PC2, general linear mixed model analyses were performed to test for significant differences across groups. Average composite score for each group were further analyzed by examining changes in severity rankings from PC1 to PC2 using existing normative data for the ImPACT. Quantitative and qualitative statistics were used to analyze informative data provided by participants in Groups B & C regarding their compliance.

Chapter 3: Results

The data collected was analyzed in several ways. Across groups, the researchers analyzed differences in recovery times, performance on the ImPACT from PC1 to PC2, and aspects of compliance.

Nonparametric statistical analyses were used to compare the mean duration of recovery across groups. To quantify this recovery period, the date of concussion was used as the start date and the date in which the stepwise progression program was initiated (i.e., when participants no longer exhibited signs of concussion) was used as the end date. Thirteen participants were excluded from Group A either because their files had no explicitly marked date in which return-to-play recommendations were made or they discontinued subsequent assessments past PC2 prior to initiation of any return-to-play recommendations.

A series of Mann-Whitney U tests were conducted to analyze potential differences across groups involving three durational periods: 1) time between date of concussion and date of PC1 assessment; 2) time between date of PC1 and date of PC2 assessments; 3) time between date of concussion and date of stepwise progression program initiation. Descriptive statistics of each durational period is displayed in Table 3.1 for each group. Results of the tests, shown in Table

Table 3.1 displays descriptive statistics (M=Mean, SD=Standard Deviation) for each group, number of days in each of three time periods.

Group	***N***	**Time Period**	***M***	***SD***
A	47	1	3.28	2.26
		2	5.64	2.04
		3	16.00	8.77
B	5	1	2.00	1.00
		2	4.20	1.64
		3	6.80	2.05
C	5	1	1.60	0.89
		2	4.80	1.78
		3	9.20	5.16

3.2, showed that there were no significant differences across all three groups concerning time periods 1 and 2. These findings indicate that participants in each group were assessed at similar times for PC1 and PC2 assessments following their date of concussion. In regards to time period 3, the duration of recovery, significant differences were found when comparing Group A (*M*=16.00, *SD*=9.8.77) to Groups B (*M*=6.80, *SD*=2.05; U[df]=220, Z=3.1816, p=0.0014) and C (*M*=9.20, *SD*=5.16; U[df]=181, Z=1.9710, p=0.0487). By conventional criteria, the difference in recovery times between Groups A and B is considered to be highly significant (p<0.005) and the difference between Groups A and C is considered to be significant (p<0.05). When comparing Groups B and C in time period 3, results revealed there was no statistically significant difference.

*Table 3.2 shows the results of a series of Mann-Whitney U tests comparing groups for each of the three time periods. *P-value is statistically significant at p<0.05.*

Group Comparisons	**Time Period**	**U**	**Z**	**P value**
A-B	1	159.5	1.3037	0.1923
	2	164.0	1.4433	0.1489
	3	220.0	3.0186	0.0014*
A-C	1	180.0	1.9399	0.0524
	2	151.0	1.0398	0.2984
	3	181.0	1.9710	0.0487*
B-C	1	15.5	0.6267	0.5309
	2	14.5	0.4078	0.6761
	3	15.0	0.5222	0.6015

In order to examine potential group differences in neurocognitive scores on the ImPACT test from PC1 to PC2, General Linear Mixed Model Analyses for repeated measures (a generalization of ANOVA for repeated measures) were conducted for each of the five dependent variables. Time effect, group effect, and interaction time*group were examined for statistical significance with the level set at α = 0.05. Only the time effect was significant for the following three dependent variables: verbal memory composite, *F*(1,67) = 4.01, α = .0494; visual memory composite, $F(1,67) = 5.00$, α = .0286; total symptom score, $F(1,67) = 22.27$, α < .0001. These time effect results indicate that verbal memory and visual memory composite scores were significantly higher at PC2 than PC1, and total symptom scores were significantly lower at PC2 than PC1. Group effect and interaction time*group were not significant for any of the dependent variables, indicating composite scores were not significantly different across groups and the change over time did not differ among the groups.

*Table 3.3 represents the results of the Test of Fixed Effects in the General Linear Mixed Model Analyses examining three effects (time, group, time*group) for each ImPACT composite score from PC1 to PC2 assessments.*Statistically significant at α < 0.05.*

	Effect	**Num DF**	**Den DF**	**F Value**	**Pr > F**
Verbal Memory Composite	Time	1	67	4.01	**0.0494***
	Group	2	67	1.12	0.3339
	Time*Group	2	67	0.95	0.3935
Visual Memory Composite	Time	1	67	5.00	**0.0286***
	Group	2	67	1.09	0.3407
	Time*Group	2	67	0.42	0.6582
Visual Motor Speed Composite	Time	1	67	1.00	0.3200
	Group	2	67	0.19	0.8241
	Time*Group	2	67	0.93	0.3977
Reaction Time Composite	Time	1	67	1.00	0.3200
	Group	2	67	0.19	0.8241
	Time*Group	2	67	0.93	0.3977
Total Symptom Score	Time	1	67	22.27	**<.0001***
	Group	2	67	0.38	0.6854
	Time*Group	2	67	0.22	0.8070

Considering the small sample sizes of the experimental groups, the researchers conducted a power analysis in order to determine the sample sizes necessary to yield significant differences across groups for such analyses of fixed effects. Using a similar fixed effects one-way ANOVA, to be able to detect a significant effect size of 0.25 (medium) given 80% power and $\alpha = 0.05$, the required sample size would be 53 per group. These results indicate that the sample sizes were too small to lend statistical tests such as the General Linear Mixed Model Analysis enough statistical power.

Average composite scores for each group were further analyzed using existing normative data for the ImPACT. Lovell and Collins (2003) compiled separate normative data for university men and university women for each ImPACT variable. Using their classification ranges and corresponding percentile rank ranges provided in Tables 3.4 (used for verbal memory, visual memory, visual motor speed, and reaction time composite scores) and 3.5 (used for total symptom score), group performance was analyzed for possible changes in classification rankings from PC1 to PC2.

Table 3.4 provides the commonly used classification ranges and corresponding percentile rank ranges in neuropsychology (Iverson, Lovell, & Collins, 2003).

Classification Range	**Percentile Range**
Mildly Impaired	<2^{nd}
Borderline	3^{rd}-9^{th}
Low Average	20^{th}-24^{th}
Average	25^{th}-75^{th}
High Average	76^{th}-90^{th}
Superior	91^{st}-98^{th}
Very Superior	>99^{th}

Table 3.5 shows the normative data collected by Iverson, Lovell and Collins (2003) on 803 men and 236 women on the Post-Concussion Symptom Scale.

University Men			*University Women*		
Classification	**Raw Scores**	**Percentile**	**Classification**	**Raw Scores**	**Percentile**
Low-Normal	0	43.3rd	Low-Normal	0	26.7th
Normal	1-5	50th-75th	Normal	1-10	32nd-75th
Unusual	6-12	78th-90th	Unusual	11-21	79th-90th
High	13-20	91st-95th	High	22-31	91st-95th
Very High	21+	>95th	Very High	32+	>95th

Considering this current study did not separate males and females for analysis, average composite scores were analyzed in ranges using both male and female normative data. Classification range labels were based on the percentile rank ranges of males and females for each variable. Descriptive statistics, percentile rank ranges, and classification ranges are provided in Table 3.6 for each group and each variable. Each group demonstrated improvements in classification range statuses from PC1 to PC2. Group A showed improvement in two variables: reaction time composite and total symptom score. Group B showed improvement in three variables: visual memory composite, reaction time composite, and total symptom score. Group C showed improvement in 3 variables: verbal memory composite, visual memory composite, and total symptom score. Group C was also the only group that showed decline from PC1 to PC2, the variable being reaction time.

*Table 3.6 provides descriptive statistics of each group's performance in each dependent variable at both assessment times. It also provides the percentile and classification ranges for each mean composite score based on ImPACT's male/female normative data. VerbalMC=verbal memory composite; VisualMC=visual memory composite; VMSC=visual motor speed composite; RTC=reaction time composite; TSS=total symptom score. *Change in classification ranges at PC2.*

Time	**Group**	**Variable**	***n***	**Mean**	**Std Dev**	**Min**	**Max**	**Percentile Range**	**Classification Range**
PC1	A	VerbalMC	60	81.23	14.99	31.00	100.00	36-37	Avg
		VisualMC	60	67.87	16.34	33.00	96.00	27-32	Avg
		VMSC	60	36.39	7.83	8.75	46.95	30-34	Avg
		RTC	60	0.65	0.23	0.46	1.83	15-17	Low Avg
		TSS	60	22.92	20.83	0.00	92.00	91->95	High -Very High
	B	VerbalMC	5	87.60	12.58	69.00	97.00	61-62	Avg
		VisualMC	5	75.60	19.77	45.00	99.00	50-57	Avg
		VMSC	5	37.40	9.33	25.78	50.18	34-39	Avg
		RTC	5	0.64	0.16	0.52	0.89	17-19	Low Avg
		TSS	5	26.40	30.16	3.00	77.00	91->95	High -Very High
	C	VerbalMC	5	83.00	11.34	71.00	96.00	43-44	Avg
		VisualMC	5	70.80	16.25	45.00	85.00	35-41	Avg
		VMSC	5	37.70	9.83	22.40	49.70	35-40	Avg
		RTC	5	0.61	0.19	0.51	0.94	25-29	Avg
		TSS	5	31.40	28.37	4.00	76.00	91->95	High -Very High
PC2	A	VerbalMC	60	83.90	11.82	39.00	100.00	45-47	Avg
		VisualMC	60	71.72	15.23	35.00	97.00	37-42	Avg
		VMSC	60	38.83	6.78	14.70	51.35	40-43	Avg
		RTC	60	0.56	0.08	0.45	0.88	49-50	Avg*
		TSS	60	8.12	12.05	0.00	60.00	32-90	Normal – Unusual*
	B	VerbalMC	5	90.20	9.15	76.00	97.00	69-73	Avg
		VisualMC	5	81.20	11.71	69.00	99.00	70-80	Avg - High Avg*
		VMSC	5	41.26	6.87	31.83	50.18	52-58	Avg
		RTC	5	0.54	0.07	0.48	0.66	60-60	Avg*
		TSS	5	8.20	13.01	0.00	31.00	32-90	Normal – Unusual*
	C	VerbalMC	5	93.40	10.55	75.00	100.00	80-82	High Avg*
		VisualMC	5	80.00	14.80	55.00	91.00	67-76	Avg - High Avg*
		VMSC	5	35.98	10.28	18.50	45.08	28-31	Avg
		RTC	5	0.68	0.26	0.52	1.14	10-11	Low Avg*
		TSS	5	12.00	25.51	0.00	58.00	79-90	Unusual*

The researchers analyzed compliance with treatment components for participants in Groups B and C, being the periodic completion of the SCULL or participation in phone calls, respectively. Participants in both groups were each contacted every two days, beginning the day after PC1 until PC2 assessment. The primary investigator sent 40% of Group B's participants three requests for survey completion and sent 60% two requests. Out of the total 12 survey requests sent out, there was a survey return rate of 91.7%. For participants in Group C, the primary investigator again attempted to contact 40% of the participants three times and 60% of the participants two times. Out of the 12 calls made, there was a response rate of 100%. The participants either answered each phone call on the first attempt or returned any missed phone calls within the same day. Four out of the five participants asked additional questions or offered additional comments following completion of the script.

The researchers then examined the degrees of compliance with the rest recommendations using data provided by participants in Groups B and C. For qualitative analysis, responses from both the SCULL and the phone calls were placed on a 5 point continuum of compliance, ranging from *very altered behavior in compliance* to *very altered behavior in non-compliance*. The SCULL already utilized the 5-point continuum for participant responses. For Group C however, subjective compliance ratings along the 5-point continuum had to be assigned. Inter-rater reliability of 90% was obtained between the primary investigator and another CMC graduate student clinician based on transcribed participant responses. All questions/responses were then grouped into five categories: Physical Stimulation (e.g. exercising, practicing), Entertainment-Related Cognitive Stimulation (e.g. cell phone/computer/television usage, going out to public places); Academic-Related Cognitive Stimulation (e.g. attending class, doing homework, writing); Water/Healthy Food Consumption, and Sleep.

For quantitative analysis of the self-reported data, percentages were calculated based on the frequency of responses along the 5-point continuum for each category. For participants in Groups B/C, respectively, 100/100% reported some degree of compliance with the CMC's recommendations for limiting physical stimulation; 61.91/66.66% reported limiting entertainment-related cognitive stimulation; 42.86%/34.57% reported limiting academic-related cognitive stimulation; 7.14/25% reported increased water and healthy food consumption, and 42.86/100% reported increased amounts of sleep. A percentage of participants in Group B also reported unaltered behavior in the categories of entertainment- and academic-related cognitive stimulation, water and healthy food consumption, and sleep. Furthermore, a percentage of participants in Group B reported altered behavior in non-compliance in the categories of cognitive- and academic-related stimulation as well as water and healthy food consumption. A percentage of participants in Group C reported unaltered behavior in the categories of entertainment- and academic-related cognitive stimulation along with water and healthy food consumption. A detailed breakdown of the responses is represented in Table 3.7.

Table 3.7 shows where the percentages of responses provided by Groups B and C lay on the compliance continuum for each behavioral category.

	Group	***Very altered behavior in compliance***	***Altered behavior in compliance***	***Unaltered behavior***	***Altered behavior in non-compliance***	***Very Altered behavior in non-compliance***
Physical Stimulation	B	85.71%	14.29%	-	-	-
	C	90.00%	10.00%	-	-	-
Cognitive Stimulation (Entertainment)	B	28.57%	33.34%	33.33%	4.76%	-
	C	22.22%	44.44%	33.33%	-	-
Cognitive Stimulation (Academic)	B	-	42.86%	42.86%	14.29%	-
	C	-	34.57%	65.43%	-	-
Water & Healthy Food Consumption	B	7.14%	-	64.29%	28.58%	-
	C	-	25.00%	75.00%	-	-
Sleep	B	-	42.86%	57.24%	-	-
	C	83.33%	16.77%	-	-	-

Chapter 4: Discussion

The research question asked was the following: *Which of the following treatment protocols will best facilitate recovery from a sports-related concussion: (a) standard of care, (b) standard of care + a self-monitoring component, or (c) standard of care + a therapeutic alliance component?* Results of Mann Whitney U tests suggested that participants who received the standard of care combined with either a self-monitoring or therapeutic alliance component demonstrated more significant gains in recovery. Across all three groups, there were no significant differences between the times the athletes were concussed, first assessed at PC1, and then re-assessed at PC2. However, significant differences across groups were observed in the times in which athletes were cleared to initiate the stepwise progression program, i.e. when they showed no further signs/symptoms of concussion. Compared to Group A which received only the standard of care, Groups B and C had significantly faster recovery times as measured by the duration between date of concussion and date of stepwise progression program initiation. By conventional criteria, the difference between recovery times of Groups A and B was found to be highly significant ($p<0.005$) and the difference between Groups A and C is considered to be significant ($p<0.05$). Further comparisons of recovery times between Groups B and C results revealed no statistically significant differences.

Objectively analyzing differences across groups in ImPACT neurocognitive test scores proved to be a challenge due to the limited sample sizes. Thus, test results were instead qualitatively compared to existing ImPACT normative data. In comparison with the normative data, each group demonstrated improvements in classification range statuses from PC1 to PC2. Qualitative analysis revealed that experimental Groups A and B improved in more variables than Group A. Group A showed improvement in two variables: reaction time composite and total symptom score. Group B showed improvement in three variables: visual memory composite, reaction time composite, and total symptom score. Group C showed improvement in 3 variables: verbal memory composite, visual memory composite, and total symptom score.

Another goal within the study was to gain some insight into how concussed athletes comply with rest recommendations according to self reports. Participants in Group B self-reported on aspects of compliance via a confidential electronic survey, and participants in Group C self-reported on aspects of compliance via a telephone call from a CMC clinician. Overall, athletes were most compliant with limiting physical activity and entertainment-related activity. For both groups, there were high response rates from 91% to 100%. Self-reported compliance was highest in regards to the limitation of physical activity – 100% participants in both groups reported some degree of compliance for limiting physical activity. Approximately 2/3 of participants in both groups limited entertainment-related cognitive stimulation and approximately 2/5 reported limiting academic-related cognitive stimulation. Self-reports were mixed in the sleep category, where 100% of participants in Group C and only 43% of participants in Group B reported increased amounts of sleep. Degree of compliance was relatively low in regards to healthy food and water consumption. Both groups reported some degree of unaltered behavior in certain categories, but only Group B reported degrees of altered behavior in non-compliance in certain categories. It is possible that Group B participants felt more comfortable in disclosing truthful information regarding compliance and non-compliance, whereas Group C may have been hindered by the fact that they were speaking with a CMC clinician. An additional point, because Groups B and C showed faster recovery rates, it is plausible that participants in Group A demonstrated lower rates of compliance.

4.1 Conclusions

Based on the results of this study, it may be concluded that when treating sports-related concussion, the institution of either a self-monitoring component or a therapeutic alliance component into the standard of care may be beneficial. This study offers preliminary evidence that either of these treatment components may boost compliance with rest recommendations by highlighting the rationale for rest and providing periodic reminders. This compliance may in turn influence faster recovery and decrease the likelihood of protracted recovery. In this study, these additional attempts to encourage athletes' compliance with rest protocols following concussion resulted in more significant improvement within the 7-10 day critical recovery period when compared to those receiving only the standard of care as measured by faster return-to-play times of concussed athletes.

4.2 Study Limitations

Several limitations to this study exist, so results must be interpreted with caution. For one, this study utilized small sample sizes for the experimental groups due to the lack of availability of participants and constraints on time for research. Replication of these findings using larger sample sizes would yield stronger and more conclusive results. Larger sample sizes would also be necessary in order to yield objective significant differences in neurocognitive test scores as demonstrated by the power analysis. A further limitation was that although the participants were alternately assigned to experimental groups, selection of participants was not random and was limited to the domain of the UTEP CMC. Due to the utilization of small samples, little generalizabilty can be applied to the general population.

Another limitation was the reliance on self-reports in regards to compliance. Self-reported data is limited by the fact that it rarely can be independently verified and has to be taken at face value. This study attempted to prevent biased self-reports by assuring athletes that all responses would remain confidential and not factor into any return-to-play decisions.

This study also did not examine long-term effects of recovery; it only followed athletes until they were returned to play. Further research would be required to assure that concussion-related symptoms did not return to these athletes (in all groups) following return to play.

There also existed a threat to validity due to possible effects of intra-rater reliability. Athletes seen in the UTEP CMC over the past few years have been joint evaluated by student clinicians and the clinic director, an experienced clinician with expertise in the area of concussion (Ph.D, CCC-SLP & ANCDS certified). Initiation of the progression program required that the following criteria be met: 1) asymptomatic at rest and with exertion; 2) within normal range of baseline on ImPACT testing. The ultimate decision of whether or not an athlete should adhere to the rest protocol or be returned to play was the responsibility of the clinic director. Despite clinical experience and qualifications, intra-rater reliability may have been threatened in instances in which decisions required more of a clinical judgment call, or the rater's ability to assess patients over time may have improved.

A final limitation to this study is the profound lack of prior research in the area. Because of this, comparisons to confirming studies or contradictory studies could not be made. To date, no studies in the literature base have attempted to encourage compliance with rest recommendations to facilitate recovery and no studies have examined the relationship between levels of compliance and measures of recovery. There is a dire need for this type of research as concussed athletes' noncompliance with physical and cognitive rest recommendations remains an important hurdle to concussion management and recovery. This study offers initial insights into how compliance may be positively influenced through the addition of treatment components, but further research is required to confirm or contradict these findings.

References

Ackery, A., Provvidenza, C., & Tator, C. (2009). Concussion in Hockey: Compliance with return to play advice and follow-up status. *The Canadian Journal of Neurological Sciences, 36*, 207-212.

Barofsky, I. (1978) Compliance, adherence and the therapeutic alliance steps in the development of self care. Social Science and Medicine 12(5), 369-376

Bederman, L. (May 2013). *Patient compliance with recommendation of physical and cognitive rest following concussion* (Master's thesis). Ohio State University.

Boutelle, K. N., & Kirschenbaum, D. S. (1998, May). Further support for consistent self-monitoring as a vital component of successful weight control. *Obesity Research*, *6*(3), 219-224.

Broglio, S. P., Macciocchi, S. N., & Ferrara, M. S. (2007). Neurocognitive performance of concussed athletes when symptom free. *Journal of Athletic Training*, *42*(4), 504-508.

Cameron, C. (1996). Patient compliance: recognition of factors involved and suggestions for promoting compliance with therapeutic regimens. *Journal Of Advanced Nursing*, *24*(2), 244-250.

Cohen, J. S., Edmunds, J. M., Brodman, D. M., Benjamin, C. L., & Kendall, P. C. Using self-monitoring: Implementation of collaborative empiricism in cognitive-behavioral therapy. *Cognitive and Behavioral Practice*. (In Press) Retrieved November 11, 2012.

DiGangi, S. A., Maag, J. W., & Rutherford, R. B. (1991). Self-graphing on on-task behavior: Enhancing the reactive effects of self-monitoring on on-task behavior and academic performance. *Learning Disability Quarterly*, *1*(4), 221-230.

Gagnon, I., Swaine, B., & Forget, R. (200). Using activity diaries to measure children's and adolescents' compliance with activity restriction after mild traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *24*(5), 355-362.

Giza, C. C. & Hovda, D. A. (2001). The neurometabolic cascade of concussion. *Journal of Athletic Training*, *36*(3), 228-235.

Grady, M. F., Master, C. L., & Gioia, G. A. (2012, September). Concussion pathophysiology: Rationale for physical and cognitive rest. *Pediatric Annals, 41*(9).

Gouvier, W.D., Prestholdt, P.H., & Warner, M.S. (1988). A survey of common misconceptions about head injury and recovery. *Archives of Clinical Neuropsychology, 3, 331-343.*

Haynes, R. B. , Sackett, D. L ., Gibson, E. S., Taylor, D. W., Hackett, B. C., Roberts, R.S. et al. (1976) Improvement of medication compliance in uncontrolled hypertension. Lancet, 1265-1268

Iverson, G. L., Brooks, B. L., Collins, M. W., & Lovell, M. R. (2006, March). Tracking neuropsychological recovery following concussion in sport. *Brain Injury*, *20*(3), 245-252.

Iverson, G. L., Lovell, M. R., & Collins, M. W. (2003). Immediate post-concussion and cognitive testing (ImPACT) normative data, version 2.0 only.

Kanfer, F. H. (1970). Self-monitoring: Methodological limitations and clinical applications. *Journal of Consulting and Clinical Psychology*, *35*(2), 148-152.

Lovell, M. R., Collins, M. W. (2003). Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) normative data. University of British Columbia & Riverview Hospital.

Lovell, M. R., Iverson., G. L., Collins, M. W., Podell, K., Johnston, K. M., Pardini, D. et al., (2010). Measurement of symptoms following sports-related concussion: Reliability and normative data for the post-concussion scale. *Applied Neuropsychology 13*(3), 166-174.

Madden, B. P. (1990) The hybrid model for concept development: Its value for the study of therapeutic alliance Advances in Nursing Science 12(3), 75-87.

Mahoney, M. J., Moore, B. S., Wade, T. C., & Moura, N. G. (1973). Effects of continuous and intermittent self-monitoring on academic behavior. *Journal of Counseling and Clinical Psychology*, *41*(1), 65-69.

McCleod, T. C. (2012, March). Cognitive rest: The often neglected aspect of concussion management. *Athletic Therapy Today*, 1-5.

McClincy, M. P., Lovell, M. R., Pardini, J., Collins, M. W., & Spore, M. K. (2006, January). Recovery from sports concussion in high school and collegiate athletes. *Brain Injury*, *20*(1), 33-39.

McCrory, P., Meeuwis, W., Aubry, M., Cantu, R., Dvorak, J., Echemendia, R. J. (2013). Consensus statement on concussion in sport: the 4th international conference on concussion in sport held in Zurich, November 2012. *British Journal of Sports Medicine,* 47, 250-258.

Moser, R. S., Glatts, C., & Schatz, P. (2012a). Efficacy of immediate and delayed cognitive and physical rest for treatment of sports-related concussion. *The Journal of Pediatrics*, *161*(5), 922-926.

Moser, R. S. & Schatz, P. (2012b). A case for mental and physical rest in youth sports concussion: It’s never too late. *Frontiers in Neurology*, *3*, 171-177.

Ponsford, J., Willmott, C., Rothwell, A., Cameron, P., Kelly, A. M., Nelms, R., & Curran, C. (2002). Impact of early intervention on outcome following mild head injury in adults. *Journal of Neurology, Neurosurgery, & Psychiatry*, *73*, 330-332.

Salvatore, A. & Fjordbak, B. S. (2011). Concussion management: The speech language pathologist’s role. *Journal of Medical Speech-Language Pathology 19*(1), 1-12.

Schapira, D. V., Kumar, N. B., Clark, R. A., & Yag, C. (1992) Mammography screening credit card and compliance. *Cancer*, *70*(2), 509-512.

Schatz, P., Pardini, J. E., Lovell, M. R., Collins, M. W., Podell, K. (2006). Sensitivity and specificity of the ImPACT test battery for concussion in athletes. *Archives of Clinical Neuropsychology*, *21*, 91-99.

Schneider, K. J., Iverson, G. L., Emery, C. A., McCrory, P., Herring, S. A., Meeuwisse, W. H. (2013). The effects of rest and treatment following sport-related concussion: A systematic review of the literature. *British Journal of Sports Medicine*, *47*, 304-307.

Wampold, B. E. (2001). *The great psychotherapy debate.* Mahwah, NJ: Erlbaum.

Zuckerman, S. L., Lee, Y. M., Odom, M. J., Solomon, C. S., Forbes, J. A., & Sills, A. K. (2012, October 27). Recovery from sports-related concussion: Days to return to neurocognitive baseline in adolescents versus young adults. *Surgical Neurology International*, *3*(130).

Appendix A

<u>SCULL</u>
(Self-Monitoring Component)

Please rate how you felt and what you did today compared to how you would normally feel and what you would normally do in a typical day before your concussion.

Pain or discomfort (headache/dizziness/nausea/depression, etc) you felt today:

① Much less ② Less ③ Same ④ More ⑤ Much more

How much you slept/napped today and last night:

① Much less ② Less ③ Same ④ More ⑤ Much more

How much you texted or used your cell phone today:

① Much less ② Less ③ Same ④ More ⑤ Much more

How much water you consumed today:

① Much less ② Less ③ Same ④ More ⑤ Much more

The healthiness of the food you consumed today:

① Much less ② Less ③ Same ④ More ⑤ Much more

The amount or intensity of your physical activity today:

① Much less ② Less ③ Same ④ More ⑤ Much more

How often watched television, play video games, or used the computer today:

① Much less ② Less ③ Same ④ More ⑤ Much more

Your level of concentration/attention/or focus today:

① Much less ② Less ③ Same ④ More ⑤ Much more

How often you went to public places today (out to dinner, school, grocery store...):

① Much less ② Less ③ Same ④ More ⑤ Much more

Appendix B

<u>Phone Call Script</u>
(Therapeutic Alliance Component)

INTRODUCTION:

Researcher: *"Hi, this is ______ from the UTEP Concussion Management Clinic. I was just calling to see how you're doing."* (Wait for participant response.)

RESPONSE ***<u>Option 1</u>*** (If participant response is positive):

Researcher: *"Great, I'm glad to hear you are recovering well. So how are you doing with the rest recommendations provided to you, like ______ and _______?"* (Wait for participant response.)

RESPONSE ***<u>Option 2</u>*** (If participant response is negative):

Researcher: *"Oh, I'm sorry to hear you aren't doing well. What do you think you could do to help yourself recover more quickly?"* (Wait for participant response.) *"And how do you feel about the recommendations provided to you, like ______ and _______?"* (Wait for participant response.)

CLOSING STATEMENT:

Researcher: *"Okay, well like I said I just wanted to check on you and I hope that you continue to get better. Do you have any questions?"*
"Thank you, goodbye."

Transcribe participant responses. Varied rest recommendations (e.g. not watching television, not texting, getting a lot of sleep, not attending classes, etc...) should be inputted into responses 1 and 2 when making repeat calls to the same participant.

Note: A therapeutic alliance fosters an environment that is comfortable, non-judgmental and empathetic. During this call, the researcher should exhibit the three qualities fundamental to supportive therapy: genuineness, unconditional positive regard, and empathetic understanding.

Curriculum Vita

Erin Ewing was born and raised in El Paso, TX. After graduating from Bel Air high school in the top ten percent, she enrolled into the University of Texas at El Paso in 2005 with a music scholarship. While pursuing a bachelor's of interdisciplinary studies in math education, she worked in technical support and customer service. After teaching a year of middle school math, she was accepted into the speech-language pathology graduate program at UTEP in 2012. Through this program she discovered her interest in concussion management and was offered the opportunity to volunteer in the Concussion Management Clinic under the supervision of Dr. Salvatore, her mentor and clinic director. Throughout graduate school, Erin has gained additional clinical experience working as a speech-language pathology assistant at a pediatric clinic. Currently, Erin continues to work toward obtaining her master's degree in speech-language pathology.

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