

STRATEGIC PLANNING

May 21, 2015

Penn State Center for Sports Concussion Research and Services

www.concussion.psu.edu

Philanthropic Priorities

- **Students support:** As equal partner of the newly created Concussion Neuroimaging Consortium (www.concussionimaging.org), our Center is searching to fund postdoctoral fellow, or graduate training lines in one or more of the core initiatives aimed at training independent clinical researchers. Core funding will be recurred via NIH (NICHD & NINDS) Training Grants, KO1 and K24 mechanisms for young investigators and post-docs.
- **Faculty support:** The highest priority for the Center is to create core junior faculty team with specific focus on development and validation of advanced neuroimaging (fMRI, DTI, ASL, SWI, EEG) and behavioral diagnostic tools aimed at detecting “pathophysiological biomarkers” of trauma brain injuries. Core funding for this priority will be searched via endowments, Brain Injury Foundations, NFL medical charities and private donors for development of residency programs and fellowships for medical professionals in charge of management of brain injured patients;

- **Research support:**

Rationale: Recently, with advances in brain imaging hardware, pulse sequences and analytical techniques, newer MRI methods have demonstrated the ability to detect and localize several pathologic and pathophysiologic consequences of concussion. These advanced MR technologies include: susceptibility weighted imaging (SWI) to detect micro-hemorrhage; MR spectroscopy (MRS) to detect metabolic alterations; diffusion tensor imaging (DTI) to detect edema and axonal injury; perfusion weighted imaging (PWI) and arterial spin labeling (ASL) to measure cerebral blood flow in brain tissue; and functional MRI (fMRI) to measure local changes in blood oxygen level in response to neuronal activity. Having a number of imaging biomarkers, all of which are obtained in a single scanning session (or multiple sessions as from longitudinal study) affords great advantages, including: (1) enhanced sensitivity; (2) ability to understand differential sensitivity of these biomarkers and the link between biomarkers and clinical deficits in concussed brain; (3) improved clinical management resulting from more precise prognostication of brain injuries; and (4) enhanced power of clinical intervention in concussed patients.

- As a partner of Concussion Neuroimaging Consortium and CIC Big 10/IVY League Concussion Consortium our Center research priorities are the following:

a) Consolidation of Penn State multi-institutional brain science experts and efforts aimed at identification of “biomarkers” of concussion and athletes (both pediatric and young adults) at risk for traumatic brain injuries.

b) Establishment of partnership with Siemens, GE, pharmaceutical and other companies as a critical component for research on neurological structure and functions via neuroimaging tools.

c) Development of validation of treatment modalities such as “Brain Cooling”, supplements, pharmaceuticals product, behavioral tools, etc. aimed at restoration of neurocognitive, vestibular/balance and physical function in brain injured patients. We are searching to expand the secured funds from private companies (Spartan, LLC), endowments and private donors.

- **Program support:** Consolidation of Penn State and world-known leading TBI experts and efforts aimed at longitudinal studies of concussion (both pediatric and young adults) via securing funding for visiting scholars. Both intramural (SSRI, Neuroscience Institute etc.) and extramural (NSF, Department of Education, Medical Rehabilitation Branch) will be approached to secure these funds.

Thematic area:

- **Development of a standard clinical protocol** using neuroimaging, neurological and neuropsychological biomarkers for accurate assessment of TBI with respect to **return-to-academic** criteria. **NIH r21 and RO1** mechanisms will be explored to secure funds for this thematic area.

Rationale: Each year, medical professionals, athletic trainers, coaches, and parents - face a critical question: What is the time frame for safe *Return-to-Play* (RTP) following concussion. According to the current best practice established by the Concussion in Sports Group (CISG), an athlete must be completely asymptomatic at rest, with cognitive exertion, and with activities of daily living prior to the initiation of a step-wise RTP protocol¹. Currently there are numerous efforts and initiatives from multiple labs and research centers focused on developing data-driven RTP guidelines. However, RTP only addresses one aspect for the *student-athlete*. *Return-to-Academics* (RTA) after concussion is another crucial element that to date has yet been adequately studied. To date there are NO evidence-based protocols regarding the RTA and other social activities for student-athletes recovering from concussion. The lack of dedicated RTA protocols is an area of major concern, as early exposure to physical and cognitive loads in concussed student-athletes may cause both short and long-term residual brain dysfunction and influence academic progress.

- **Children's Health and Development:** As a member of Adolescence Brain and Cognitive Development (ABCD) Federation Consortium, our Center has initiated a longitudinal (10 years) study aimed to:
 - a) characterize the associations between sports participation, mild traumatic brain injury (mTBI), and patterns of SU, within the context of normative developmental variation.
 - b) determine whether concussion occurred early in child life influences the trajectories of brain development and diverse patterns of substance use or abuse (SU). We are currently searching multi-institutional NIH RO1 grant to secure funds for this study.

Rationale: Exposure to early or repetitive mild Traumatic Brain Injury (mTBI) will increase risk of SU. Injuries to the developing brain represent another critical pathway that may connect participation in certain types of sports and SU in adolescents. Participation in contact sports is associated with increased likelihood of mTBI, also known as *concussion*. In the United States, approximately 145,000 children and adolescents aged 0–19 years are estimated to be living with substantial and long-lasting limitations in social, behavioral, physical, or cognitive functioning following mTBI⁵¹. The Institute of Medicine recent report on concussion in youth highlights convincing data regarding concussion in the middle school age (10-13 years old) population. The *rapid development* hypothesis theorizes that middle school may be a particular vulnerable age, as the brain undergoes rapid myelination during this time. In pediatric populations, some effects of mTBI may not be present initially, but can emerge later in a child's development. This delay of onset can manifest itself in later academic failure, chronic behavior problems, social isolation, and difficulty with employment and the law. Emerging evidence indicates that adolescent athletes who have experienced a mTBI have increased risk for frequent alcohol consumption and cannabis use. Recent studies suggest that mTBI results in disruption of the still maturing cognitive and affective neural pathways underlying effortful cognitive control and decision making. Consequently, concussed adolescents may be limited in their ability to exert control over aspects of their behavior, and may be particularly vulnerable to SU. Despite theoretical plausibility, we do not have a good understanding of the nuanced associations among sports participation, mTBI, structural and functional changes in the developing brain, and SU. Given the high risk of mTBI in adolescent population and the limited knowledge of long-term neural, cognitive, mental and behavioral consequences of concussive injury, it is critical to initiate longitudinal studies.