Sport-Related mTBI: A Public Health Ethical Imperative to Act

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In this paper we will argue that sports related mTBI in children and youth meet the criteria for being a significant public health issue of ethical import worthy of serious reform in public policy to address the health related harms associated with them.

Concussion suffered in sport or recreational activities by children and adolescents, is classified by the World Health Organization as a minor traumatic brain injury (mTBI). Cited in a US Center for Disease Control and Prevention (CDC) report to the Congress, these serious traumatic brain injuries suffered in youth sport and recreational activities are referred to it as a "silent epidemic". The report also stated that mTBI is a public health problem, the magnitude and impact of which are underestimated by current surveillance systems[1]. The yearly incidence of sports- and recreation-related mTBIs in the United States is estimated between 1.6 and 3.8 million, many of which remain undiagnosed or do not result in doctor or hospital visits.[2]

Today, eleven years after mTBI was characterized as an important public health problem, there exists a large gap of direct, objective, coordinated and comprehensive evidence upon which to measure preventative interventions concerning acute and recurrent mTBI among the youth.[3] This important deficit raises serious ethical issues concerning how best to mitigate the harm of often preventable brain injuries to vulnerable youth population suffered while in pursuit of the otherwise positive benefits derived from sporting and recreational activities. The effect of concussion on developing brains is of particular concern.

IS mTBI A PUBLIC HEALTH ISSUE?

A public health issue is one that has broad significance to a population requiring the utilization of collective resources to address significant health threats. Essential public health functions relate to targeting and protecting entire populations from disease, preventing injury and illness and promoting health. Public health is informed by epidemiology and rests upon a foundation of securing community health. Health care focuses on treating individuals who are not well, usually after illness or injury has occurred.

Public health works upstream looking for ways to prevent people from becoming sick or injured. Public health problems are often identified by the magnitude of potential harm associated with the health threat. Risks that are prevalent in society with identifiable and well documented

adverse consequences are often targets of public health action. Excellent examples of these are found in controlling tobacco to reduce cancer and cardiovascular disease and seat belt legislation and motor vehicle safety improvements to reduce the risk of death and injury from motor vehicle accidents. The question is whether the magnitude of harm from contact sports in children and youth in terms of mTBI qualifies as a public health problem

EXPOSURE, INCIDENCE AND HEALTH CONSEQUENCES OF mTBI

Children throughout the world participate in contact and collision sport (e.g. soccer, basketball, rugby, American football and ice-hockey) from the ages of 6 through 16, their formative physical and social development periods. In the US alone, approximately 44 million boys and girls participate in an organized sport annually.[4] 7.7 million US High School students participated in school sponsored athletics during the 2012-2013 school year.[5]

In a recent 10-year period, there has been a 100% increase among 8- to 13-year-olds and a 200% increase in sports-related emergency room visits for concussion among 14- to 19-year olds.[6] Previous research has indicated that concussions represent from 5.5% to 22% of all high school athletic injuries.[7, 8] Despite the recent and rapid growth of knowledge and public awareness, and there continues to be an innate cultural resistance to the non-biased documentation of the incidence of this injury in the sports the youth of our society plays.

The findings of a recent Australian epidemiological study concerning the frequency and participation-adjusted rate of hospitalisation for sport-related concussion, both overall and across several sports, increased significantly over the 9 years. These findings, along with high levels of public concern, make prevention of head injury in sport a population health priority in Australia.[9]

The literature concerning sport-related mTBI has abandoned grading of mTBI by international consensus in 2009, recognizing all brain trauma as serious.[11] The 2012 consensus guidelines state that an individual who is suspected of sustaining a concussion should be removed from that activity and not return until a medical evaluation has been completed. The guidelines state that an individual who suffers a concussion should not return to play until a six step protocol is completed, with a minimum of 24 hours between each step. These consensus guidelines also make a differentiation between adults and children concerning concussion diagnosis and treatment. [12]

Incidence reporting however has lacked a direct independent standardized approach, that is unbiased by participants engaged in the sporting event or those individuals directly involved of supervising the sport or activity. Current research is significantly dependent upon prospective evaluation or retrospective review of various hospital emergency department and other injury surveillance data bases that tend to significantly underreport the concussion incidence. [13, 14, 15, 16]

Two recent longitudinal prospective, ice-hockey studies study young adult subject groups (2009-10 junior men and 2011-12 university men and women players) utilizing direct observation, diagnosis and treatment by non-biased specialist physicians that utilized internationally

recognized definitions and treatment protocol. These studies demonstrated the significantly underreported incidence of mTBI compared to age, sex and skill level published evidence. [17, 18] The incidence rate (per 1000 athlete exposures) in these two studies was between 3 to 7 times higher than ever previously reported for the sex, age group and level of sport. In each study greater than twenty percent of individuals participating suffered a medically diagnosed mTBI during the period of the study.[17, 18]

There has also been no published prospective evidence concerning the objective advanced MRI imaging of sport concussion in the paediatric age group. Recently published advanced MRI evidence from the prospective 2011-12 collegiate ice-hockey study demonstrated acute and cumulative micro structural vascular and white matter injury.[10,19, 20] This important initial evidence, although not directly related due to lack of pathological correlation, converges with the documented evidence of mild cognitive impairment (MCI) and pathological evidence of Chronic Traumatic Encephalopathy (CTE) as well as other neurodegenerative diseases already documented, among individuals that have sustained repetitive brain trauma.[21-25]

Further, and more importantly, the human and economic toll that this injury has upon our culture is also reflected on the less documented incidence of mental illness[26, 27], associated physical illnesses, as well as loss of academic and occupational productivity among those individuals that sustain this 'invisible injury'.[1] A recent Canadian study showed elevated risks of psychological distress, suicidality, utilization of prescription medication for depression and anxiety and other negative social and mental health outcomes associated with mTBI.[28]

ETHICAL ISSUES

It is clear that the burden of morbidity and the sequelae from mTBI in children and youth is substantial. This is an ethical issue.

Ethical concerns can arise at both the individual level (as in most medical ethics) or at the collective level in terms of public health ethics. At both levels, minimizing harm, and protecting vulnerable persons are central tenets. Vulnerability occurs when persons or populations are unable to optimally protect themselves from hazards or advocate for their own best interests thus requiring enhanced protections. Typically, we consider children and youth to be vulnerable and this is reflected in many social, cultural and legal practices which seek to protect them from adverse circumstance and risk.

A 2013 University of Virginia study documented the results of instrumented American football helmets of participants between 9 and 12 years. A total of 50 players (age = 11.0 ± 1.1 years) on three teams were equipped with helmet mounted accelerometer arrays, which monitored each impact players sustained during practices and games. During the season, 11,978 impacts were recorded for this age group. Players averaged 240 ± 147 impacts for the season. Some of the impacts measured were some recorded high magnitude impacts were similar to those seen at the high school and college level.[29]

The question that is most obvious concerning these findings is: Knowing that players average 240 impacts per season, why would a parent knowingly allow this? The risk of injury is different than allowing a child to participate in an activity in which he/she may sustain a single, accidental, medically diagnosed, and treated head trauma (e.g. waterskiing, basketball, and baseball).,

The current data demonstrates that there is converging documented evidence concerning repetitive brain injury suffered in youth sport and recreational activities. Given the status of children and youth as vulnerable populations, the onus for protection from this harm does not accede to the children and youth themselves, but rather to the adults who organize, co-ordinate and fund their sporting activities. They are the stewards of the well-being of children and youth and with them the responsibility for protection lies.

However, we have abundant reason to believe we have failed in our collective responsibility to secure the well-being of youth and children and assure that they grow and develop to their fullest capability. These injuries are preventable.

MOVING FORWARD

If we see mTBI as an educational issue then solutions will focus on better training for coaches and trainers to identify mTBI more accurately, better awareness among players concerning symptoms and appropriate steps to take in the case of an injury and improved training for educational institutions to accommodate injured athletes. If we see mTBI as a research issue, we will devote resources to better understanding mechanisms of injury, look for cellular markers of damage, look for improved diagnostics and imaging and longer and larger cohort studies to better understand the evolution and consequences of mTBI. All of these proposed remedies are laudable and have significant support. They will take time and investment in resources to come into effect.

However, if we see mTBI as a public health issue, we may wish to ask whether we have sufficient grounds to take precautionary steps to dramatically prevent further injury. We have knowledge of the nature of the injuries and their consequences and the means to protect children and youth from incurring these injuries.

What are the logical and available solutions to changing the sporting environment so that our children develop their social and physical skills through participation in athletics? Dramatic rule changes should be made to the games that children play from the recreational to the elite competitive level. Game and rule structure must be changed to eliminate head contact in all children's sports.

Options would include changes that would decrease the number of violent collisions secondary to natural laws include increasing the size of the playing surfaces, decreasing the number of

participants on the field of play. We should also consider logically eliminating the use of the head in games like soccer [30], and enforcing significant suspensions to participants or supervising adults involved in games in which head injuries occur.

Ultimately if non-biased surveillance determines that these significant considered changes do not alter the incidence of these serious, and previously non-documented brain injuries, consideration must be given to completely abolishing collision sports for participants under the age of 16. The age of 16 is considered as the earliest age at which an individual has the minimal ability of consent and capacity to make an educated decision concerning taking responsibility for their own independent actions.

Recently the Ministry of Education in Ontario (Canada) mandated publicly funded institutions to institute concussion curriculum education for all students grade 1 to 12, as well as mandating return to learn and return to play protocol for all students by January 31$^{s t}$ 2015. Addressing the education of the next generation is a significant step in the self-advocacy, and generational change concerning this injury and the sports that are causal.[31]

In Canada, two major commissions of inquiry have concluded that in matters of public health, pursuit of greater certainty regarding causality is not warranted when safety is at issue. Justice Horace Krever considered the results of the failure to invoke precautionary measures in taking steps to secure the safety of the blood supply "a public health disaster."[32] His reasoning was endorsed by Justice Archibald Campbell with respect to the public health response to SARS.[33]

It is worth noting that the accumulated evidence regarding mTBI in youth and children is approaching a more mature level than that of the Canadian blood system or in the case of SARS. In the case of SARS, there was, initially, no specific evidence about SARS coronavirus as it was a newly identified pathogen. Still a very large and comprehensive commission of enquiry found the health system negligent in not taking sufficient protective measures for health care workers. So, we know more about mTBI, but not everything. The point of the precautionary approach is to forego more specific evidence in order to mitigate harm. If we have the means to do that we have the moral obligation to act upon this knowledge.

If mTBI is truly both a public health problem and an important ethical concern, we would do well to reflect on this and take appropriate and immediate action to protect the futures of hundreds of thousands of youths involved in contact sports.

We continue to study sport related concussion, and attempt to find better treatments for this injury. We fail our next generation by not acting now on this issue. We must make significant structural changes in the games we play.

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