2018

Return to Play Decision Making with Concussed Athletes: Sports Medicine Practitioners' Responses

Courtney N. Condiracci
Antioch University, New England

Return to Play Decision Making with Concussed Athletes:

Sports Medicine Practitioners' Responses

by

Courtney N. Condiracci

B.S., Northeastern University, 2010
M.S., Antioch University New England, 2015

DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of
Doctor of Psychology in the Department of Clinical Psychology
at Antioch University New England, 2018

Keene New Hampshire

ANTIOCH UNIVERSITY
NEW ENGLAND

Department of Clinical Psychology

DISSERTATION COMMITTEE PAGE

The undersigned have examined the dissertation entitled:

RETURN TO PLAY DECISION MAKING WITH CONCUSSED ATHLETES: SPORTS MEDICINE PRACTITIONERS' RESPONSES

presented on July 26, 2018

by

Courtney N. Condiracci

Candidate for the degree of Doctor of Psychology
and hereby certify that it is accepted*.

Dissertation Committee Chairperson:
Gargi Roysircar, EdD

Dissertation Committee members:
Vincent Pignatiello, PsyD
Jonathan Lichtenstein, PsyD

Accepted by the
Department of Clinical Psychology Chairperson
George Tremblay, PhD

on **7/26/18**

* Signatures are on file with the Registrar's Office at Antioch University New England

For Roy Henry Schaefer

Acknowledgments

The beauty that you see in me is a reflection of you, thank you for your part in my journey - Rumi

To my family, thank you for your unconditional love and support.

To my advisor, Dr. Gargi Roysircar, thank you for your guidance, mentorship, and encouragement throughout this journey. You have been instrumental in my professional development and I am honored to have worked with you.

To Dr. Jonathan Lichtenstein, thank you for fostering my passion for the field. It was many years ago, working with you on one of our first cases together at Dartmouth-Hitchcock Medical Center, that initiated my passion for sports-related concussions. I am unbelievably grateful for our friendship.

To Dr. Vincent Pignatiello, thank you for your thoughtfulness and enthusiasm while being so dedicated to supporting my development as a psychologist.

To Ashland Thompson, thank you for sharing your knowledge of statistical analysis.

To Michael Bussiere II, I have felt so blessed to have you by my side. Thank you for your courageousness in accompanying me through the trials and tribulations encountered along this journey.

Table of Contents

List of Tables

List of Figures

Abstract

Sports-related concussions continue to be a serious health concern as the prevalence and incidence of concussion continue to increase annually (Center for Disease Control [CDC], 2016). Decisions regarding return to play (RTP) following concussion represent one of the biggest challenges for sports medicine professionals. The literature recommends implementing an individualized, collaborative, multi-dimensional approach to increase accuracy when assessing concussion recovery and making RTP decisions (McCrory et al., 2013). The current study examined the self-reported practices of sports medicine professionals surrounding RTP decisions. The study utilized an author-developed questionnaire, Sports Medicine Practice Questionnaire (SMPQ), administered as an online survey to assess the practices of sports medicine professionals responsible for returning athletes to play after a concussion. A sample of 141 participants responded to the SMPQ. Most respondents (89%, $n = 126$) reported using neurocognitive testing to aid in their RTP decision. A majority of respondents (95%) reported engaging in consultation practices to confirm readiness to RTP. Significant consultation discrepancies were observed between participants' preference for consulting with team physicians versus neuropsychologists. Gender differences regarding consultation practices were noted with females consulting with neuropsychologists more than their male counterparts. Significant regional differences between the Northeast and South were found with the South endorsing greater implementation of post-exertional neurocognitive testing. From the pilot questionnaire consisting of 43 items, a revised brief 16-item SMPQ was generated, which yielded an internal consistency Cronbach $\alpha = .70$. The implications of the findings are discussed with regard to the Concussion in Sports Group consensus statement (McCrory et al., 2017) and recognized current guidelines on the implementation of neurocognitive tests, gradual RTP exertion protocols, and consultation practices when making the RTP decision.

Keywords: Sports-related concussions, return to play, computerized neurocognitive testing, gradual exertion protocol, multidisciplinary consultation, survey study

Return to Play Decision Making with Concussed Athletes:

Sports Medicine Practitioners' Responses

As many as 1.6 million to 3.8 million sports- and recreation-related Traumatic Brain Injuries (TBIs), including concussions and other head injuries, occur in the United States each year (Langlois, Rutland-Brown, & Wald, 2006). The Concussion in Sports Group consensus statement defines concussion as "a complex pathophysiologic process affecting the brain, induced by traumatic biomechanical forces" (McCrory et al., 2013, p. 250). Given the complexity of diagnosing and monitoring concussions, neurocognitive testing has become a "cornerstone" of the concussion recovery evaluation process (McCrory et al., 2013). Proper concussion management has, therefore, become important, with a key challenge of developing appropriate guidelines for return to play (RTP). Decisions regarding RTP following concussion represent one of the biggest challenges for sports medicine professionals.

The study sought to increase an understanding of the current practices of sports medicine professionals involved in concussion management. The study rested on the premise that computerized neurocognitive testing provides sports medicine professionals an objective measure of an athlete's recovery. First, the study examined the self-reported practices of sports medicine professionals surrounding the RTP decision. In particular, it examined whether gradual RTP protocols and computerized neurocognitive testing were implemented. Second, the study assessed the occurrence of multidisciplinary consultation between sports medicine professionals.

Neurometabolic Cascade: The Link Between Pathophysiology and Concussive Symptoms

One of the hallmarks of concussion is that neurological signs and symptoms are affected after a biomechanical force to the brain, in the absence of macroscopic neural damage (Giza & Hovda, 2014). When a biomechanical injury occurs, a neurometabolic cascade of events transpires, including ionic shifts, metabolic changes, and axonal dysfunction, which impairs neurotransmission, impacting cellular and physiological functioning (Giza & Hovda, 2014). The initial ionic flux and glutamate release result in significant energy demands and a period of metabolic crisis for the injured brain. Potassium efflux and sodium and calcium influx occur, creating depolarization that causes a diffuse, "spreading depression-like" state that may account for post-concussive impairments. In order to restore homeostasis, there is an increased demand for intracellular energy, adenosine triphosphate. The increased activity of membrane ionic pumps produces a depletion of intracellular reserves, which causes hyperglycolysis and produces an impaired glucose metabolism that can last multiple days and is associated with behavior impairments in spatial learning as well as working memory deficits (Giza & Hovda, 2014).

Concussion symptoms fall into four major domains: (a) physical (i.e., headaches, dizziness, nausea/vomiting), (b) sleep (i.e., insomnia, fatigue, drowsiness), (c) cognitive (i.e., memory problems, slow processing, concentration or attention problems), and (d) emotional (i.e., irritability, anxiety, depression; CDC, 2016). The majority (80–90%) of all sports related concussions resolve within 7–10 days. However, the recovery timeline may be longer in children and adolescents (McCrory et al., 2005; Thunnan, Branche, & Sniezek, 1998). It has been shown that cognitive recovery may precede or follow physical symptom resolution, suggesting that the assessment of cognitive function should be an important component in any RTP protocol (Aubry et al., 2002; Bleiberg et al., 2004; McCrory et al., 2005; McCrory et al., 2009; McCrory et al., 2013).

A range of premorbid and comorbid factors may predict the potential for prolonged or persistent symptoms. Although approximately 80% of patients recover within two weeks, 20% of athletes take over two weeks to recover fully. This variability in recovery time may be attributable to risk factors associated with concussion. Identifying factors that influence risk and recovery from concussion has become an important part of the clinical management of injury (Elbin, Covassin, Gallion, & Kontos, 2015). Elbin and colleagues distinguished two types of risk factors in the sports-related concussion literature: (a) primary risk factors (e.g., experience of previous concussion) increase the likelihood for a concussion, and (b) secondary risk factors (e.g., learning disabilities, attention deficit spectrum disorders, history of mood disorders) predispose an athlete for poor recovery outcomes.

Statement of the Problem

Development of concussion guidelines and return to play protocols. The RTP decision is challenging for clinicians because athlete symptom reports are complicated by their subjective nature and poor specificity. Over the past 30 years, multiple concussion guidelines have been published to provide guidance and direction for sports medicine professionals in making RTP decisions (Collins, Lovell, & McKeag, 1999). All guidelines have been developed with the same end-goal in mind: to help professionals provide the best possible medical care to their patients. Despite the identified need for a cohesive set of guidelines, there has been minimal agreement and consistency in the administration of these guidelines. This has led to confusion regarding which system to follow and overall communication amongst clinicians. What was originally developed to aid in the decision-making process inevitably required clinicians to learn multiple systems in order to communicate effectively. Additionally, there is limited empirical evidence to support the proposed guidelines and RTP decisions. Although initially useful in focusing attention on the need for guidance for professionals making RTP decisions, the guidelines have not differentiated among injured athletes and instead have relied on a “one size fits all” approach to concussion management (Echemendia, Giza, & Kutcher, 2015; McCrory et al., 2013).

Individualized Management: One Size Does Not Fit All

In November 2001, an international concussion consensus conference was held in Vienna. This group, later known as the Concussion in Sport Group (CISG), evolved and eventually met on three additional occasions: once in Prague (2004) and twice in Zurich (2008, 2012). The goal for the CISG was to review the world's literature and develop a consensus statement on the definition, detection, assessment, and management of concussion worldwide. The original 2001 Vienna meeting led to a paradigm shift for how concussions were to be managed. Their statement highlighted the absence of scientifically validated RTP guidelines and recommended that concussion management and RTP decisions be implemented on an individualized basis. This shift ensured that athletes return to play only when they are completely asymptomatic (Gomez & Hergenroeder, 2013), and have returned to baseline on neurocognitive testing (Littleton & Guskiewicz, 2013). The CISG guidelines have been helpful to the sports medicine community by offering providers a systematic approach to RTP following a concussion.

The CISG guidelines were built on the principles outlined in the previous consensus documents and sought to develop further conceptual understanding of concussions using a formal consensus basis approach. The clear consensus of CISG was that the management of concussion must be individualized to each athlete, as there is no one-size fits all protocol. Individuals suspected of concussion should be removed from play and should not return until properly evaluated. Once a concussion is diagnosed, physical and cognitive rest is recommended until the acute symptoms resolve, and then a graded exertion program is followed prior to medical clearance and RTP. The CISG guidelines imply that athletes should not be granted RTP approval until they have demonstrated the ability to perform to the maximum exertion level of their sport without recurrent symptoms. Additionally, it is recommended that all athletes should have a clinical neurological assessment as part of their overall management. Neuropsychological assessment has been described by the CISG as a cornerstone of concussion management. The CISG guidelines recommend that neurocognitive testing should be utilized as an aid to the clinical decision-making process but should not be the sole basis of management decisions (McCrory et al., 2013). The ultimate RTP decision should remain a medical one in which a multidisciplinary approach, when possible, has been taken.

The Graduated RTP protocol, originally proposed by the CISG, is an international best practice protocol that has become widely cited and disseminated in clinical practice (Alla, Sullivan, & McCrory, 2012). This protocol outlines six progressive stages of incremental tasks related to sport performance, ranging from light aerobic exercise to sport specific activities. It is important for coaches, athletes, and medical personnel to consider individual factors, including sex, age, migraine history, or learning disabilities, which are suspected to increase susceptibility and prolonged recovery after a concussive event (McCrory et al., 2013).

Each progression within the graduated RTP protocol hinges on the athlete being asymptomatic at rest and also after performing the physical and cognitive exertion associated with each level. If the athlete experiences symptoms during activity, the progression should be halted and restarted at the preceding symptom-free step (McCrory et al., 2013). An athlete's frequency and past history of concussions, as well as the presence of prolonged symptoms should be considered prior to starting the RTP progression. Making safe RTP decisions for athletes recovering from concussion are key responsibilities of clinicians, athletic trainers, and coaches. This helps ensure that an athlete is not returning to play while still recovering from a concussion. Premature RTP may place the athlete at potential risk for short- and long-term negative consequences (McCrory, Davis, & Makdissi, 2012; McKee et al., 2009).

Second impact syndrome (SIS) is a very rare condition in which a second concussion occurs before the first concussion has properly healed, causing a rapid and severe brain swelling and often catastrophic results (McLendon, Kralik, Grayson, & Golomb, 2016). Over the past decade, researchers believe that chronic traumatic encephalopathy (CTE) is caused by repeated brain trauma, which triggers progressive degeneration of the brain issue and the build-up of hyperphosphorylated tau at the depths of the sulci (McKee, et al., 2016). CTE is associated with memory disturbance, behavioral and personality changes, speech and gait abnormalities, and eventually progressive dementia. These symptoms often begin years or even decades after the last brain trauma. Proper concussion management is essential for safeguarding athletes from permanent cognitive impairment (McClincy, Lovell, Pardini, Collins, & Spore, 2006).

The "cornerstone" of concussion management: computerized neurocognitive testing.

Neurocognitive testing contributes significantly to concussion assessment and management (McCrory et al., 2013). The baseline and post-injury assessment model of concussion management is the standard of care within sports medicine (Aubry et al., 2002; McCrory et al., 2005; McCrory et al., 2009; McCrory et al., 2013; Moser et al., 2007). Baseline pre-season neurocognitive testing is recommended to provide an accurate representation of the preconcussion cognitive status of individual athletes (Covassin, Elbin, Stiller-Ostrowski, & Kontos, 2009). Acquiring a baseline profile allows the practitioner to compare an athlete's post-concussion neurocognitive performance to themselves, rather than normative data. Multiple studies have demonstrated the benefits of using neurocognitive testing to clarify the persistent effects of concussion, to track recovery, and to make more informed decisions regarding return to play after injury (Broglio, Macciocchi, & Ferrara, 2007; Collins et al., 1999; Lovell & Collins, 1998; Macciocchi, Barth, Alves, Rimel, & Jane, 1996; Maddocks & Saling, 1996). A number of computerized neurocognitive test batteries have been designed specifically to assess sports-related concussion. The Immediate Post-Concussion Assessment and Cognitive Test (ImPACT) is the most widely used computerized testing program in the sports setting.

ImPACT is a computerized neuropsychological test battery commonly used in the assessment of cognitive changes following concussion. ImPACT is comprised of three sections: demographics, concussion symptoms, and neurocognitive tests. The demographics section requires the athlete to self-report basic demographic and mental health information, such as learning disabilities, neurological disorders, previous concussions, and sports participation. The symptom section requires the athlete to rate the severity of 22 concussive symptoms. The neuropsychological section consists of six neurocognitive test modules, loading onto four composite indices in verbal and visual memory, reaction time, and processing speed (Lovell, 2004; Schatz et al., 2006). The Verbal Memory Composite score is comprised of the average percent correct for a word recognition measure, a symbol-matching task, and a letter recognition measure. The Visual Memory Composite score represents the percentage of correct scores for a design memory task and a memory task that requires the identification of series of highlighted X’s and O’s after a distractor task. The Reaction Time Composite score represents the average response time in milliseconds on a symbol-matching task, a choice reaction time, and inhibition task. The Processing Speed Composite is a compilation of the weighted average of two tasks that are used as interference tasks for the memory measures.

Research has shown ImPACT to be a valid, reliable, sensitive, and specific tool for interpreting cognitive change in the assessment and management of sports-related concussion (Iverson, Lovell, & Collins, 2005; Schatz et al., 2006; Schatz, 2010). Assessment of ImPACT indices have been shown to be both sensitive (81.9–94.6%) and specific (89.4–97.3%) in identifying cognitive deficits (Schatz & Sandel, 2013; Schatz et al., 2006), with a positive likelihood ratio of 7.73:1 and a negative likelihood ratio of .20:1 (Schatz et al., 2006). Reliability data on the ImPACT composite scores range from 0.67 to 0.85 over a 7-day period (Iverson, Lovell, & Collins, 2003) and 0.62 to 0.85 over 1 year (Elbin, Schatz, & Covassin, 2011). ImPACT produces a Reliable Change Index (RCI) that represents the change in an individual's score, and determines whether or not the change is significant. ImPACT was designed to reduce practice effects through randomization of stimuli presentation. The ImPACT battery is intended to be used repeatedly over short intervals (Iverson et al., 2003). ImPACT can play an important role within the context of a multi-faceted approach to managing sports-related concussion.

Computerized neurocognitive testing provides an objective measure for determining the subtle cognitive changes likely affected by concussive injury. This then provides data to make more informed decisions regarding RTP. When both symptoms and cognitive test scores return to baseline, an athlete is considered recovered and eligible to start the RTP protocol (McCrory et al., 2013). Additionally, the CISG guidelines also suggest that athletes should not be given RTP approval until they have demonstrated the ability to perform to the maximum exertion level without recurrent symptoms (McCrory et al., 2013).

Neurocognitive testing with physical exertion. Athletes who have recovered from concussion should return to normal levels of neurocognitive efficiency at rest and remain symptom-free with exercise (Lambourne & Tomporowski, 2010). As such, with full recovery, neurocognitive test performance should remain stable following moderate exertion (McGrath et al., 2013). Yet, gradual RTP protocols have not typically included computerized neurocognitive reassessment to monitor for recurrence of post-concussive symptoms and neurocognitive declines post-exertion.

To date, only McGrath and colleagues (2013) have examined the impact of physical exertion on neurocognitive performance for concussed athletes. The purpose of their study was to examine the post-exertion neurocognitive performance among concussed student athletes, who were asymptomatic and had returned to baseline neurocognitive test levels. More specifically, this study examined the neurocognitive performance of a sub-set of student athletes who did not maintain or "failed" to perform at baseline levels of neurocognitive function, following a moderate exertional protocol. The study is briefly described below.

Fifty-four student athletes (43 male, 11 female) participated in the study (McGrath et al., 2013). Athletes were excluded from the study if they reported a history of brain surgery, a learning disability, attention-deficit/hyperactivity disorder (ADHD), special education, previous treatment for depressive or anxiety symptoms, seizure disorders, speech pathology, or substance abuse. After the student-athletes' neurocognitive test scores returned to baseline, they were moved to the physical exertion protocol. The physical exertion protocol consisted of 15–25 minutes of moderate cardiovascular exercise. Following a brief rest period (5–10 minutes), the participants completed the post-exertional ImPACT test.

Of the 54 participants, 15 (27.7%) exhibited significant declines in cognitive test scores following a moderate exertion trial. Group differences were significant for decline on the verbal and visual memory composite scores specifically, but such drops were not associated with symptom recurrence. These findings suggested that neurocognitive decline during post-exertion testing may reflect incomplete recovery and warrant additional recovery time before athletes returning to play. And as all participants in the McGrath et al. study (2013) returned to neurocognitive baseline levels 4–5 days later, post-exertion computerized neurocognitive testing may add significant value to the existing consensus-based RTP strategy by detecting those athletes who are likely not yet ready to return to contact.

A Multidisciplinary Approach to Return to Play Decisions

Implementing a collaborative, multi-dimensional approach has been suggested to increase accuracy when assessing concussion recovery and making RTP decisions (McCrory et al., 2013). The identified goals for concussion management are: returning an athlete to activity in a safe manner; ensuring recovery has occurred based on contemporary best practices; and reducing the risk of a second concussion (Harmon et al., 2013). Given the increased awareness of concussions occurring during sports participation, researchers have often sought to understand the current practice patterns utilized by athletic trainers, emergency room physicians, primary care physicians, and other sports medicine professionals (Kinnaman, Mannix, Comstock, & Meehan, 2013; Notebaert & Guskiewicz, 2005; Stache, Howell, & Meehan, 2016; Williams et al., 2014; Zemek et al., 2014).

Neuropsychologists are uniquely qualified to interpret neuropsychological tests and can play an important role within the context of a multifaceted-multimodal and multidisciplinary approach to managing sports-related concussions (McCrory et al., 2013). Ferrera and colleagues (2001) determined that certified athletic trainers routinely refer 40% of injured players for neurocognitive testing and consultation with a clinical neuropsychologist. In addition to providing expertise in the assessment of cognition, neuropsychologists are in a position to address psychological sequelae of sports-related concussion (Echemendia et al., 2013).

Given that neuropsychologists receive extensive specialized training in brain–behavior relationships, they are appropriate consultants for other sports medicine professionals to engage on a proper course of action for management and RTP decisions based on neurocognitive testing results. In many settings neuropsychologists may not be utilized in such a way. One study found that computerized neurocognitive tests utilized in high schools are most often interpreted by athletic trainers and/or physicians (approximately 80%) rather than neuropsychologists (approximately 17%; Meehan, d'Hemecourt, Collins, Taylor, & Comstock, 2012). Such information is concerning, as it suggests that neurocognitive information collected in order to determine best care might not be utilized or interpreted properly. Although the final RTP decision should remain a medical one, neuropsychologists are in the best position to interpret neurocognitive tests and should be consulted as part of best clinical care. Yet, limited data exist examining the current consultation practices between neuropsychologists and sports medicine professionals.

Knowledge Gap

Return to play decision-making following concussion is challenging for many reasons. Similar to concussion diagnosis, much of the determination hinges upon the athlete's self-report of their symptoms, injecting a very high degree of subjectivity into this medical judgment call. Thus, objective forms of assessment must be employed when determining whether an athlete is ready to return to play. Given the complexity of diagnosing and monitoring concussions, neurocognitive testing has become the cornerstone of concussion management. However, it is unclear to what extent this specialized testing is being utilized appropriately. To date, limited knowledge exists regarding the self-reported practice patterns of sports medicine professionals managing the recovery of concussed athletes. Placing the focus on neurocognitive testing, the present study sought to investigate how and when this form of objective assessment is implemented by sports medicine professionals as part of their care for concussed athletes. The following research questions were posed:

1. Do sports medicine professionals administer ImPACT to make return to play decisions?
2. Do sports medicine professionals implement a graduated RTP exertion protocol to assess recovery?
3. Is post-exertion ImPACT testing part of their concussion management protocol?
4. Do sports medicine professionals consult with neuropsychologists as part of their RTP decision-making process?

Definition of Terms

Concussion: Concussion is defined as “a complex pathophysiological process affecting the brain, induced by biomechanical forces” (McCrory et al., 2013, p. 250).

Consultation: Refers to the procedure whereby, on request by one professional, another professional reviews an athlete’s medical history, examines the athletes, and provides treatment recommendations.

Graduated Return to Play Protocol: Graduated exertion protocol has been developed by the Concussion in Sports Group (CISG) to ensure an athlete is asymptomatic at rest as well during provocative exercise. The step-wise process for return to play protocol is:

1. No activity, complete physical and cognitive rest; once asymptomatic, proceed to step 2
2. Light aerobic exercise (e.g., walking or stationary bicycle), no resistance training
3. Sport-specific exercise (e.g., skating drills in ice hockey, running drills in soccer); progressive addition of resistance training at step 3 and 4
4. Noncontact drills (e.g., passing drills in football and ice hockey)

5. Full contact drills after medical clearance (i.e., resume normal training activities)
6. Return to play (i.e., normal game play)

Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT): ImPACT is defined as a computerized neuropsychological test battery commonly used in the assessment of cognitive changes following concussion. The battery consists of 6 neurocognitive test modules, loading onto four composite indices in verbal memory, visual memory, reaction time, and processing speed. (Lovell, 2004)

Neuropsychologist: A neuropsychologist is defined as:

> A doctoral-level professional within the field of psychology with special expertise in the applied sciences of brain-behavior relationship. Clinical neuropsychologists use this knowledge in the assessment, diagnosis, treatment, and/or rehabilitation of patients across the lifespan with neurological, medical, neurodevelopmental, and psychiatric conditions, as well as other cognitive and learning disorders. The clinical neuropsychologist uses psychological, neurological, cognitive, behavioral, and physiological principles, techniques, and tests to evaluate patients' neurocognitive, behavioral, and emotional strengths and weaknesses and their relationships to normal and abnormal central nervous system functioning. (Barth et al., 2003)

Sports Medicine Professional: Refers to physicians, athletic trainers, sports psychologists, sports neuropsychologists, and physical therapists, who are trained to provide medical treatment and rehabilitation to injured athletes.

Summary

The standard of care in concussion management for athletes involves an individualized approach to ensure a full recovery. The management of concussions varies depending on the knowledge of the healthcare practitioner and the resources that are available to the practitioner to assist with decisions regarding medical clearance and return to play. The most common reason for variations in management of concussions is lack of awareness of or confusion about the many available published guidelines for the care of concussions. Although there is increased understanding about the consequences of returning a concussed athlete too soon and the effects of repeated concussions over time, it is important that every injury be managed individually and that practitioners adhere to published guidelines. This study evaluated the current practices that are being implemented by sports medicine professionals, who are responsible for providing medical clearance to athletes who have suffered a concussion.

Method

The study utilized a survey to examine current sports medicine practices pertaining to returning concussed athletes to play. These practices include: (a) utilization of computerized neurocognitive testing, (b) implementation of exertion protocols, and (c) consultation practices between sports medicine professionals.

Participants

Participants were licensed professionals within the sports medicine field currently involved in concussion management. Participants were not restricted by profession, years of experience, or practice setting. A total of 176 participants began the survey; among these 141 completed the survey. Depending upon the number of questions answered within the survey, between 105 and 141 participants were included in the analyses. Table 1 provides information on the demographic questions answered by the participants.

Ninety-two percent of participants (n = 129) earned a degree in athletic training. Concerning the years of practice the participants had within the sports medicine field, 30.5%

(*n* = 43) reported 0 to 5 years, 31.2% (*n* = 44) reported 6 to 10 years, 12.8% (*n* = 18) reported 11 to 15 years, 13.5% (*n* = 19) reported 16 to 21 years, and 12.1% (*n* = 17) reported 21+ years. The average number of years of experience in sport medicine was 10.5 years. When reporting their highest educational degree, 5% reported having their Bachelor's degree (*n* = 7), 79.5% reported having their Master's degree (*n* = 112), 8.4% reported having their Doctorate (*n* = 12), and 7.1% reported "Other" (*n* = 10). The participants were professionally experienced, well-educated practitioners.

The most common employment setting was a college/university (138/141 [97.9%]), followed by a medical center/hospital (4/141 [2.8%]), and a high school (3/141 [2.1%]). The vast majority were college athletic trainers. The average number of concussed athletes that the participants had served was 54 concussions, with a reported minimum of 1 and a maximum of 6,000. Regarding participants' geographic location of practice, 34.8% (*n* = 49) reported that they were from the Northeast, 31.2% (*n* = 44) reported they were from the South, 12.8% (*n* = 18) reported they were located in the West, 20.6% (*n* = 29) reported they were located in the Midwest, and the response of 0.7% (*n* = 1) appeared unclear. Concerning the participants' sex, 53.9% (*n* = 76) reported being female, 44.7% (*n* = 63) reported being male, and 1.4% (*n* = 2) preferred not to report their gender. There were more female than male participants.

Effect Size

The study assumed a medium effect size in order to determine the necessary number of participants. In order to detect a medium effect size for the analyses, a minimum of 150 participants was anticipated to result in an estimated power of .80 at $p < .05$. The study used a descriptive statistical design to assess the practices of sports medicine professionals with regard to the RTP guidelines and consultation practices.

Measure: Sports Medicine Practice Questionnaire (SMPQ)

I developed a 43-item survey, Sports Medicine Practice Questionnaire (SMPQ), to evaluate the use of RTP guidelines and consultation practices by sports medicine professionals. The SMPQ also assessed the use of the ImPACT computerized neurocognitive testing battery, physical exertion, and self-reporting practice scenarios. Demographic items were included. Questions' response format consisted of a combination of a Likert-type scale, multiple choice, dichotomous Yes/No responses, and fill-in-the-blank short written answers (see Appendix C for the survey items). The SMPQ was not constructed as a psychometric test, as theorized and operationalized by Anastasi and Urbina (1997) and the Standards for Psychological Testing and Measurement (AERA/APA/NCME, 2014).

Items were generated through a review of the literature on sports-related concussions and current published guidelines (Covassin et al., 2009; McCrory et al., 2013). The survey consisted of five topic areas: (a) making the RTP decision, (b) computerized neurocognitive testing, (c) gradual RTP practice protocol, (d) consultation practices, and (e) concussion management education and training. While constructing the survey, I sought feedback from a number of sources, which included an expert in the field of neuropsychology, three licensed psychologists, and two clinical psychology faculty members.

Demographic items. There were eight demographic items including: (a) professional education level, (b) professional licensure, (c) years of certification, (d) employment setting, (e) years of experience, (f) number of concussions assessed annually, (g) geographic location of practice, (h) employment setting, and (i) sex. The scoring format for demographic items was multiple-choice. Participants were first asked to complete the demographic items.

Making the RTP decision. This section is comprised of six items (questions 1–6) that pertained to: (a) understanding how sports medicine professionals apply return to play standards, (b) type of evaluative methods used, and (c) self-reported practice behaviors. The following questions are sample items of this section: “Do you personally speak to the athlete to assess their current symptoms?” “Do you have them fill out a self-report symptom form?” Both questions utilize a dichotomous Yes/No answer response.

Computerized neurocognitive testing. This section is comprised of 11 items (questions 7–17) that evaluate sports medicine professionals’ computerized neurocognitive testing practices. The questions covered the following: (a) baseline administration, (b) decline in post-injury neurocognitive scores, (c) neurocognitive scores’ return to baseline but with symptom presentation, and (d) post-exertion neurocognitive testing. The following question is a sample item: “When you administer baseline cognitive testing, do you check the scores to see if they are valid?” Response options are “Yes,” “No,” and “I don’t know how to check a baseline validity.” Another sample item is: “Do you administer neurocognitive testing while the athlete is still symptomatic?” The response format utilizes a Likert-type scale of “Always,” “Sometimes,” and “Never.”

Gradual RTP protocol practices. This section is comprised of 16 items (questions 18–33) that evaluate the implementation of a physical exertion component for making RTP decisions. The items cover the following: (a) employing a standardized exertion protocol, (b) presence of symptom recurrence, (c) decline in neurocognitive test performance, and (d) administration of post-exertion procedures. The following questions are sample items: “After the athlete is asymptomatic and their neurocognitive scores return back to baseline, do you implement a standard exertion protocol?” “As part of the physical stepwise progression, do you administer a neurocognitive test after exertion?” Both questions utilize a dichotomous Yes/No answer response.

Consultation practices. This section is comprised of five items (questions 34–38) related to consultation practices of sports medicine professionals, which evaluate: (a) identified instances for consultation, (b) frequency of consultation, (c) incidence of neuropsychological consultation, and (d) adherence to consultation recommendations. The following questions are sample items: “Do you seek consultation when making the RTP decision?” “Do you consult with neuropsychologists for your interpretation of neurocognitive testing?” Both questions utilize a dichotomous Yes/No answer response.

Concussion management education and training. This section is comprised of five items (questions 39–43) related to heightened awareness of how the significance of sports-related concussions has transformed the perception and management of this injury over recent years. Questions cover the following: (a) participation in continuing education, (b) frequency of training, (c) training venue, and (d) perceived benefit of continued education. The following question is a sample item: “Have you undergone training in the use of ImPACT or other computerized neurocognitive tests?” Item response to the question utilizes a dichotomous Yes/No answer response. Another sample item is: “Would receiving additional education in the area of concussion management be beneficial to your work?” Item response options to the question includes “Yes,” “No,” and “I don’t know.”

Expert evaluation of the SMPQ

Before administering the SMPQ to sports medicine professionals**,** it was submitted for a review by a panel of two experts; both experts are licensed psychologists. One is the Director of Pediatric Neuropsychological Services at a Northeastern academic medical center, a sports neuropsychologist, and a concussion management expert; the other is the Director of the Psychological Services Center in a Northeastern clinical psychology departmental training clinic. These experts provided feedback on the SMPQ's face validity and content validity.

Face validity. Face validity refers to the extent to which a test is subjectively viewed as covering the concept it intends to measure. It pertains to the relevance of a test, as it appears to test participants (Anastasi & Urbina, 1997). The experts provided overall opinions about whether the items appeared to measure the relevant dimension they purported to measure.

Face validity questions for the expert panel. The following questions were asked of the two experts regarding instrument face validity: "Do the items appear to you to evaluate the relevant construct (e.g., return to play practices)?" "Can you identify any ambiguous survey items or sections on the instrument?" "Do some items need to be removed?"

Content validity. Content validity refers to the adequacy of a test's items to represent accurately the construct the test purports to measure. In addition, does the test carry out the purpose and objectives for which the test was developed? Establishing content validity of a measure is less a quantitative than a judgmental evaluation of experts (Anastasi & Urbina, 1997). The experts reviewed the items of the SMPQ to ensure that the items covered contents of a construct being measured.

Content validity questions for experts. The following questions were asked to the experts on whether the contents of the SMPQ met the purposes for constructing the test and demonstrated adequate and representative contents: "Do items provide an adequate evaluation of return to play practices utilized by sports medicine professionals?" "Do the items on the SMPQ assess factors that may influence sports medicine professionals in determining RTP decisions?" "Do the items on the SMPQ assess utilization and implementation of computerized neurocognitive testing and post-exertion protocols?" "Do the items on the SMPQ quantitatively assess interdisciplinary practices surrounding RTP decision?"

Procedure

Permission to conduct this study was obtained from Antioch University New England's Institutional Review Board (IRB), the human subjects committee. Participants were recruited through a posting on athletic training listservs and by sending email announcements to university-based athletic programs. Representatives for each of these sites were contacted by email in order to enlist their willingness to forward the survey's recruitment information to their colleagues and employees. The survey was hosted by SurveyMonkey.com.

A recruitment letter (see Appendix A) included a link to the study. The provided link took individuals to the online survey site where they were provided an informed consent form (see Appendix B) that included a brief description of the study: (a) requirements for participation, (b) the benefits of participating, and (c) research ethics about confidentiality and anonymity. Participants first answered demographic questions (Appendix C). Next, participants were asked to respond to the 43-item survey. The survey took between 20–30 minutes. Participants were offered the chance to win one of two $50.00 gift cards for participating in the study. Once the appropriate number of participants was obtained (n = 176), the survey was discontinued. The researcher collected and downloaded the data and proceeded with data analyses using SPSS statistics software.

Participant anonymity and confidentiality. Anonymity was provided as the study did not require participants' names or other identifiers and did not record computer IP addresses. In order to be entered in the raffle drawing after taking the survey, participants were asked to send an email to an email address that was established for the study. As the researcher, I had access to this email. Participants were notified in the informed consent form that this email was in no way linked to their responses and was used for the sole purpose of choosing a raffle winner. Emails were numbered in the order that they were received. Winners were chosen from a random drawing from the number of participants and a gift certificate was emailed to the winner's address. To observe confidentiality, the data collected by the survey was downloaded to my personal computer which is password protected. In addition to the data and SPSS analyses being stored on the computer's hard drive, the data and results were printed and placed in a locked filing cabinet in the my office. When reporting the results in this dissertation and in other forms of dissemination, only group statistics are reported with no reference to individual participants.

Risks and benefits. Given the anonymous and fairly innocuous nature of the online survey, it was anticipated that participants experienced no or very minimal risk in their participation. Participants were informed that they did not have to answer any questions they did not wish to and could discontinue the survey at any point. As a benefit, participants might have been motivated to complete the measure to contribute towards research on sports-related concussions and perhaps influence practice guidelines. Additionally, the study's appeal might have been the results' potential implications for future systemic training and knowledge of sports medicine professionals as well.

Research Hypotheses

In response to the research questions in the first section, research hypotheses for the study were the following:

Hypothesis 1. Sports medicine professionals administer the ImPACT battery as part of their RTP protocol.

Hypothesis 2. Less than 50% of those who implement an exertion protocol administer a post-exertional neurocognitive test.

Hypothesis 3. More than 75% of sports medicine professionals engage in consultation to confirm readiness to RTP.

Hypothesis 4. Sports medicine professionals engage in multidisciplinary consultation practices to confirm readiness with team physicians rather than with neuropsychologists.

Data Analyses

Descriptive statistics, such as mean, median, mode, standard deviation, and frequency distribution, were calculated for categories of items, such as RTP criteria, utilization of neurocognitive testing, consultation with neuropsychologists, and physical-exertion practice. In addition, three tests of difference (one Analyses of Variance [ANOVA] and two t-tests) were conducted to examine differences for consultation and by demographic variables (sex and regional location).

Results

The purpose of the study was to gain insight into the current practices that are being implemented by sports medicine professionals, who are responsible for providing RTP clearance to athletes who have suffered a concussion. A total of 176 participants began the survey. Participants were removed due to failure to complete the demographic section or lack of completion on 25% of the items (10 items) in the SMPQ. Depending upon the number of completed questions within the total survey, between 105 and 141 participants were included in the analyses.

Hypothesis 1

It was predicted that sports medicine professionals administer computerized neurocognitive testing as part of their RTP protocol. Item 1 of the SMPQ was utilized to calculate the frequency. Overall, 89% (n = 126) of the participants utilized computerized neurocognitive testing in making their RTP decision. Hypothesis 1 was supported.

Hypothesis 2

It was predicted that less than 50% of those who implement an exertion protocol (item 18) administer a post-exertion neurocognitive test (item 21). Overall, 34% (n = 40) of participants who implemented an exertion protocol administered a post exertional neurocognitive test. Hypothesis 2 was supported.

Hypothesis 3

It was predicted that more than 75% of sports medicine professionals engage in consultation to confirm readiness to RTP. Overall, 95% (n = 129) of the participants sought consultation (item 34) to confirm readiness; 80% (n = 84) of the time participants consulted with a team physician (item 34), and approximately 8% (n = 8) of participants consulted with both a team physician and a neuropsychologist (item 34). When prompted if participants sought consultation with a neuropsychologist (item 35) to confirm readiness, 31% (n = 41) agreed. Hypothesis 3 was supported.

Hypothesis 4

It was predicted that sports medicine professionals engage in consultation practices to confirm readiness with team physicians rather than with neuropsychologists. A paired sample t-test was conducted to compare consultation practices with team physicians (item 34) versus neuropsychologists (item 36). There was a significant difference in scores for team physicians (M = 0.8, SD = 0.402) and neuropsychologists (M = 0.295, SD = 0.458); t (104) = 7.93, p = 0.0001. Hypothesis 4 was supported. See Table 2.

Descriptive Statistics

Answers to the research hypotheses guided descriptive statistical analyses of the five sub-categories of the SMPQ as well as of individual items. The sub-categories consisted of:

(a) making the RTP decision, (b) computerized neurocognitive testing, (c) gradual RTP practice protocol, (d) consultation practices, and (e) concussion management education and training.

Making the RTP decision. Participants were asked to select all the evaluative tools and information they use in making the RTP decision: 97.2% (*n* = 137) endorsed "gradual exertion protocol"; 96.5% (*n* = 136) endorsed "asymptomatic during exertion and rest"; 80.9% (*n* = 114) endorsed "athlete self-report"; 87.2% (*n* = 123) endorsed "medical clearance"; 71.6% (*n* = 101) endorsed "balance testing"; 42.6% (*n* = 60) endorsed "visual tracking"; 89.4% (*n* = 126) endorsed "administering neurocognitive testing"; and 49.6% (*n* = 70) endorsed "neurocognitive testing administration post-exertion." When making the RTP decision, participants favored "clinical examination" the most 44.4%; followed by "symptom checklist" 22.5%; and "computerized neurocognitive testing" 20.1%. When an athlete sustains a concussion during play, participants assessed their status: 24.8% "immediately"; 34.0% in "10–30 minutes"; 24.8% "daily"; and 3.5% "hourly or continuously." See Figure 1 for additional information on participant responses after a sports-related concussion.

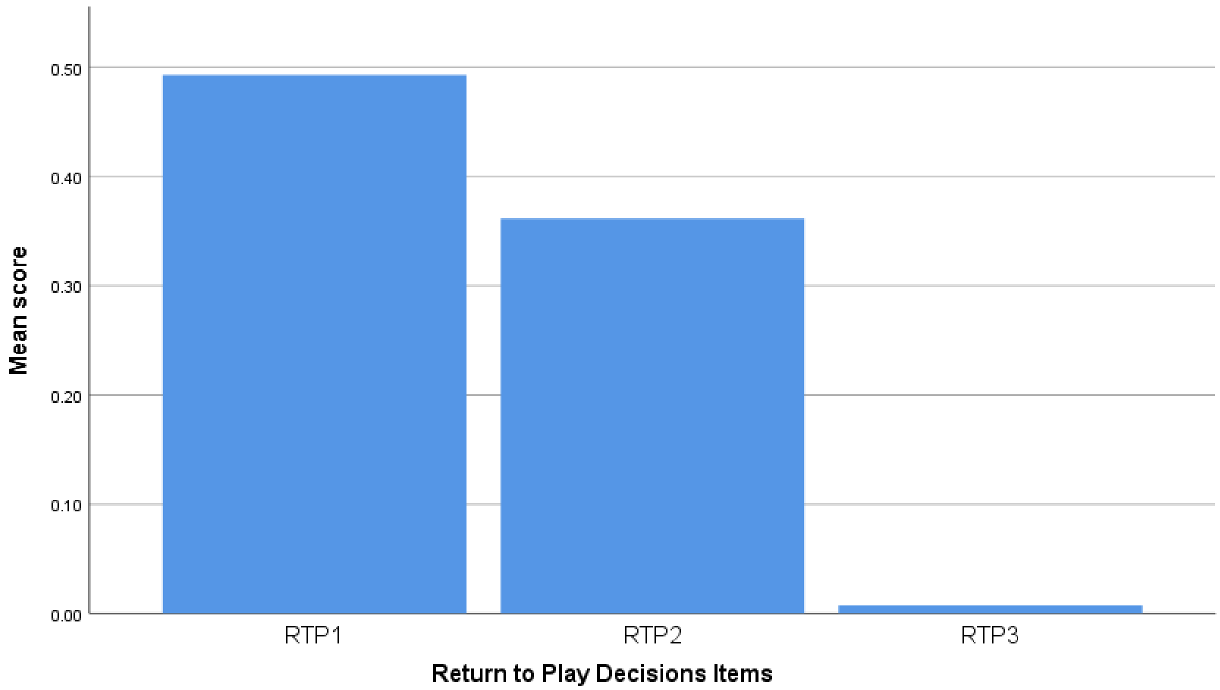

Figure 1. Mean Scores of RTP Decision Items. Note*:* RTP1 = Speak to athletic trainer (item 4); RTP2 = Obtain athletics self-report (item 5); RTP3 = Obtain parent signature (item 6).

Computerized neurocognitive testing. Participants were asked if they administered neurocognitive testing while the athlete is symptomatic: 55.4% (*n* = 77) reported *sometimes*, 36% (*n* = 50) *never*, and 8.6% (*n* = 12) *always*. Participants waited to administer a neurocognitive test under the following conditions: 74% *until the athlete is symptom free*; 36% after *reduction of symptoms*; and 33% owing to *poor previous test performance*. When presented with a scenario on RTP decisions, 84.5% would not return an athlete to competition despite a return to baseline performance on computerized neurocognitive testing if the athlete was still symptomatic. When asked if they would return an athlete who is symptom free but their computerized neurocognitive test results were significantly worse than baseline, 88.4% responded *no*. See Figure 2 for information on participants' consultation practice.

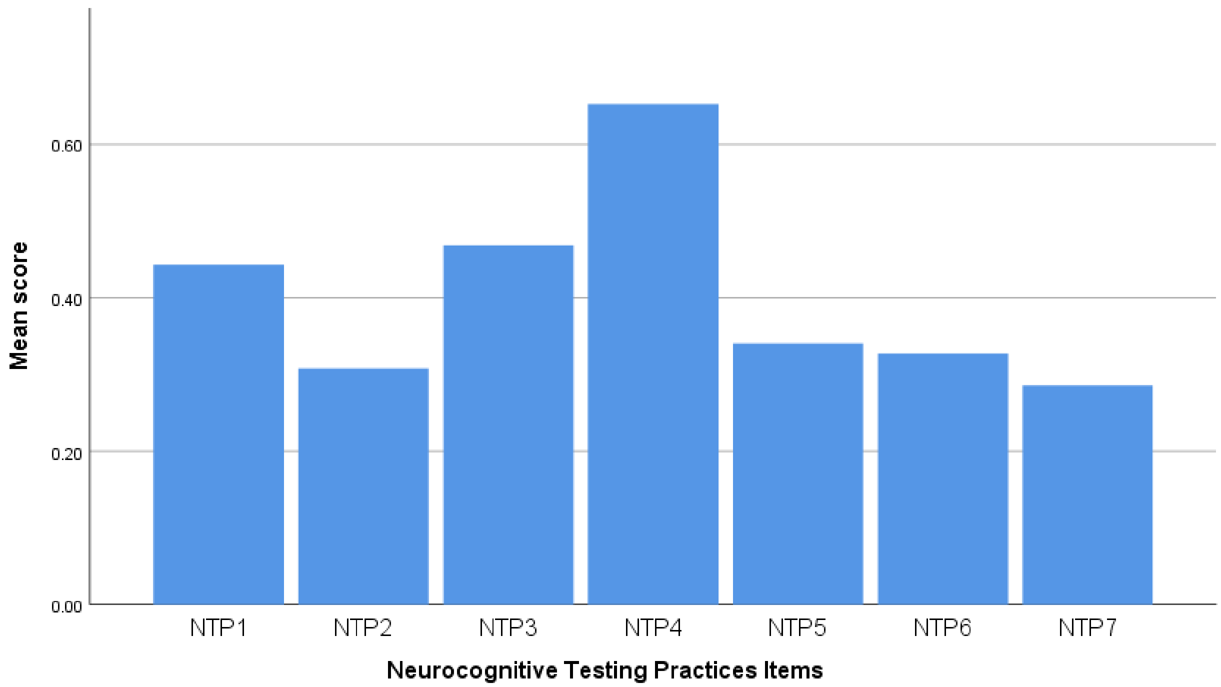

Figure 2. Mean Scores for Consultation Practice Items. Note: NTP1 = How often baseline scores are used (item 7); NTP2 = Neurocognitive tasks performed (item 8); NTP3 = Baseline test environment (item 9); NTP4 = Post-test environment (item 10); NTP5 = Check score validity (item 12); NTP6 = Use z scores (item 13); NTP7 = Use RC index (item 14).

Gradual RTP protocol practices. Once an athlete is asymptomatic and their neurocognitive scores return to baseline, nearly all participants (90%) implemented a standard exertion protocol as part of their RTP practice. A majority of the respondents (86.3%) followed the Zurich protocol, while the rest (8.5%) implemented an institution-specific exertion protocol. As part of the physical stepwise progression, a third of the participants (31.2%) administered a neurocognitive test after exertion. Participants were asked at what stage during the physical stepwise progression, they administered a neurocognitive test after exertion: 42.9% endorsed *stage 2*; 22.4% endorsed *stage 3*; 18.4% endorsed *stage 4*; and 16.3% endorsed *stage 5*. Prior to administering a neurocognitive test, the duration of exertion participants implemented were: 20 minutes (40.3%); 15 minutes (20.9%); 10 minutes (11.9%); 5 minutes (1.5%); and “other” responses (25%). Some of the “other” responses were “varies by sport” and “after full practice.”

When an athlete report symptoms during the exertion protocol, 85.7% of participants returned the athlete to the previous exertion step. When the athlete is symptomatic, participants were asked how long they waited before allowing the athlete to resume exertion: 53% reported “24 hours”; 25.6% reported “24 hours and symptom free”; 11.1% reported “until symptom free”; and 10.2% reported “depends on severity and frequency of symptoms.” Participants were asked how long they waited after exertion to administer a neurocognitive test: 29.3% reported “5–15 minutes”; 22.0% reported they “do no administer”; 7.3% reported “immediately”; 7.3% reported “within a few hours”; 12.2% reported “24 hours”; 2% reported “same day”; 19.5% reported “other.” Some of the “other” responses were “as directed by physician,” “after step 4,” and “enough time for athlete to return to their resting heart rate.”

For those who implement an exertion test, participants endorsed implementing the following exercises: 89.8% *stationary bike*; 43.9% *walking on treadmill*; and 36.4% *elliptical*. Nearly all participants (93%) assessed the athlete for symptoms before having them perform a computerized neurocognitive test. The majority of participants (87%) reported they performed a symptom check immediately after physical exertion. When asked if they would re-administer a neurocognitive test if the athlete’s scores had not returned to baseline, 64% responded *yes*. See Figure 3 for participants’ gradual RTP protocol practice.

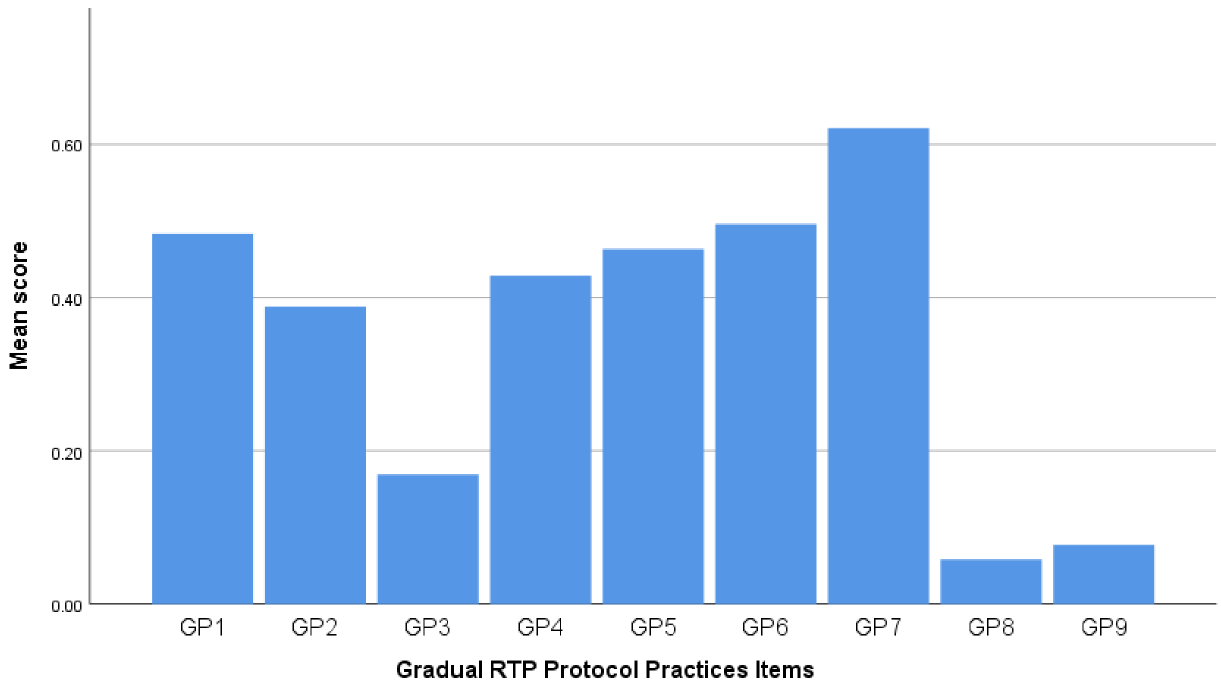

Figure 3. Mean Scores for Gradual RTP Protocol Practice Items. Note: GP1 = Implement standard exertion (item 18); GP2 = Implement Zurich protocol (item 19); GP3 = Neurocognitive test after exertion (item 20); GP4 = Return to Previous Step after exertion (item 25); GP5 = Assess symptoms before testing (item 28); GP6 = Test again if post-exertion neurocognitive testing does not return to baseline (item 29); GP7 = Check symptoms after physical exertion (item 30); GP8 = Return asymptomatic but neurocognitive scores worse than baseline (item 32); GP9 = Return symptomatic if neurocognitive scores back to baseline (item 33).

Consultation practices. When asked if participants seek consultation to make the return to play decision, 95% of participants answered “yes.” A vast majority of the participants (80%) endorsed consulting with team physicians. When asked if participants consulted with a neuropsychologist for the interpretation of neurocognitive tests, two third of the participants (69%) responded “no.” Participants followed the recommendations provided by the consultant with the following frequency: 85% “always”; 11% “usually”; 4% “sometimes”; and 1% “rarely.”

Participants sought consultation for the following reasons: 99.2% “prolonged recovery,” followed by 72.5% “history of concussion,” 60.3% “loss consciousness,” 47.1% “identified premorbid risk factors,” and 13.8% “other.” Some “other” responses included: “I always seek consultation from the team physician"; "it's part of the policy for any concussion to meet with consultants"; "a neuropsychologist interprets and renders an opinion on the neurocognitive test on a regular basis;" and "a team physician is part of the entire process regardless of history." See Figure 4 for information on consultation practices.

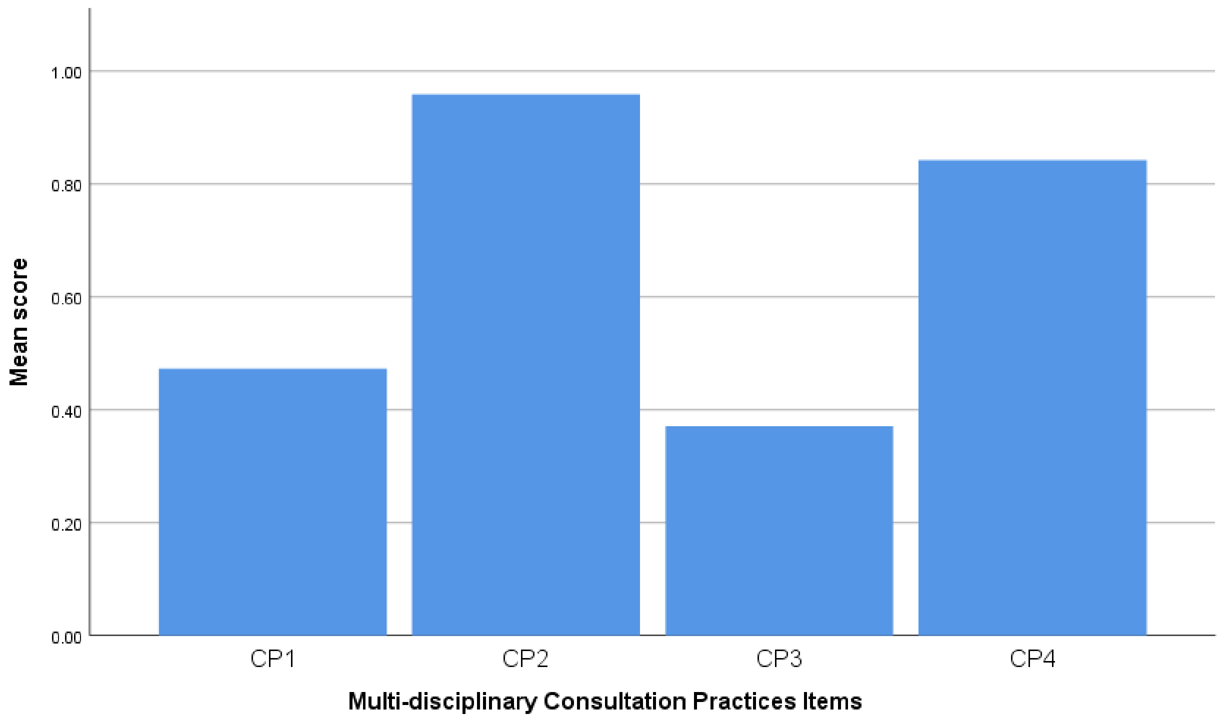

Figure 4. Mean Scores for Consultation Practice Items. Note: CP1= Seek consultation (item 34); CP2 = How often recommendations are followed (item 37); CP3 = Consult neuropsychologist about baseline, post injury or both (item 36); CP4 = Consult neuropsychologists for interpretation of neuro-test (item 35).

Concussion management education and training. More than half of the participants had undergone training in the use of the ImPACT battery (63.6%). When asked the last time they attended a training that addressed concussion management: 27.3% responded *within 2 years*; 32.3% responded *within 6 months*; and 40.4% indicated *within the year*. More than half (59.2%) reported they received education on the topic of concussion management *within 6 months*; 26.4% responded *within the year*; and 14.3% reported *within 2 years*. When asked specifically what venue or forum they last received any information on concussion management, participants endorsed the following practices: attending *conferences* (71.3%); receiving *continuing education credits* (65.6%); having *published journal article* (53.5%); attending *training programs (*25.8%); and attending *webinars* (25.6%). Last, a vast majority (83.7%) agreed that receiving additional education in the area of concussion management would be beneficial to their work, while 11.6% responded *no*, and 4.7% indicated *uncertainty*. See Figure 5 for information on participants' responses on education and training.

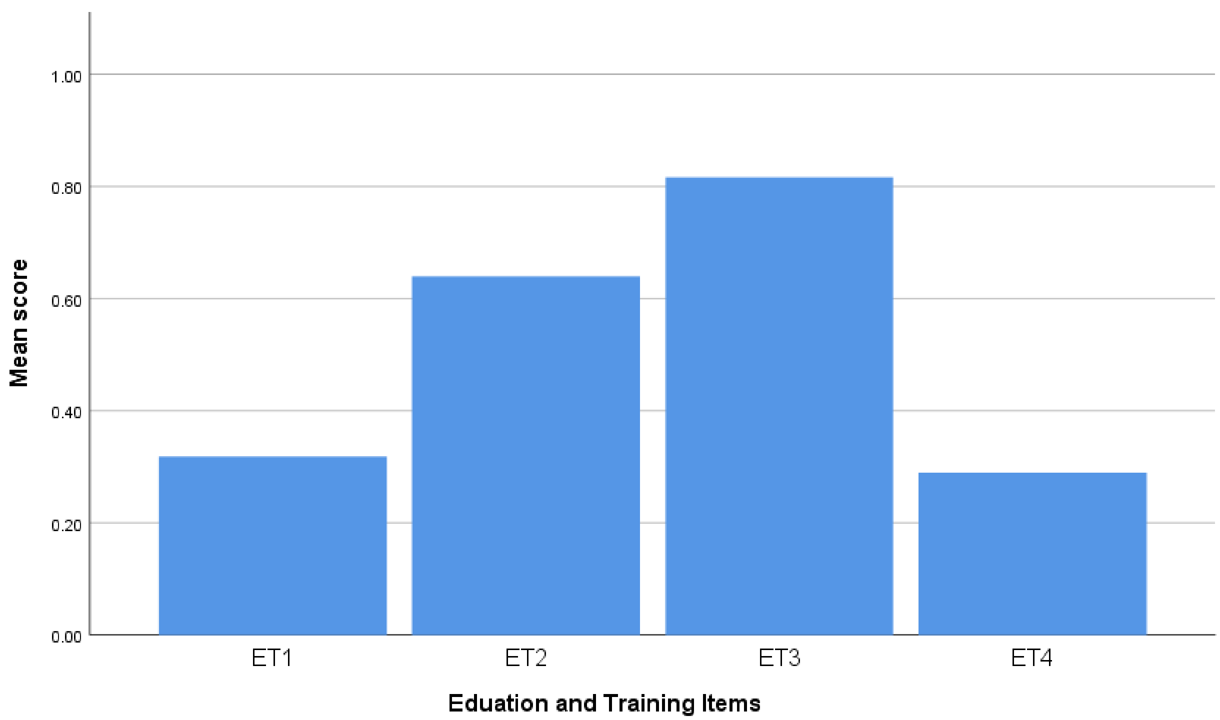

Figure 5. Mean Scores for Education and Training Items. Note: ET1 = ImPACT computerized training (item 39); ET2 = When last training received on concussions (item 40); ET3 = When last education received on concussions (item 41); ET4 = Will additional education on concussion management benefit practice? (item 43).

Gender Difference

An independent sample t-test was conducted to compare gender differences between female respondents consulting with neuropsychologists (item 36; *n* = 70) (*M* = 1.78, *SD* = 0.413) and male respondents consulting with a neuropsychologist (*n* = 58) (*M* = 1.57, *SD* = 0.50);

t(126) = 2.68, *p* = 0.008. Females consulted with neuropsychologists significantly more often than males.

Regional Differences

A one-way ANOVA was conducted to compare four regional locations on the implementation of post-exertion neurocognitive tests (item 21). Given the variability within the scores, the means did not satisfy the criteria for an ANOVA. A corrected model, Robust Test of Equality of Means, was utilized to control for variability in the means. There was a significant difference for location on the implementation of post-exertion neurocognitive tests at the $p < .05$ level for the four locations [$F(3,126) = 4.132$, $p = 0.008$]. Post hoc comparisons using the Bonferroni adjustment method indicated that the mean score for the South (*n* =39)(*M* = 0.5385, *SD* = 0.505) was significantly different from that of the Northeast (*n* = 46)(*M* = .1957, *SD* = .4011). However, the Midwest (*n* = 26)(*M* = 0.3462, *SD* = 0.4852) and the West (*n* =19) (*M* = 0.2632, *SD* = 0.4524) did not significantly differ from the Northeast and South. Taken together, the results suggest that sports medicine professionals practicing within the Southern region of the United States implement post-exertion neurocognitive tests more than those in the Northeast region. See Table 3.

Face Validity Determination

The SMPQ was submitted for a review by a panel of two experts. These experts provided their opinion about whether the items appear to evaluate the relevant dimension they purport to assess. The following questions were asked of the members of the panel regarding the face validity. The reviewers' responses are provided alongside the questions.

Do the items appear to you to evaluate the relevant construct (e.g. return to play practices)? Both reviewers responded "yes."

Can you identify any ambiguous survey items or section in the survey? One reviewer said "No." The second reviewer gave some corrective feedback: "I might rephrase: Do you calculate regression-based z-scores (RBz) to determine reliable change from baseline to post-injury?" "Might be useful to differentiate between computerized cognitive testing and the type of cognitive testing that can be found on the SAC" "I think Question 1 and 2 should contain mostly the same items, but there is divergence between them." "Evidenced-base practice? Is this different than just years practicing in the field?" "This should be more specific. Since these questions are fairly wide-ranging, the concept of "test" is not 100% clear. Not sure if we mean cognitive test or a physical exertion test."

Do some items need to be removed? One reviewer stated, "No." The second reviewer responded, "I don't think so."

Content Validity Determination

The expert panel was asked the following questions pertaining to the content validity of the SMPQ. The panel's responses follow the questions.

Do items provide an adequate evaluation of return to play practices utilized by sports medicine professionals? One reviewer said he believes "the items are an adequate assessment." The second review said, "I think so."

Do items on the SMPQ assess factors that may influence sports medicine professions in determining RTP decisions? One reviewer said, "Based on your literature review, I believe the items do assess relevant factors for RTP." The second reviewer agreed.

Do items on the SMPQ assess utilization and implementation of computerized neurocognitive testing and post-exertion protocols? One reviewer said, "Yes, there are items specific to computerized neurocognitive protocols." The second reviewer agreed.

Do items on the SMPQ quantitatively assess interdisciplinary practices surrounding RTP decisions? One reviewer said, “Yes, but this is not the focus of the survey and I think that is okay.” The second reviewer agreed and responded, “There is a whole section dedicated to multidisciplinary practice.”

One reviewer’s feedback suggested some modification is needed with item content.

Additional Analysis

Revised SMPQ: Internal Consistency Reliability. The SMPQ was constructed to evaluate current self-reported practices that are being implemented by study participants responsible for providing medical clearance to athletes who have suffered a concussion. In order to assure that the 43 items generated were consistently assessing the same construct, RTP practices, correlations between items and correlations between items and the full scale were conducted. The diverse scoring format (Yes/No; Yes/No/Do Not Know; Always/ Sometimes/Never) was seen as a weakness when analyses were performed, raising the conjecture that the SMPQ might have low internal consistency. Diverse types of scoring, it was understood, would prevent sample trends in responses. With the realization that the evaluation survey was designed to elicit individual practices of study participants rather than sample norms, the following question arose: Would the SMPQ, whose 43 items were based on the recent Concussion in Sport Group guidelines, have acceptable internal consistency reliability? The internal consistency test of the SMPQ 43-item full scale showed a very low Cronbach’s alpha, as expected. Subsequently, Cronbach’s alpha test of internal consistency was applied to a select collection of items that appeared most relevant to the study’s questions.

The items were either on a 3-point Likert-type scale ranging from 1 (a little) to 3 (a lot) or a 5-point Likert scale ranging from 1 (never) to 5 (always). Yes (1) and No (0) responses were also applied. The scoring for each item is provided below.

Do you have them fill out a self-report symptom form? Item response options are: yes or no.

After an athlete has completed post-injury cognitive testing and they have successfully returned to play, do you do any of the following: Item response options are: obtain a new baseline before their next season (3); obtain a new baseline if they have been scheduled to take an updated baseline test (2); and use the last test from their completed protocol as their "new baseline" (1).

Of the following options, which one best describes the environment in which your athletes take baseline cognitive tests: Item response options are: office (3); classroom (2); computer in the athletic training room (ATR) (1); computer lab (1).

Of the following options, which one best describes the environment in which your athletes take post-injury cognitive tests: Item response options are: office (3); classroom (2); computer in the ATR (1); computer lab (1).

When you administer baseline cognitive testing, do you check the scores to see if they are valid? Item response options are: yes or no.

Do you use regression-based z-scores to calculate significant change? Item response options are: yes or no.

Do you use the RC index to calculate significant change? Item response options are: yes or no.

After the athlete is asymptomatic and their neurocognitive scores return to baseline, do you implement a standard exertion protocol? Item response options are: yes or no.

As a part of the physical stepwise progression, do you administer a neurocognitive test after exertion? Item response options are: yes or no.

Do you assess the athlete for symptoms before having them test? Item response options are: yes or no.

After a stage of physical exertion, do you conduct a symptom check immediately after? Item response options are: yes or no.

When do you consult with neuropsychologists for the interpretation of neurocognitive testing? Item responses options are: both baseline and post injury (3); only for baseline (1); only for post-injury (1).

How often do you follow the recommendations provided by the consultant? A 5 point Likert scale is utilized to assess frequency of use, which includes the following: always (5); usually (4); sometimes (3); rarely (2); never (1).

Have you undergone training in the use of ImPACT or other computerized neurocognitive tests? Item response options are: yes or no.

When did you last receive education on the topic of concussion management? Item response options are: within 6 months (3); within the year (2); within 2 years (1).

Would receiving additional education in the area of concussion management be beneficial to your work? Item response options are: yes (3); I don't know (2); no (1).

The revised 16-item SMPQ was found to be reliable at a minimal acceptable level ($\alpha = .70$). Table 4 shows the questions retained in the revised SMPQ along with item-to-full scale Cronbach's alpha.

Summary

The results confirmed the study's research hypotheses that the majority of athletic trainers utilized computerized neurocognitive testing and engaged in consultation practices to confirm readiness to RTP. Significant differences were observed between consultative practices, with the majority of participants seeking consultation with team physicians rather than with neuropsychologists. Nearly one third (n = 40) of participants who implemented an exertion protocol, administered a post-exertional neurocognitive test as part of their practice. Bar graph frequency distribution on select items for each of the five SMPQ subcategories: (a) making the RTP decision, (b) computerized neurocognitive testing, (c) gradual RTP practice protocol, (d) consultation practices, and (e) concussion management education and training, provided further clarity for answers to the research questions and hypotheses. Other percentages on participant responses, not included in bar graphs, were reported in the text. Further analysis identified significant differences between post-exertional neurocognitive implementation between the Northeast and Southern regions. Females were found to consult with neuropsychologists more than their male colleagues. Finally, a 16-item revised scale was created after running internal consistency reliability analysis on the original SMPQ survey.

Discussion

The results of the study confirmed all four hypotheses. Participants reported that they administer neurocognitive testing as part of their RTP protocol. Nearly one-third (n = 40) of participants who implemented an exertion protocol administered a post-exertional neurocognitive test. Overall, 95% of participants engaged in consultation to confirm readiness to RTP. Participants engaged in consultation practices to confirm readiness to RTP with team physicians (80%) rather than with neuropsychologists. Further analysis revealed females consult with neuropsychologists more than their male counterparts. Finally, respondents practicing within the Southern region of the United States implemented post-exertion neurocognitive tests more than those practicing in the Northeast region.

Neurocognitive Testing

At the time of the study, nearly all respondents (89%) endorsed utilizing neurocognitive testing as part of their RTP protocol. Given that the majority of participants utilized neurocognitive testing as a tool in the RTP evaluative process, they are in a position to implement post-exertion testing as part of their gradual RTP protocol. McGrath et al. (2013) shed light on the utility of incorporating neurocognitive testing throughout the gradual exertion protocol to ensure that the athlete is fully recovered prior to clearance. This article could serve as continuing education material for sports medicine professionals and athletic trainers who are engaged in concussion management.

Since the initiation of this study, an updated consensus statement was released by the Concussion in Sport Group [Berlin 2017], which recognized the assessment of cognitive function as an important component in the overall assessment and RTP decision-making process (McCrory et al., 2017). Concussed athletes report diverse physical, cognitive, and emotional symptoms, stemming from the initial injury, throughout the recovery process. Researchers (Bleiberg et al., 2004; Bleiberg & Warden, 2005) have found that in most cases, cognitive recovery largely overlaps with the time course of symptom recovery during the first two weeks after injury. Cognitive recovery may precede or be delayed when compared to physical symptom resolution, suggesting a variable recovery period for concussed athletes (McCrea, Leo, & Nelson, 2003). The Berlin guidelines suggest that post-injury neurocognitive testing may be used to assist with the RTP decision and is typically implemented when an athlete is clinically asymptomatic (McCrory et al., 2017).

Current practice tends to rely favorably on the implementation and integration of cognitive findings post-injury; however, there is a noticeable decline in the utilization of neurocognitive testing after the athlete is "asymptomatic" and initiation of the gradual exertion protocol has occurred. Therefore, given the importance of not making premature RTP decisions following concussion, post-exertion computerized neurocognitive testing as part of the athlete's physical stepwise progression may add significant value to ensuring a safe return to play (McGrath el al., 2013). As symptom reporting remains a very subjective form of assessment, and athletes are notorious for under-endorsing their symptoms (Wallace, Covassin, Nogle, Gould, & Kovan, 2017), objective test data could identify asymptomatic athletes who are continuing to recover from a cognitive perspective.

The sports culture has embraced the socialization of pain and injury. Young (2004) identified ideas such as the "normalization" and "rationalization" of risk, pain, and injury as part of the "sport ethic" or "culture of risk." Many athletes profess that the game and team are more important than their individual health. They often believe that by admitting to having symptoms of a concussion; they will be letting down their coaches, parents, and teammates (Anderson, Pomerantz, Mann, & Gittelman, 2013; Kroshus, Baugh, Daneshvar, & Viswanath, 2013). Anderson et al. (2013) surveyed high school football players and discovered that despite being knowledgeable about the symptoms and dangers of concussions, the majority of players considered it was "ok" to play with a concussion and agreed that they would play through any injury to win a game.

It is important to highlight the significant regional differences between the South and Northeast in the implementation of this practice. In a region, such as the South, where sport involvement is more a worldview rather than a game, implementing computerized neurocognitive testing post-exertion may offer additional objective information about the recovery process. Concussion symptoms, by their nature, are subjective and depend on the awareness, honesty, and willingness of athletes to accurately provide feedback on their physical and mental status. This information may identify those athletes who may minimize their symptoms as an attempt to receive clearance prematurely.

Consultation Practices

While most participants endorsed the use of computerized neurocognitive testing, most did not consult with a neuropsychologist to interpret test data. This is concerning as current consensus statements and position papers (Barth et al., 2003; Lichtenstein, Linnea, & Maerlender, 2017; McCrory et al., 2017) recommend that neurocognitive assessment should be performed by neuropsychologists because they are in the best position to interpret neurocognitive tests by virtue of their training and experience. Moreover, there is a growing body of literature indicating that psychological factors play a significant role in symptom recovery or contribute to the risk of persistent symptoms in some cases, including but not limited to, chronic migraines, anxiety, depression, attention problems and sleep dysfunction (McCrory et al., 2017). Such psychological outcomes suggest that there is room for improvement in consultation practices and integration of neuropsychologists' expertise throughout the RTP evaluative process. Although computerized neurocognitive testing was widely utilized by this sample, it was much less common that a neuropsychologist being involved in the interpretation of evidence.

Interestingly, there was a significant gender difference in consultation practices with neuropsychologists, with females consulting more than their male counterparts. This finding might have been related to the larger number of women participants in the study. While keeping in mind this demographic characteristic of the study sample, consideration is given to differences found in practice patterns between male and female physicians (Tsugawa et al., 2017): female physicians more likely to adhere to clinical guidelines and evidence-based practice; to use more patient-centered communication; and to provide more psychosocial counseling than their male counterparts. Effective communication is essential for receiving appropriate medical care, as it is the primary vehicle for gathering data to inform diagnostic and treatment decisions (Kurtz, Silverman, & Draper, 2005).

Communication skills influence a variety of factors in clinical practice, which has been documented to improve patient understanding, adherence to treatment, and enhanced treatment outcomes (Kurtz et al., 2005). It has been argued that while female physicians offer a more empathetic communication style and spend more time with patients, they also make more referrals compared with male physicians (Rossdale, Kemple, Payne, Calnan, & Greenwood, 2007). One study investigated gender-specific differences in attitude, association, and experiences regarding doctor-patient communications (Löffler-Stastka et al., 2016). Female doctors tended to describe the doctor–patient communication with positive attributes, such as “helpful” and “gentle,” while male physicians described communication the doctor–patient communication as “overbearing” and “robust.” In this research framework on gender differences in the doctor–patient communication process, the study’s finding may suggest that female athletic trainers are more likely to pursue psychological consultation once an injury is recognized (see Hunt, Ford, Harkins, & Wyke, 1999). Regarding pragmatic practice implications, female athletic trainers may employ a holistic and collaborative approach and seek clarification on symptom endorsement (i.e., severity, frequency, occurrence) when compared to their male counterparts. Identifying gender differences in how athletic trainers provide care to concussed athletes could improve the quality of care received by all concussed athletes.

Evidence-based Literature, Consensus Guidelines, and Effects on Practice

The sports medicine field is slowly incorporating a blended approach of neurocognitive and physical exertion protocols. The CISG has consistently provided expert-based approaches and recommendations for the management of sport-related concussions. However, if athletic trainers are neither aware nor follow these guidelines, they are not providing up to date care. This then places the athlete at an increased risk. Thus, from a public health perspective, it was important to look at particular behaviors of those responsible for making the RTP decision, so as to better inform the educational needs of sports medicine professionals and identify potential weaknesses in their practice.

Findings suggest variability in the implementation of the consensus driven guideline. The majority of participants (90%; n = 117) implement an exertion protocol to assess readiness to RTP, where 86.3% (n = 101) follow the CISG gradual exertion protocol. Of those who implement an exertion protocol, 31.2% administer a neurocognitive test after exertion. This finding suggests that an evidence-based literature and approach in making the RTP decision (McGrath et al., 2013) has had an effect on the practice of athletic trainers. However, variability in practice behaviors was observed at the duration and type of exertion implemented, step of physical activity performed, and recovery time, prior to neurocognitive test administration.

Further findings indicate that participants are implementing a multifaceted-multimodal approach in making the RTP decision, as recommended by the Berlin guidelines (McCrory et al., 2017). Multidisciplinary involvement was observed: a vast majority of participants sought consultation with team physicians (80%; *n* = 84). Physician consultation seemed more important than consultation from neuropsychologists. Consultation for the interpretation of a neurocognitive test with neuropsychologists was limited (31.5%; *n* = 41). More than half of participants (63.6%) endorsed receiving training in the use of the ImPACT battery. The Berlin guidelines have recommended that neuropsychologists perform the interpretation of neurocognitive testing because they are in the best position to do such interpretation by virtue of their training and experience (McCrory et al., 2017).

As the field of concussion management research continues to evolve, so does the practice. A vast majority of the participants (83.7%) agreed that receiving additional education in the area of concussion management would be beneficial to their practice. Over half (58.3%) of the participants received education on the topic of concussion management within 6 months, and a quarter (27.6%) attended concussion management training. To ensure that athletes receive the most effective care, it is recommended that those involved in the management of concussed athletes have access to the latest research and clinical findings to influence practice behaviors.

Revised SMPQ Measure

Administration of the original 43-item SMPQ took participants between 30–45 minutes to complete. The current medical climate has gravitated towards the implementation of brief measures that optimize sensitivity and specificity to the identified construct. Development of the revised 16-item SMPQ is a step in the right direction, as time allocation is vital within clinical settings. Administration of the revised SMPQ would have answered three out of the four research questions; yet, only one of four hypotheses would have been answered. Additionally, the knowledge acquired from the original administration of the SMPQ shed light on the idiosyncratic practice patterns of the participants, which will be lost out if the revised SMPQ is administered. Multiple revisions with regard to the scoring system of either the SMPQ or the revised SMPQ are necessary for future applications.

Limitations of the Study

The study had several limitations that need to be taken into account when considering the results. First, the sample was self-selected, which may suggest that those who chose to participate in the study may be more active in concussion management and have experience with recovering athletes. Further, this snapshot of knowledge and practices of sports medicine practitioners was derived from a convenience sample recruited through professional listservs, which limited accessibility and might have captured professionals who are more informed of the Concussion in Sport Group recommendations than others in this field. The sample was ultimately comprised of mainly college/university-based athletic trainers, and therefore, the conclusions that are reached may not be appropriate for others working in the sports medicine other than athletic trainers working within college sports programs. Athletic trainers in many universities or colleges are mandated by their employer (i.e., the university) to seek consultation (J. Lichtenstein, personal communication, July 17, 2018). That is, university-based athletics programs consult with concussion management experts to assist their athletic trainers, and such decisions are made at levels far above that of the individual athletic trainer. Thus, consultation rates might be lower for non-university based sports medicine practitioners as well as athletic trainers who are not mandated to consult.

A number of problems were observed regarding the study's survey, SMPQ. The identified construct of the SMPQ was RTP practices. This overarching construct encompassed multiple topics: neurocognitive testing, gradual RTP decisions, and consultation practices.

During the construction of the survey, all items aligned with the conceptual framework of the study and were centered on the current published guidelines and recommendations. The majority of items were dichotomous in wording and close-ended in meaning, which restricted range of scores. The survey may be likened to a poll, but that should not limit the meaning of its results. Descriptive statistics and frequencies were provided, to capture the prevalence of practitioner utilization of best practices in sports concussion management, such as neurocognitive testing and consultation with neuropsychologists. The study's descriptive statistics may set a basic frame for more complex investigations in the future, such as exploring perceived challenges participants may face when implementing recommended concussion guidelines.

In order to assure that the SMPQ consistently evaluated the same construct, RTP practices, correlations between selected items and correlations between these selected items and the full scale were conducted. It was expected that numerous items would have low as well as negative correlations. Thus items were removed, which decreased the original survey from 43 items to 16 items. Cronbach's alpha test of internal consistency was chosen for the reliability test. A minimal acceptable level of internal consistency was achieved, Cronbach $\alpha = .70$. The straightforward contents of the SMPQ allowed participants to respond openly about their practice patterns. There was a high response rate within a short period of two weeks. However, for future possible use, as a stand-alone evaluation tool, the SMPQ requires considerable refinement with regard to its defining construct and scoring system.

A final limitation consisted of the close-ended questions that were asked of experts regarding the content and face validities of the SMPQ; these questions were similar to the dichotomous answer format (Yes/No) of many SMPQ items. Open-ended focus-group/ qualitative questions beginning with "how," "what," "what if," "describe," "explain more," and "give some examples" might have tapped into the knowledge and experience of the experts, and their critical review could have generated rich text themes and subthemes. The results section mostly reported expert responses verbatim, and these responses on content and face validity have not been used to evaluate the SMPQ.

Future Directions in Research

The current study was conducted toward gaining understanding of the current practices implemented by athletic trainers in returning athletes to play following concussion. Future research could examine perceived and actual challenges athletic trainers face regarding seeking consultation from neuropsychologists. Exploring how athletic trainers incorporate recommendations from neuropsychologists in making the RTP decision warrants investigation. Furthermore, identifying differences in how male and female athletic trainers practice and seek consultation, could lead to improved care across the field.

As the incidence of sports-related concussions continue to increase every year (CDC, 2016), there is a need to educate coaches, athletes, and professionals on advancing their knowledge of concussion symptoms and proper concussion management. A 2011 study found that concussions accounted for nearly 15% of all sports-related injuries in high school athletes (Meehan, d'Hemecourt, Collins, & Comstock, 2011). The most common reason for variations in management of concussions is lack of awareness of and confusion about the published guidelines for concussion care. Education about available resources will be important to help inform the field and ensure the safe clearance for injured athletes. Therefore, the dissemination and availability of current literature and training resources warrant evaluation.

Some disparities in practice observed in this study raise questions regarding the knowledge base of the study's sample. The disparities were administration of post-exertional neurocognitive testing throughout the gradual RTP protocol and consultation with a neuropsychologist to confirm RTP. The majority of participants are employed at a college/university setting. The discrepancies could be attributed to a university-established protocol rather than an individual practice. In addition, identifying the resources that are available to sports medicine professionals would be valuable. It is expected that resources available to NCAA Division I, II, and III universities may differ from those available at less competitive colleges. This could include access to neuropsychologists and continuing education pertaining to changes in practice guidelines.

Historically, most concussions were not considered serious. The sports culture has embraced the socialization of pain and injury. In recent years, significant ramifications for repeated concussions and poor management have been identified (McClincy, et al., 2006; McCrory et al., 2017; McKee et al., 2009). The recent expansion in concussion literature over the past decade has resulted in a cultural shift in the awareness and treatment of concussions (McCrory et al., 2017). Perhaps the most challenging aspect of managing sport-related concussion is recognizing the injury, especially in situations where no obvious concussion signs are present. Athletic trainers are on the front line for concussion treatment. The average number of years of experience in athletic training for the study's sample was 10.5 years. The participants have been in the field for a long time. It would be important to evaluate how the athletic training curriculum has evolved to incorporate the advancements in concussion management. In addition, certified athletic trainers must submit continuing education units for recertification on a yearly basis. It would be interesting to see if any of these hours are mandated towards the recognition and treatment of concussions. Last, determining whether athletic trainers' years of experience have an effect on practice behaviors warrants future investigation.

Conclusion

The study used an online survey to investigate the self-reported practices of sports medicine professionals managing the recovery of concussed athletes. Participants completed a demographic section before answering an author-created survey, the SMPQ. The SMPQ evaluated the use of RTP guidelines and consultation by sports medicine professionals. The SMPQ also assessed the use of ImPACT computerized neurocognitive testing, physical exertion, and self-reporting practice scenarios.

The results of the study confirmed all four hypotheses. Participants reported that they utilize computerized neurocognitive testing as part of their RTP protocol. Nearly one-third ($n = 40$) of participants who implemented an exertion protocol administered a post-exertional neurocognitive test. Overall, 95% of participants engaged in consultation to confirm readiness to RTP. Participants engaged in consultation practices to confirm readiness to RTP with team physicians rather than with neuropsychologists. Further analysis revealed gender specific consultation practices with neuropsychologists and regional differences regarding implementation of neurocognitive testing post-exertion. This was an exploratory study, which yielded a revised, brief 16-item SMPQ measure, which was found to be reliable at a minimal acceptable level, Cronbach $\alpha = .70$.

References

Alla, S., Sullivan, S. J., & McCrory, P. (2012). Defining asymptomatic status following sports concussion: Fact or fallacy? *British Journal of Sports Medicine*, *46*(8), 562–569. doi:10.1136/bjsm.2010.081299

American Educational Research Association., American Psychological Association., National Council on Measurement in Education., & Joint Committee on Standards for Educational and Psychological Testing (U.S.). (2014). *Standards for educational and psychological testing*.

Anastasi, A., & Urbina, S. (1997). *Psychological testing* (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Anderson, B. L., Pomerantz, W. J., Mann, J. K., & Gittelman, M. A. (2013). I can't miss the big game": High school (HS) Football Players' Knowledge and Attitudes about Concussions. In *Pediatric Academic Societies Annual Meeting, (*May, Vol. 6). Washington, DC.

Aubry, M., Cantu, R., Dvorak, J., Graf-Baumann, T., Johnston, K., Kelly, J., Lovell, M., McCrory, P., Meeuwisse, W., & Schamasch, P. (2002). Summary and agreement statement of the first International Conference on Concussion in Sport, Vienna 2001. *British Journal of Sports Medicine*, *36*(1), 6–10. doi:10.1136/bjsm.36.1.6

Barth, J. T., Pliskin, N., Axelrod, B., Faust, D., Fisher, J., Harley, J. P., . . . & Silver, C. (2003). Introduction to the NAN 2001 definition of a clinical neuropsychologist: NAN policy and planning committee. *Archives of Clinical Neuropsychology*, *18*(5), 551–555. doi:10.1093/arclin/18.5.551

Bleiberg, J., Cernich, A. N., Cameron, K., Sun, W., Peck, K., Ecklund, J., . . . & Warden, D. L. (2004). Duration of cognitive impairment after sports concussion. *Neurosurgery*, *54*(5), 1073–1080 doi:10.1227/01.NEU.0000118820.33396.6A

Bleiberg, J. & Warden, D. (2005). Duration of cognitive impairment after sports concussion. *Neurosurgery, 56*(5), E1166.

Broglio, S. P., Macciocchi, S. N., & Ferrara, M. S. (2007). Sensitivity of the concussion assessment battery. *Neurosurgery, 60*(6), 1050–1058. doi:10.1227/01.NEU.0000255479.90999.C0

Center for Disease Control and Prevention. (2016). *Injury prevention & control: Traumatic brain injury & concussion*. http://www.cdc.gov/traumaticbraininjury/symptoms.html (accessed September 13, 2016).

Collins, M. W., Lovell, M. R., & Mckeag, D. B. (1999). Current issues in managing sports-related concussion. *Jama*, *282*(24), 2283-2285. doi:10.1001/jama.282.24.2283

Covassin, T., Elbin III, R. J., Stiller-Ostrowski, J. L., & Kontos, A. P. (2009). Immediate post-concussion assessment and cognitive testing (ImPACT) practices of sports medicine professionals. *Journal of Athletic Training*, *44*(6), 639–644. doi:10.4085/1062-6050-44.6.639

Echemendia, R. J., Giza, C. C., & Kutcher, J. S. (2015). Developing guidelines for return to play: Consensus and evidence-based approaches. *Brain Injury*, *29*(2), 185–194. doi:10.3109/02699052.2014.965212

Echemendia, R. J., Iverson, G. L., McCrea, M., Macciocchi, S. N., Gioia, G. A., Putukian, M., & Comper, P. (2013). Advances in neuropsychological assessment of sport-related concussion. *British Journal of Sports Medicine*, *47*(5), 294–298. doi:10.1136/bjsports-2013-092186

Elbin, R. J., Covassin, T., Gallion, C., & Kontos, A. P. (2015). Factors influencing risk and recovery from sport-related concussion: Reviewing the evidence. *SIG 2 Perspectives on Neurophysiology and Neurogenic Speech and Language Disorders*, *25*(1), 4–16. doi:10.1044/nnsld25.1.4

Elbin, R. J., Schatz, P., & Covassin, T. (2011). One-year test-retest reliability of the online version of ImPACT in high school athletes. *The American Journal of Sports Medicine*, *39*(11), 2319–2324. doi:10.1177/0363546511417173

Ferrara, M. S., McCrea, M., Peterson, C. L., & Guskiewicz, K. M. (2001). A survey of practice patterns in concussion assessment and management. *Journal of Athletic Training*, *36*(2), 145–149.

Giza, C. C., & Hovda, D. A. (2014). The new neurometabolic cascade of concussion. *Neurosurgery*, *75*(suppl_4), S24-S33.

Gómez, J. E., & Hergenroeder, A. C. (2013). New guidelines for management of concussion in sport: Special concern for youth. *Journal of Adolescent Health*, *53*(3), 311–313. doi:10.1016/j.jadohealth.2013.06.018

Harmon, K. G., Drezner, J. A., Gammons, M., Guskiewicz, K. M., Halstead, M., Herring, S. A., & Roberts, W. O. (2013). American Medical Society for Sports Medicine position statement: Concussion in sport. *British Journal of Sports Medicine*, *47*(1), 15–26. doi:10.1136/bjsports-2012-091941

Hunt, K., Ford, G., Harkins, L., & Wyke, S. (1999). Are women more ready to consult than men? Gender differences in family practitioner consultation for common chronic conditions. *Journal of Health Services Research & Policy*, *4*(2), 96–100. doi:10.1177/135581969900400207

Iverson, G. L., Lovell, M. R., & Collins, M. W. (2003). Interpreting change on ImPACT following sport concussion. *The Clinical Neuropsychologist*, *17*(4), 460–467. doi:10.1076/clin.17.4.460.27934

Iverson, G. L., Lovell, M. R., & Collins, M. W. (2005). Validity of ImPACT for measuring processing speed following sports-related concussion. *Journal of Clinical and Experimental Neuropsychology*, *27*(6), 683–689.

Kinnaman, K. A., Mannix, R. C., Comstock, R. D., & Meehan, W. P. (2013). Management strategies and medication use for treating pediatric patients with concussions. *Acta Paediatrica*, *102*(9), e424–e428. doi:10.1111/apa.12315

Kroshus, E., Baugh, C. M., Daneshvar, D. H., & Viswanath, K. (2014). Understanding concussion reporting using a model based on the theory of planned behavior. *Journal of Adolescent Health*, *54*(3), 269–274. doi: 10.1016/j.jadohealth.2013.11.011.

Kurtz, S., Silverman, J., & Draper, J. (2005). Simulated patients. *Teaching and learning communication skills in medicine*. Oxfordshire: Radcliffe Publishing.

Lambourne, K. & Tomporowski, P. (2010). The effect of exercise-induced arousal on cognitive task performance: A meta-regression analysis. *Brain Research*, *1341*, 12–24. doi:10.1016/j.brainres.2010.03.091

Langlois, J. A., Rutland-Brown, W., & Wald, M. M. (2006). The epidemiology and impact of traumatic brain injury: A brief overview. *The Journal of Head Trauma Rehabilitation*, *21*(5), 375–378. doi:10.1097/00001199-200609000-00001

Lichtenstein, J. D., Linnea, K. S., & Maerlender, A. C. (2017). Patterns of referral in high school concussion management programs: A pilot study of consultants from different disciplines. *Applied Neuropsychology: Child*, 1-8. doi:10.1080/21622965.2017.1340158

Littleton, A., & Guskiewicz, K. (2013). Current concepts in sport concussion management: A multifaceted approach. *Journal of Sport and Health Science*, *2*(4), 227–235. doi:10.1016/j.jshs.2013.04.003

Löffler-Stastka, H., Seitz, T., Billeth, S., Pastner, B., Preusche, I., & Seidman, C. (2016). Significance of gender in the attitude towards doctor–patient communication in medical students and physicians. *Wiener klinische Wochenschrift*, *128*(17-18), 663–668. doi:10.1007/s00508-016-1054-1

Lovell, M. (2004). *ImPACT version 2.0 clinical user's manual*. February, 8, 2005.

Lovell, M. (2009). The management of sports-related concussion: Current status and future trends. *Clinics in Sports Medicine*, *28*(1), 95–111. doi:10.1016/j.csm.2008.08.008

Lovell, M. R., & Collins, M. W. (1998). Neuropsychological assessment of the college football player. *The Journal of Head Trauma Rehabilitation*, *13*(2), 9–26. doi:10.1097/00001199-199804000-00004

Macciocchi, S. N., Barth, J. T., Alves, W., Rimel, R. W., & Jane, J. A. (1996). Neuropsychological functioning and recovery after mild head injury in collegiate athletes. *Neurosurgery*, *39*(3), 510–514. doi:10.1227/00006123-199609000-00014

Maddocks, D., & Saling, M. (1996). Neuropsychological deficits following concussion. *Brain Injury*, *10*(2), 99–104. doi:10.1080/026990596124584

McCrea, M., Guskiewicz, K. M., Marshall, S. W., Barr, W., Randolph, C., Cantu, R. C., . . . & Kelly, J. P. (2003). Acute effects and recovery time following concussion in collegiate football players: The NCAA Concussion Study. *JAMA*, *290*(19), 2556–2563. doi:10.1001/jama.290.19.2556

McCrea, M., Leo, P. D., & Nelson, L. D. (2014). Neuropsychological effects of sport-related concussion. *Neuropsychology: A Review of Science and Practice*, *2*, 138.

McCrory, P., Davis, G., & Makdissi, M. (2012). Second impact syndrome or cerebral swelling after sporting head injury. *Current Sports Medicine Reports*, *11*(1), 21–23. doi:10.1249/JSR.0b013e3182423bfd

McCrory, P., Johnston, K., Meeuwisse, W., Aubry, M., Cantu, R., Dvorak, J., Graf-Baumann, T., Kelly, J., Lovell, M., & Schamasch, P. (2005). Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. *British Journal of Sports Medicine*, *39*(4), 196–204. doi:10.1136/bjsm.2005.018614

McCrory, P., Meeuwisse, W. H., Aubry, M., Cantu, B., Dvořák, J., Echemendia, R. J., Engebretsen, L., Johnston, K., Kutcher, J.S., Raftery, M., & Sills, A. (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*(5), 250–258. doi:10.1136/bjsports-2013-092313

McCrory, P., Meeuwisse, W., Dvorak, J., Aubry, M., Bailes, J., Broglio, S., Cantu, R.C., Cassidy, D., Echemendia, R.J., Castellani, R.J., & Davis, G. A. (2017). Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016. *Br J Sports Med*, bjsports-2017. doi:10.1136/bjsports-2017-097699

McCrory, P., Meeuwisse, W., Johnston, K., Dvorak, J., Aubry, M., Molloy, M., & Cantu, R. (2009). Consensus statement on concussion in sport: The 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *British Journal of Sports Medicine*, *43*(Suppl 1), i76 –i84. doi:10.1136/bjsm.2009.058248

McClincy, M. P., Lovell, M. R., Pardini, J., Collins, M. W., & Spore, M. K. (2006). Recovery from sports concussion in high school and collegiate athletes. *Brain Injury*, *20*(1), 33–39. doi:10.1080/02699050500309817

McGrath, N., Dinn, W. M., Collins, M. W., Lovell, M. R., Elbin, R. J., & Kontos, A. P. (2013). Post-exertion neurocognitive test failure among student-athletes following concussion. *Brain Injury*, *27*(1), 103–113. doi:10.3109/02699052.2012.729282

McKee, A. C., Cantu, R. C., Nowinski, C. J., Hedley-Whyte, E. T., Gavett, B. E., Budson, A. E., & Stern, R. A. (2009). Chronic traumatic encephalopathy in athletes: Progressive tauopathy after repetitive head injury. *Journal of Neuropathology & Experimental Neurology*, *68*(7), 709–735. doi:10.1097/NEN.0b013e3181a9d503

McKee, A. C., Cairns, N. J., Dickson, D. W., Folkerth, R. D., Keene, C. D., Litvan, I., . . . & Gordon, W.A. (2016). The first NINDS/NIBIB consensus meeting to define neuropathological criteria for the diagnosis of chronic traumatic encephalopathy. *Acta Neuropathologica*, *131*(1), 75–86. doi:10.1007/s00401-015-1515-z

McLendon, L. A., Kralik, S. F., Grayson, P. A., & Golomb, M. R. (2016). The controversial second impact syndrome: A review of the literature. *Pediatric Neurology*, *62*, 9–17. doi:10.1016/j.pediatrneurol.2016.03.009

Meehan III, W. P., d'Hemecourt, P., Collins, C. L., & Comstock, R. D. (2011). Assessment and management of sport-related concussions in United States high schools. *The American Journal of Sports Medicine*, *39*(11), 2304–2310. doi:10.1177/0363546511423503

Meehan, W. P., d'Hemecourt, P., Collins, C. L., Taylor, A. M., & Comstock, R. D. (2012). Computerized neurocognitive testing for the management of sport-related concussions. *Pediatrics*, *129*(1), 38–44. doi:10.1542/peds.2011-1972

Moser, R. S., Iverson, G. L., Echemendia, R. J., Lovell, M. R., Schatz, P., Webbe, F. M., & Bush, S. S. (2007). Neuropsychological evaluation in the diagnosis and management of sports-related concussion. *Archives of Clinical Neuropsychology*, *22*(8), 909–916. doi:10.1016/j.acn.2007.09.004

Notebaert, A. J., & Guskiewicz, K. M. (2005). Current trends in athletic training practice for concussion assessment and management. *Journal of Athletic Training*, *40*(4), 320–325.

Rossdale, M., Kemple, T., Payne, S., Calnan, M., & Greenwood, R. (2007). An observational study of variation in GPs' out-of-hours emergency referrals. *Br J Gen Pract*, *57*(535), 152–154.

Schatz, P. (2010). Long-term test-retest reliability of baseline cognitive assessments using ImPACT. *The American Journal of Sports Medicine*, *38*(1), 47–53. doi:10.1177/0363546509343805

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*, 2(1), 91–99. doi:10.1016/j.acn.2005.08.001

Schatz, P., & Sandel, N. (2013). Sensitivity and specificity of the online version of ImPACT in high school and collegiate athletes. *The American Journal of Sports Medicine*, *41*(2), 321–326. doi:10.1177/0363546512466038

Stache, S., Howell, D., & Meehan III, W. P. (2016). Concussion management practice patterns among sports medicine physicians. *Clinical Journal of Sport Medicine*. 26(5), 381–385. doi:10.1097/JSM.0000000000000270

Thunnan, D. J., Branche, C. M., & Sniezek, J. E. (1998). The epidemiology of sports-related traumatic brain injuries in the United States: Recent developments. *The Journal of Head Trauma Rehabilitation*, *13*(2), 1–8. doi:10.1097/00001199-199804000-00003

Tsugawa, Y., Jena, A. B., Figueroa, J. F., Orav, E. J., Blumenthal, D. M., & Jha, A. K. (2017). Comparison of hospital mortality and readmission rates for Medicare patients treated by male vs female physicians. *JAMA Internal Medicine*, *177*(2), 206–213. doi:10.1001/jamainternmed.2016.7875

Wallace, J., Covassin, T., Nogle, S., Gould, D., & Kovan, J. (2017). Knowledge of concussion and reporting behaviors in high school athletes with or without access to an athletic trainer. *Journal of Athletic Training*, *52*(3), 228–235. doi:10.4085/1062-6050-52.1.07

Williams, R. M., Welch, C. E., Weber, M. L., Parsons, J. T., & McLeod, T. C. V. (2014). Athletic trainers' management practices and referral patterns for adolescent athletes after sport-related concussion. *Sports Health: A Multidisciplinary Approach*, *6*(5), 434–439. doi:10.1177/1941738114545612

Young, K. (2004). Sports-related pain and injury: Sociological notes. In K.Young (Ed.), Sporting bodies, damaged selves: Sociological studies of sports related injuries. Oxford: Elsevier.

Zemek, R., Eady, K., Moreau, K., Farion, K. J., Solomon, B., Weiser, M., & Dematteo, C. (2014). Knowledge of pediatric concussion among front-line primary care providers. *Pediatrics & Child Health*, *19*(9), 475–480. doi:10.1093/pch/19.9.475

Table 1

Participant Demographics (n=141)

	n	%
Name of Discipline		
Athletic Training	129	91.5
Other	5	3.5
Sports/Rehabilitation Medicine	2	1.4
Family Medicine	2	1.4
Psychology	2	1.4
Neurology	1	0.7
Educational Degree		
BS	7	5.0
MS	82	58.2
MEd	30	21.3
Other	10	7.1
MD	5	3.5
PhD	5	3.5
EdD	1	0.7
DPT	1	0.7
Employment Setting		
College/University	138	97.9
Medical Center	4	2.8
High School	3	2.1
Other	2	1.4
Private Clinic	1	0.7
Years of Practice		
0-5 years	43	30.5
6-10 years	44	31.2
11-15 years	18	12.8
16-20 years	19	13.5
21+ years	17	12.1
Gender		
Female	76	53.9
Male	63	44.7
Prefer not to say	2	1.4
Location of Practice		
Northeast	49	34.8
South	44	31.2
West	18	12.8
Midwest	29	20.6
Location unclear	1	0.7

Note. Participants were allowed to select multiple employment settings; therefore, total responses may exceed 100%.

Table 2

Results of Paired Sample t-test for Consultation Practices

	Consult Physician		Consult Neuropsych			95% CI for Mean Difference		
Outcome	M	SD	M	SD	*n*		t	df
	.800	.402	.295	.458	150	.379, .631	7.93***	104

*** p = .0001.

Table 3

Post-Exertional Neurocognitive Implementation by Location

Source	*df*	*SS*	*MS*	*F*	*p*
Between Groups	3	2.607	.869	4.132	.008
Within Groups	126	26.500	.210		
Total	129	29.108			

Note. Northeast (*n* = 46), South (*n* = 39), Midwest (*n* = 26), West (*n* = 19)

Table 4

Item-to-Full Scale Reliability for Revised SMPQ

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1. Do you have them fill out a self-report symptom form?	23.4107	21.192	.260	.680
Q2. After an athlete has completed post-injury cognitive testing and they have successfully returned to play, do you do any of the following:	22.9643	19.453	.306	.673
Q3. Of the following options, which one best describes the environment in which your athletes take baseline cognitive tests:	21.7143	14.790	.519	.641
Q4.Of the following options, which one best describes the environment in which your athletes take post-injury cognitive tests:	20.8929	16.788	.513	.638
Q5. When you administer baseline cognitive testing, do you check the scores to see if they are valid?	23.0893	21.210	.312	.677
Q6. Do you use regression-based z-scores to calculate significant change?	23.2500	17.282	.516	.638
Q7. Do you use the RC index to calculate significant change?	23.3393	17.719	.501	.642
Q8. After the athlete is asymptomatic and their neurocognitive scores return back to baseline, do you implement a standard exertion protocol?	23.1964	22.052	.194	.687

Q9. As a part of the physical stepwise progression, do you administer a neurocognitive test after exertion?	23.6964	21.597	.124	.690
Q10. Do you assess the athlete for symptoms before having them test?	23.2679	21.800	.182	.686
Q11. After a stage of physical exertion, do you conduct a symptom check immediately after?	22.2857	21.553	.204	.684
Q12. When do you consult with neuropsychologists for the interpretation of neurocognitive testing?	22.6786	21.168	.217	.682
Q13. How often do you follow the recommendations provided by the consultant?	19.3929	21.188	.144	.690
Q14. Have you undergone training in the use of ImPACT or other computerized neurocognitive tests?	23.5536	21.124	.234	.681
Q15. When did you last receive education on the topic of concussion management?	21.5893	20.683	.205	.684
Q16. Would receiving additional education in the area of concussion management be beneficial to your work?	24.0893	22.337	.010	.694

Appendix A

Recruitment Statement

Hello! My name is Courtney Condiracci and I am inviting sports medicine professionals to participate in a brief survey as part of my doctoral dissertation research. This anonymous survey will require that you answer a series of questions online, which is expected to take you between 20 to 30 minutes. In order to thank you for your time, you will have the opportunity to enter a raffle for one of two $50 gift cards to Amazon.com. To participate in this survey and/or for more information on the purpose of this study, your role, risks and benefits, and how your responses will be used, and who to contact with concerns, please visit my research site:

[Insert hyperlink here]

Thank you! Your consideration is greatly appreciated.

Courtney Condiracci, M.S.
Doctoral Candidate
40 Avon Street, Keene, NH 03431

Appendix B

Informed Consent Form

My name is Courtney Condiracci and I am a doctoral candidate in the Department of Clinical Psychology at Antioch University New England, Keene, NH. I work with concussed athletes, and so I am interested in doing a research study with sports medicine professionals. If you currently work with concussed athletes and are involved in their recovery and clearance, I am inviting you to participate in my study. Please read the following form, that explains the purpose of the study, your role and rights as a participant, foreseeable risks and benefits, and how the information you provided will be used.

Purpose of the Study

The purpose of my study is to understand the current return to play practices utilized by sports medicine professionals in returning athletes to play who have been diagnosed with a concussion. Additionally, the study seeks to investigate the multidisciplinary consultation practices between sports medicine professionals.

Your Role

Once you provide your consent, you will be taken to a survey and asked a series of questions. Your responses are expected to take between 20 to 30 minutes. Please know that your participation in the study is voluntary and you may discontinue at any point. Although I encourage you to respond to all items, you have the right to skip any question you do not wish to answer. You will not be penalized in any way for discontinuing the survey or choosing not to answer a question. Upon completion of the survey, you will be provided with directions and an email address. Please send an email to this address in order to be entered in a randomly selected drawing for one of two $50 gift certificates to Amazon.com. To protect your anonymity, your email address will be kept separate from your survey answers.

Risks and Benefits

Your participation involves minimal risk to you. It is not anticipated that the survey will cause you stress. Your privacy will be respected; you are not be asked to provide your name or contact information on the survey and your IP address will not be collected. Your participation is voluntary and you may stop at any time you like and you will not be penalized for that. Your participation in my study will help to increase understanding about the current return to play practices of sports medicine professionals. You may be motivated to complete the survey because you have been told that your input will contribute to future training and knowledge of sports medicine professionals as well as potentially influence practice guidelines.

How Information Will be Stored and Used

Under no circumstance will you be identified by name in the course of this study or in any publication thereof. Every effort will be made that all information provided will be treated as strictly confidential. All data will be numerically coded and securely stored. Anonymous and average group findings will be reported for professional purposes only. The study is to be submitted in partial fulfillment of requirements for the degree of Doctor of Psychology at Antioch University New England, Keene, New Hampshire. The results of the study will be reported in my dissertation. In addition, information may be used for educational purposes through professional presentation(s) and/or publication(s).

An email address for the gift card drawing has been established for this survey and is only accessible by me. Furthermore, your responses will not be associated with your email address in any way. Please feel free to respond as openly and honestly as possible. Once the survey is discontinued, the data will be analyzed and reported. You may contact me with questions regarding this survey at: ccondiracci@antioch.edu.

If you have any questions or concerns about your rights as a research participant, please contact: Dr. Kevin Lyness, Chair of IRB at Antioch University New England, klyness@antioch.edu, (603) 283-2149, or Dr. Melinda Treadwell, Provost, Antioch University New England, mtreadwell@antioch.edu, (603)-283-2444.
Thank you! Your participation in my survey is greatly appreciated.

By checking the box below, you agree that you have read and understood the above information and willingly and freely consent to participation in the study.

□ I consent to participation in this study.

Appendix C

Sports Medicine Practice Questionnaire Survey Questions

Demographic Section:

1. Education/Name of Discipline
    a. Psychology
    b. Internal Medicine
    c. Sports/Rehabilitation Medicine
    d. Athletic Training
    e. Psychiatry
    f. Neurology
    g. Physical Therapy
    h. Family Medicine
    i. Other Please, explain: ___________________________

2. Highest Level of Education
    a. BA
    b. BS
    c. MS
    d. MEd
    e. PhD
    f. PsyD
    g. MD
    h. DO
    i. DPT
    j. EdD
    k. Other Please, explain: ____________________________

3. License/Certification Status (select all that apply)
    - ▫ Licensed Athletic Trainer
    - ▫ Licensed Psychologist
    - ▫ Licensed Neuropsychologist
    - ▫ Licensed Medical Physician
    - ▫ Licensed Physical Therapist
    - ▫ Certified ImPACT Trained Athletic Trainers (ITAT)
    - ▫ Credentialed ImPACT Consultant (CIC)

4. Employment Setting. Select all that apply:
    - ▫ High School
    - ▫ College/University
    - ▫ Medical Center/Hospital
    - ▫ Private Clinic

- Other Please, explain: ______________________________

5. Years of evidence-based practice
   a. 0-5
   b. 6-10
   c. 11-15
   d. 16-20
   e. 21+

6. Number of concussions evaluated per year
   a. [Open Text Response]

7. What is your gender?
   a. Female
   b. Male
   c. Transgender
   d. Other
   e. Prefer not to say

8. City, State location of practice
   a. [Open Text Response]

The following questions pertain to making the Return to Play (RTP) decision

1. Which of the following evaluative tools do you use in making the RTP decision? (*Select all that apply*)
   - Administer neurocognitive testing
   - Gradual physical exertion protocol
   - Asymptomatic during exertion and rest
   - Cognitive resting return to baseline after exertion
   - Athlete self-report
   - Medical clearance
   - Parent signed agreement
   - Balance testing back to baseline
   - Visual tracking back to baseline
   - Other, Please explain: ______________

2. When making a RTP decision, which piece of data do you favor most? Rank order the following from 1 to 6, with 1 indicating what you favor the most:
   - Clinical examination
   - Athlete self-report
   - Symptom Checklist
   - Computerized neuropsychological testing
   - Balance testing
   - Visual oculomotor testing

3. When an athlete sustains a concussion during play, with what frequency do you assess their status?
    a. [Open Text Response]

4. Do you personally speak to the athlete to assess their current symptoms?
    a. Yes
    b. No

5. Do you have them fill out a self-report symptom form?
    a. Yes
    b. No

6. Do you receive parent signatures in addition to doctor signatures?
    a. Yes
    b. No

The following questions pertain to neurocognitive testing practices

7. How often do you obtain cognitive baseline scores on your athletes?
    a. Every year
    b. Every 2 years
    c. Every 3 years
    d. We don't do baseline testing
    e. Other

8. After an athlete has completed post-injury cognitive testing and they have successfully returned to competition, do you do any of the following?
    a. Obtain a new baseline before their next season
    b. Use the last test from their completed protocol as their "new baseline"
    c. Obtain a new baseline if they have been scheduled to take an updated baseline test

9. Of the following options, which one best describes the environment in which your athletes take baseline cognitive tests:
    a. Computer lab
    b. Office
    c. Computer in the athletic training room
    d. Classroom
    e. Other

10. Of the following options, which one best describes the environment in which your athletes take post-injury cognitive tests:
    a. Computer lab
    b. Office
    c. Computer in the ATR
    d. Classroom

e. Other

11. If you do not obtain a cognitive baseline score, why not?
    a. Lack of time
    b. Limited staff
    c. Limited resources
    d. Limited funding
    e. Other

12. When you administer baseline cognitive testing, do you check the scores to see if they are valid?
    a. Yes
    b. No
    c. I don't know how to check a baseline for validity.

13. Do you use regression-based z scores to calculate significant change?
    a. Yes
    b. No
    c. I don't know this statistics

14. Do you use the RC Index to calculate significant change?
    a. Yes
    b. No
    c. I don't know the RC Index

15. Do you administer neurocognitive testing while the athlete is still symptomatic?
    a. Always
    b. Sometimes
    c. Never

16. If you selected b) Sometimes as your answer to #15, under what circumstances would you do this?
    a. [Open Text Response]

17. Under what conditions do you wait to administer a neurocognitive test? (Select all that apply)
    a. Athlete is symptom free
    b. Reduction in symptoms
    c. Poor previous test performance.
    d. Other

The following questions pertain to gradual RTP protocol practices

18. After the athlete is asymptomatic and their neurocognitive scores return back to baseline, do you implement a standardized exertion protocol?
    1. Yes
    2. No

3. Other

19. Do you follow the Zurich consensus gradual RTP protocol?
    a. Yes
    b. No

20. If not, what protocol do you follow?
    a. [Open Text Response]

21. As part of the physical stepwise progression, do you administer a neurocognitive test after exertion?
    a. Yes
    b. No

22. If yes, at what stage during the physical stepwise progression, do you administer a neurocognitive test after exertion?
    a. Step 2: Light aerobic exercise
    b. Step 3: Sport-specific exercise
    c. Step 4: Noncontact drills
    d. Step 5: Full contact drills

23. If you institute an exertion test, what is the duration of exertion performed prior to administering a neurocognitive test?
    a. 5 minutes
    b. 10 minutes
    c. 15 minutes
    d. 20 minutes
    e. Other

24. If you do an exertion test, what exercise are you implementing?
    a. Stationary bike
    b. Walking on treadmill
    c. Elliptical
    d. Other

25. If the athlete reports symptoms at any point of the exertion protocol, do you return them to step 0 or the previous step?
    a. Yes
    b. No
    c. [Open Text Response]

26. How long would you wait before allowing the athlete to resume exertion?
    a. [Open Text Response]

27. How long do you wait after exertion to administer a neurocognitive test?
    a. [Open Text response]

28. Do you assess the athlete for symptoms before having them test?
    a. Yes
    b. No

29. Would you test the athlete again if their first post-exertion neurocognitive test scores had not returned to baseline?
    a. Yes
    b. No
    c. I don’t know

30. After a stage of physical exertion do you do a symptom check immediately after?
    a. Yes
    b. No
    c. I don’t know

31. If you selected b) No as your answer to #30, how long do you wait to check symptoms?
    a. [Open Text Response]

32. Would you return athletes who are asymptomatic but their computerized neurocognitive test results are significantly worse than baseline?
    a. Yes
    b. No
    c. Other

33. Would you return symptomatic athletes if their neurocognitive scores were back to baseline?
    a. Yes
    b. No
    c. Other

The following questions pertain to multi-disciplinary consultation practices

34. Do you seek consultation when making the RTP decision?
    a. Yes
    b. No
    c. If so, with whom? ____________________

35. Do you consult with neuropsychologists for your interpretation of neurocognitive testing?
    a. Yes
    b. No

36. If yes, do you consult?
    a. Only for baseline
    b. Only for post-injury
    c. For both baseline and post-injury

37. How often do you follow the recommendations provided by the consultant?
    a. Always
    b. Usually
    c. Sometimes
    d. Rarely
    e. Never

38. When are you prone to seek consultation? (Select all that apply)
    a. Premorbid risk factors
    b. History of concussion
    c. LOC from current concussion
    d. Prolonged recovery/PCS
    e. Other

The following questions pertain to concussion management education and training

39. Have you undergone training in the use of ImPACT or other computerized neurocognitive tests?
    a. Yes
    b. No

40. When did you last attend a training that addressed concussion management?
    a. Within 6 months
    b. Within the year
    c. Within 2 years
    d. Other

41. When did you last receive education on the topic of concussion management?
    a. Within 6 months
    b. Within the year
    c. Within 2 years
    d. Other

42. In which venue or from which resource did you last receive information on concussion: (select all that apply)
    a. Published journal article
    b. Webinar
    c. Didactics
    d. Training program
    e. Conference
    f. Continuing Education Credits
    g. Other

43. Would receiving additional education in the area of concussion management be beneficial to your work?
    a. Yes
    b. No
    c. I don’t know

Appendix D

Revised Sports Medicine Practice Questionnaire

1. Do you have them fill out a self-report symptom form?
    a. Yes
    b. No

2. After an athlete has completed post-injury cognitive testing and they have successfully returned to play, do you do any of the following:
    a. Obtain a new baseline before their next season
    b. Use the last test from their completed protocol as their "new baseline"
    c. Obtain a new baseline if they have been scheduled to take an updated baseline test

3. Of the following options, which one best describes the environment in which your athletes take baseline cognitive tests:
    a. Computer lab
    b. Office
    c. Computer in the athletic training room
    d. Classroom

4. Of the following options, which one best describes the environment in which your athletes take post-injury cognitive tests:
    a. Computer lab
    b. Office
    c. Computer in the athletic training room
    d. Classroom

5. When you administer baseline cognitive testing, do you check the scores to see if they are valid?
    a. Yes
    b. No
    c. I don't know how to check a baseline for validity.

6. Do you use regression-based z-scores to calculate significant change?
    a. Yes
    b. No
    c. I don't know this statistics

7. Do you use the RC index to calculate significant change?
    a. Yes
    b. No
    c. I don't know the RC Index

8. After the athlete is asymptomatic and their neurocognitive scores return back to baseline, do you implement a standard exertion protocol?
    a. Yes
    b. No

9. As a part of the physical stepwise progression, do you administer a neurocognitive test after exertion?
    a. Yes
    b. No

10. Do you assess the athlete for symptoms before having them test?
    a. Yes
    b. No

11. After a stage of physical exertion, do you conduct a symptom check immediately after?
    a. Yes
    b. No
    c. I don't know

12. When do you consult with neuropsychologists for the interpretation of neurocognitive testing?
    a. Only for baseline
    b. Only for post-injury
    c. For both baseline and post-injury

13. How often do you follow the recommendations provided by the consultant?
    a. Always
    b. Usually
    c. Sometimes
    d. Rarely
    e. Never

14. Have you undergo training in the use of ImPACT or other computerized neurocognitive tests?
    a. Yes
    b. No

15. When did you last receive education on the topic of concussion management?
    a. Within 6 months
    b. Within the year
    c. Within 2 years

16. Would receiving additional education in the area of concussion management be beneficial to your work?
    a. Yes
    b. No
    c. I don't know