**PROPOSAL TITLE:** Retrospective Neuropsychological Chart Review of Athletes with Prolonged Recovery from Sports-Related Traumatic Brain Injury (TBI)

**BACKGROUND:** Approximately 36 million youth (6-14 years of age) and 7 million high school students participate annually in community-based and interscholastic sports. An additional 400,000 athletes participate in collegiate sports. Participation in sports provides many physical and psychological health benefits and promotes positive psychosocial development. Sports-related traumatic brain injury (TBI) is increasingly being recognized as a public health concern with an estimated 1.6 to 3.8 million sports-related TBIs occurring annually (Langlois, Rutland-Brown, & Wald, 2006). Concussion diagnosis is made be a licensed health care professional and typically involves either sideline evaluation (if a certified athletic trainer or other medical professional is available) and/or follow-up by a health care professional off the field. Sideline screenings commonly include brief cognitive batteries (e.g., Sport Concussion Assessment Tool V.3, Standardized Assessment of Concussion) or balance assessments (e.g., Balance Error Scoring system). More in depth neuropsychological assessment is often completed post-injury and can greatly aid in the assessment and understanding of post-concussive neuropsychological deficits (Giza et al., 2013; McCrory et al., 2013). ImPACT is one of the most commonly used computerized assessments; however other computer administered tests and cognitive assessments (e.g., Delis Kaplan Executive Functioning System, Wechsler Adult Intelligence Scale-4th Edition, etc.) are used by neuropsychologist to better assess cognitive domains impacted by sports-related TBI. Importantly, neuropsychological outcomes and post-concussion symptom reporting

Recovery time from sports-related TBI can vary greatly among athletes, however approximately 80%-90% of sports-related TBIs resolve within 7-10 days (McCrory et al., 2005). Identifying prognostic factors associated with prolonged recovery (>10 days) from sports-related TBI is critical for improving treatment and management. Sports-related TBI prognostic factors examined to date have primarily focused on demographic variables, medical history, and concussion-specific variables (e.g. symptom type and severity). Age, education level, the number and severity of concussion symptoms, previous concussion, and medical and psychiatric comorbidities are all variables that have been identified as sports-related TBI recovery prognostic factors (Dougan, Horswill, & Geffen, 2013; Giza et al., 2013; Makdissi, Davis, Jordan, et al., 2013; Meehan et al., 2013).

Dougan and colleagues’ (2013) recent meta-analysis examined studies that obtained neuropsychological, postural stability, and post-concussion symptom outcomes 1-10 days after sports-related TBI. Female athletes, adolescent (compared to adults) athletes, and athletes with less education (<16 years) had increased risk of neuropsychological dysfunction. The meta-analysis (Dougan et al., 2013) also discussed the paucity of sport-related TBI literature with data examining prognostic factors associated with prolonged sports-related TBI recovery (>10 days), highlighting the need for research examining prognostic factors associated with prolonged recovery. Importantly, few psychosocial variables (e.g., anxiety, depression, peer support/relationships, positive/negative affect, etc.) have been examined as prognostic factors of prolonged sports-related TBI recovery.

The American Medical Society for Sports Medicine’s concussion position statement (Harmon et al., 2013) recommends that athletes experiencing prolonged recovery from a sports-related TBI undergo comprehensive neuropsychological evaluation conducted by a neuropsychologist. Furthermore, it has been suggested that athletes experiencing prolonged recovery should be given a battery of patient-reported outcomes (e.g., assessments of anxiety, depression, sleep, general health, headaches/migraines, drug and alcohol abuse) in addition to self-reported concussion symptom questionnaires completed multiple times during the recovery period (Makdissi, Cantu, Johnson, McCrory, Meeuwisse, 2013). These recommendations provide important guidance for future research and clinical practice, however little research has focused on identifying the most appropriate patient-reported outcome measures for use with youth and high school athletes.

**Hypothesis**

Individuals with a pre-existing mental health history, underlying biological family history or those who experience significant emotional symptoms during their recovery from a concussion would experience a prolonged & more complicated recovery than those without these factors.

**OBJECTIVE:** The purpose of this study is to conduct a retrospective chart review of youth and high school patients referred for neuropsychological evaluation because of prolonged recovery from a sports-related TBI. Diagnostic and outcome measurement data will be analyzed to determine 1) the number of patients reporting a psychiatric condition prior to the occurrence of a sports-related TBI, 2) the number of sports-related TBI patients diagnosed with a comorbid psychiatric condition, 3) psychosocial variables associated with prolonged recovery, 4) neurocognitive factors associated with prolonged recovery

**METHODS:** Retrospective chart review of patients seen by Dr. Adam Shunk and Dr. Jon Thompson for prolonged recovery from sports-related TBI. Patients completed various neuropsychological outcome measures (references provided in Appendix A) and provided information about their medical histories.

Data will be collected from the medical history and various neuropsychological tests that were administered to evaluate participants functioning across multiple domains which include: language, attention, executive functioning, learning and memory, visuospatial analysis and fine motor abilities. Not all tests were administered to every participant, so the chart review is expected to result in differences in the number of available tests scores and data amongst the participants.

Cognitive measures:

Woodcock Johnson tests of Cognitive Abilities-3rd Edition (WJ-COG-III)

Delis Kaplan Executive Functioning System (DKEFS)

Wide Range Assessment of Learning and Memory- 2nd Edition (WRAML-2)

Paced Auditory Serial Addition Test (PASAT)

ImPACT computerized test

MEDICAL SYMPTOM VALIDITY TEST (MSVT)

NEPSY-2, A Developmental Neuropsychological Assessment Battery

Wechsler Adult Intelligence Scale-4th Edition (WAIS-4)

Woodcock Johnson Test of Achievment-3rd Edition (WJ-ACH-3)

 Conners Continuous Performance Test Revised (CPT-2)

Emotional Personality Measures:

Behavior Assessment System for Children, 2nd Edition (BASC- parent and self report forms)

Post Concussion Symptom Inventory

Medical History Information from clinical interview, standardized rating scales or forms completed by the patient or family

 ICD-9 code

Presenting problem

Number of concussions

Previous Mental Health diagnosis

Psychiatric Medications

Recent psychosocial stressors

History of special education services

Sleep difficulties

Mood symptoms

Anxiety symptoms

Somatic complaints

Reported cognitive difficulties

Family history of mental health disorders

**Patient Population**

Consecutive referrals of 8-25 year old patients from an outpatient physician practice who were diagnosed with sports-related traumatic brain injury and referred for neuropsychological evaluation.

**Study Design**

Retrospective chart review.

**Inclusion Criteria**

Any 8-25 year old patient who was seen for neuropsychological evaluation from the years 2008- May 31, 2013.

**Exclusion Criteria**

Athletes less than 8 years of age or older than 25 years of age at time of first appointment will not be included in the study.

**Sample Size**

Two hundred charts will be reviewed for this study.

**Data Procedure**

Data will be collected from summary tables and forms in the individual patient charts. Appendix B contains a list of all variables that will be collected from the summary tables and forms in the charts. All data will be recorded into a password protected excel spreadsheet and data will be de-identified with no direct link possible to connect the participant’s name or identification number to their data.

There are no direct risks or discomforts to the participants included in the study. The potential secondary risks include loss of confidentiality. In order to minimize this potential risk, no personally identifiable data will be collected and all data will be held in possession of the research team at all times during data collection. Charts will be reviewed at St. Vincent Sports Performance were the primary investigator of the study is located. These forms will be held in possession of the research team at all times during data collection and stored in the primary investigators locked office in a locked cabinet accessible only to the research team. No personally identifiable data will be kept in electronic format. All electronic files will be password protected. Once all data is entered into the excel data collection spreadsheet, the data will be imported into SPSS 19.0 for all data analysis. These forms will be held in possession of the research team at all times during data collection and stored in the primary investigators locked office in a locked cabinet accessible only to the research team. No personally identifiable data will be kept in electronic format. All electronic files will be password protected.

**Researcher Training**

All researchers working on the study have completed Human Subjects Training. The primary investigator will be overseeing the training of the primary research assistant doing the record abstraction.

**Statistical Analysis**

Descriptive statistics will be used to examine demographic and medical history data and the scores from the neuropsychological tests. Pearson product-moment correlations (*r*) and Spearman rho correlations will be used to examine the relationships among the cognitive, emotional, and medical history data. Additional analyses may include (will be dependent upon how much data/scores are retrieved from the chart reviews) chi-square tests, t-tests, regression analyses, analysis of variance (ANOVA), and multivariate analysis of variance (MANOVA).

**Limitations**

A single clinician in one practice saw the majority of the participants and participants were from one geographic region.

**Significance**

To our knowledge, this will be the first study to conduct a comprehensive chart review of youth and adolescent patients. This research will allow the examination of variables (e.g., comorbid psychological and physical conditions, emotions, cognitive function, etc.) that may be prognostic factors associated with complicated and prolonged recovery to sport-related TBI. Improved understanding of prognostic factors may help in the identification of sport-related TBI patients that may be at increased risk for complicated and prolonged recovery.

Dougan BK, Horswill MS, Geffen GM. Athletes’ age, sex, and years of education moderate the acute neuropsychological impact of sports-related concussion: a meta-analysis. *J Int Neuropsychol Soc*. 2013;4:1-17.

Giza CC, Kutcher JS, Ashwal S, Barth J, Getchius TS, Gioia GA, et al. Summary of evidence-based guideline update: Evaluation and management of concussion in sports: Report of the the Guideline Development Subcommittee of the American Academy of Neurology. *Neurology*. 2013;80(24):2250-2257.

Harmon KG, Drezner J, Gammons M, et al. American Medical Society for Sports Medicine Position Statement: Concussion in Sport. *Clin J Sport Med*. 2013;23:1-18.

Langlois JA, Rutland-Brown W, Wald MM. The epidemiology and impact of traumatic brain injury: a brief overview. *J Head Trauma Rehabil* 2006;21:375–378.

Makdissi M, Cantu RC, Johnson KM, McCrory P, Meeuwisse WH. The difficult concussion patient: what is the best approach to investigation and management of persistent (>10 days) postconcussive symptoms? *Br J Sports Med*. 2013;47:308-313.

Makdissi M, Davis G, Jordan B, Patricios J, Purcell L, Putukian M. Revisiting the modifiers: how should the evaluation and management of acute concussions differ in specific groups? *Br J Sports Med*. 2013;47:314-320.

McCrory P, Johnston K, Meeuwisse W, et al. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. *Br J Sports Med*. 2005;39:196-204.

McCrory P, Meeuwisse WH, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Br J Sports Med*. 2013;47:250-258.

McNally KA, Bangert B, Dietrich A, Nuss K, Rusin J, Wright M, Taylor HG, Yeates KO. Injury versus noninjury factors as predictors of postconcussive symptoms following mild traumatic brain injury in children. *Neuropsychology*. 2013;27(1):1-12.

Meehan WP 3rd, Mannix RC, Stracciolini A, Elbin RJ, Collins MW. Symptom severity predicts prolonged recovery after sport-related concussion, but age and amnesia do not. *J Pediatr*. 2013; epub ahead of press.

Olsson KA, Lloyd OT, Lebrocque RM, McKinlay L, Anderson VA, Kenardy JA. Predictors of child post-concussion symptoms at 6 and 18 months following mild traumatic brain injury. *Brain Inj*. 2013;27(2):145-157.