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Concussion

The Problem: There are no definitive "Gold Standard" measures for the diagnosis, prognosis, or prediction of recovery from Traumatic Brain Injuries (TBI). Instead, diagnoses are symptom-based, relying heavily on professionals of varied backgrounds and training to identify, classify, determine and track the course of treatment. Today, treatment programs for TBI are based solely on expert recommended "best practices" instead of evidence based empirical studies or randomized clinical trials of intervention effectiveness (IOM, 2013). Unfortunately, the lack of Gold Standard diagnostic systems and the absence of research-based best practice interventions to maximize recovery have profound negative consequences for 100 million plus young men and women participating in sports programs. According to a Center for Disease Control Report for the general U.S. population, of the cases of TBI reported during from 2000 through the last quarter of 2012, 75% were characterized as mild TBI/concussion, 19% as moderate TBI, and 4% as severe TBI. Interestingly, the percentage of TBI cases in the military classified as mild TBI (77%) is nearly the same as that reported for the military. Tragically, the absence of effective diagnosis and intervention systems for mild TBI means these individuals in the general population and the military face prolonged recovery periods with uncertain prognoses for recovery to a level that would enable them to resume a normal, productive lifestyle.

The major barrier to effective diagnosis in cases of suspected mild TBI is the heavy reliance on injured individuals to accurately report symptoms. In the absence of objective measures, this long-used approach is fatally flawed. As Betthauser et al. (2012) noted, new work must move forward to identify reliable, accurate, and clinically-useful measures to assess TBI (Hudak et al, 2011).

Solutions:

1. Assessment and Treatment Changes: To advance our ability to objectively diagnose, monitor and remediate concussion, there is an urgent need for a evidenced based battery of cutting-edge neural imaging and cognitive/behavioral tests. These integrative procedures must be able to predict and track the effectiveness of research-based interventions, providing objective and frequently updated information to the patient and the practitioner throughout the recovery period. Given the high incidence of concussion as a milder form of TBI (75%-77% of all cases of TBI in civilian and military populations), the need for advanced research is most pressing.

2. Rule Changes: The focus should be on reducing the speed of contact as well as the target area impacted. Dr. Tim Gay notes in his book, *The Physics of Football* (2005, 1st Ed.), that the speed of the players colliding as well as their physical size combine to multiply the g-forces that contribute to injuries in general, and concussions in particular. Rotational forces that impact the head at an angle are thought to be a major contributor to concussion incidence. As the NFL as already done, changing the line up for kickoffs and returns or perhaps eliminating the kickoff and kickoff returns altogether could reduce both the frequency as well as the severity of concussions and other injuries. Thirty percent of injuries occur during kickoffs, with at least 20% involving concussions. Rules that further restrict blows to the head are another possibility.

3. Equipment Changes: More work must move forward to evaluate the protective aspects of sporting equipment. The 5-star rating for football helmets primarily measures linear forces that do play a role in head injuries. However the system is much less sensitive to detecting rotational forces, a prime contributor to concussion. There is also a trend among athletes to wear less equipment. While this may provide the athlete with a sense of agility, it also opens them up to more possibilities of injury.

Playing Surfaces: Another area of review should involve the playing surface of the field or court. A surface with some flexibility could potentially reduce both physical injuries as well as concussions.

Fraud: There are also claims made by a number of manufacturers that some devices have proven to reduce concussion (e.g., mouth guards, head bands). Unfortunately the research support is either non-existent or consistent lacking in support for such claims. Parents, children and sporting enthusiasts are lulled into a false sense of security regarding their protective gear, perhaps furthering their chances for injury.

Proposed Approach: The research goals to pursue should press the development of (1) a scientifically-based, objective system to identify the presence of mild TBI using integrative neuroimaging and neurobehavioral research tools at different stages of the lifespan, a task not previously attempted, and (2) a research-based intervention protocol that uses neuroimaging and neurobehavioral tools to monitor progress and rate of intervention effectiveness for mild TBI at different stages of life. This work would investigate the long-term consequences of earlier and repeated mild TBI, as well as the effectiveness of cognitive interventions with this population. Research with advanced aged former athletes could explore how TBI events relate to chronic traumatic encephalopathy (CTE), a progressive degenerative neural disease thought to result from a history of successive TBIs. To be most effective, these initiatives would require an interdisciplinary team of cognitive neuroscientists, cognitive and behavior scientists, geneticists, anthropologists, sociologists, endocrinologists, learning and memory specialists, statisticians, vestibular/auditory specialists, neurologists, occupational therapists, and developmental psychologists specializing in cognitive impairments, intervention techniques, and large data set analysis techniques.

This approach stands in stark contrast to previous efforts to study mild TBI that largely tracked behavior or a few brain measures over short time intervals (e.g., 2 hours to 6 weeks) following mild TBI. Few studies recorded baseline measures prior to injury needed to track changes in neurobehavioral functioning following concussion, and even fewer examined the effects of multiple mild TBIs, the time intervals between them, the g-force of the causal blow, or the site or direction of impact. Without preconcussion measures, researchers are unable to determine whether athletes actually recovered to their preconcussion levels of neurocognitive functioning. In sharp contrast, a longitudinal study would track all of these dimensions in our active youth, high school and college athlete populations. By comparing the neurobehavioral results of such individuals at different ages ranging from those in their early elementary school sport programs through the adult years to those in their late adult years, we will gain new insights into TBI diagnosis as well as short term and long term consequences, such as CTE. Importantly, we will have a unique opportunity to develop and test the effectiveness of neurocognitive intervention systems linked to well-specified information on mild TBI and CTE.

References

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