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Sports Legacy Institute "Hit Count™" White Paper

Concussions have been making headlines in professional sports for the past five years, and recently professional sports organizations have taken unprecedented steps to protect athletes from concussions and minimize their exposure to repetitive brain trauma, including sub-concussive blows.

Unfortunately, youth sports organizations have not received the same public scrutiny, and therefore while most programs have taken positive steps on the concussion issue, few if any are actively working to limit exposure to sub-concussive brain trauma. Today, children are exposed to levels of brain trauma that are considered dangerous and unacceptable for adults.

It is time to take more aggressive steps to protect the developing brains of youth athletes.

We believe that the fastest and most effective path to safer youth sports* is to **regulate the amount of brain trauma that a child is allowed to incur in a season and a year.** Like youth baseball has widely adopted a "Pitch Count" to protect the ulnar collateral ligament of the elbow from wear and tear, we urgently call for the development and adoption of a ***Hit Count*™** to limit the frequency of repetitive brain trauma. Theoretically, a lower ***Hit Count*™** would reduce the risk of concussion, risk of brain damage from sub-concussive blows, and would theoretically reduce the risk of Chronic Traumatic Encephalopathy (CTE), a degenerative brain disease linked to repetitive brain trauma.

We do not claim ownership of this idea. A ***Hit Count*™** has been proposed by prominent researchers, many of whom have provided the research evidence to support this policy proposal. Our goal is to make this great idea a reality.

To summarize, we are asking youth sports organizations to change the ways games are played and practiced, with the goal of significantly reducing the number of head hits children incur during sports participation. We hope that leaders of youth sports organizations can see the wisdom of this request.

Science

Scientific evidence exists to support ***Hit Count*™s.** There are still gaps and unknowns in the research connecting brain trauma to negative outcomes. As with most public health problems, we must make policy decisions before we have absolute knowledge of the issue, as we have with smoking policy. The world now acknowledges smoking is a risk for lung cancer. Has science definitively explained why only 10-20% of smokers die of lung cancer? No. Do we allow children to smoke? No.

Concussions/Traumatic Brain Injury: Decades of studies have illustrated that concussions can have both short and long-term negative neurological consequences. For the sake of brevity, rather than provide a literature review it is simpler to quote the Centers for Disease Control and Prevention:

Traumatic Brain Injury (TBI) can cause a wide range of functional short- or long-term changes affecting thinking, sensation, language, or emotions.

- Thinking (i.e., memory and reasoning);
- Sensation (i.e., touch, taste, and smell);
- Language (i.e., communication, expression, and understanding); and
- Emotion (i.e., depression, anxiety, personality changes, aggression, acting out, and social inappropriateness).[1]

TBI can also cause epilepsy and increase the risk for conditions such as Alzheimer's disease, Parkinson's disease, and other brain disorders that become more prevalent with age.[1] Repeated mild TBIs occurring over an extended period of time (i.e., months, years) can result in cumulative neurological and cognitive deficits. Repeated mild TBIs occurring within a short period of time (i.e., hours, days, or weeks) can be catastrophic or fatal. [2]

Sub-concussive Brain Injury: Evidence is accumulating that sub-concussive impacts, or impacts that do not produce any clinical concussion symptoms, may still be damaging to the brain, both in the short- and long-term. One study on high school football players found that players who received normal football brain trauma and did not report any concussion symptoms still had functional MRI changes that mimicked concussion players.[3]

Chronic Traumatic Encephalopathy: The evidence connecting brain trauma to CTE is older and more robust than many believe. It was first identified and named "Punch Drunk" in 1928, and both clinical[4] and pathological[5] studies have revealed that:

1. There is a distinct pathology in the brains of victims of repetitive brain trauma
2. *Everyone* diagnosed with CTE upon autopsy (now over 100 cases) received extraordinary brain trauma
3. There are no reported cases of CTE pathology in individuals who *did not* receive abnormal and excessive repetitive brain trauma
4. CTE risk appears linked to lifetime brain trauma exposure rather than diagnosed concussions

Referring back to the smoking analogy, smoking as a risk factor for lung cancer becomes even more interesting. Smokers are 'only' 15-30 times more likely to develop lung cancer than non-smokers.[6] Brain trauma victims are *infinitely* more likely to develop CTE, because no one has ever been diagnosed with CTE who was not exposed to that risk factor.

There are no recent epidemiological studies of CTE. One random sample of 250 boxers in the United Kingdom found that 17% had indications of CTE using primitive techniques of the time. At the Boston University Center for the Study of Traumatic Encephalopathy, a non-random sample of over 40 athletes who played ten or greater years of American football, with or without a history of other sports, has found that over 90% of cases are positive for CTE. The incidence and prevalence is unknown at this time.

The hypothesis that CTE is linked more to lifetime brain trauma exposure rather than concussions is admittedly tenuous. Historically, concussions have not been reported – some estimates indicate fewer than 10% of concussions end up in a medical report - so it is impossible to know any individual's true concussive and sub-concussive history. Whether or not the cause of CTE is only concussions, sub-

concussions, or a combination of both, a ***Hit Count™*** would limit exposure to either or both types of brain trauma would theoretically reduce one's risk of CTE.

Therefore, the science supports limiting an athlete's lifetime exposure to brain trauma.

Brain Trauma Exposure Data

Due to recent technological advances, we now have a better idea of the frequency and force of brain trauma received by athletes in football and hockey.* The table below includes most, but not all, studies on the frequency and severity of impacts in football and ice hockey. There is no similar published data on other contact sports.

Sport & Study	**Level**	**Mean Hits**	**Peak Hits**	**Mean g-force**	**Minimum**	**% 10-20**	**Revised mean**	**Revisted peak**
Football								
Crisco et al [7]	College	420**	1444	21**				
Mihalek et a l [8]	College	950	-	22				
Schnebel et al [9]	College	1353	-	-				
Broglio et al [10]	High School	652	2235	-				
Schnebel et al [11]	High School	520	-	-				
Talavage et al [12]	High School	/	1855	/				
Ice Hockey								
Brainard et al[13]	College Male	347	785	-				
	Avg. 118 sessions							
ibid	College Female	179	373	-				
	Avg. 105 sessions							
Reed et al [14]	Age 13-14	140	255	22	10g	36%	90	163

** Median

"-": not reported "/": not applicable to study

At this time no published data exists for football below high school. This data, from a limited number of teams and players, reveals that:

- Football players may receive 2,500 hits to the head exceeding 10g's each season
- The average may be around 1,000 hits per season
- The mean hit is just over 20 g's
- There is little difference between head acceleration in college and high school football

In hockey, players receive only a fraction of the number of hits to the head, but some male players still receive near 1,000 blows to the head per season. Due to technology limitations, soccer remains an unknown, although anecdotal evidence suggests that some individuals are involved in thousands of headers per season, mostly in practice.

Brain Injury and Age

The fact that the data indicates youth athletes are exposed to brain trauma with high frequency and severity is concerning, as most experts agree that the young brain is more vulnerable to trauma than the mature brain. The young athlete is at biomechanical disadvantages as well, as their head reaches 90% of full size by age 5, yet their body is only 20% of adult mass. Young athletes also have an absence of medical resources to help identify when a concussion has occurred. Among many other disadvantages, studies show children lack the knowledge and verbal skills to report concussion symptoms to adults.

Ethics

The other major problem with this data is the medico-legal concept of "informed consent." The laws of our society are constructed around the idea that human beings below the age of 18 are not developmentally mature enough to fully understand the consequences of their actions, and therefore cannot give informed consent. We have a separate court system for children, they cannot vote, and they cannot serve in the military or own firearms.

In the United States we are in the middle of a national discussion about whether or not professional football and hockey are too dangerous for the participants, and yet we expose children to the same sports without their informed consent.

Changes in the Pros

The ethics issue becomes even more complicated when we realize the efforts that professional athletes have made to protect themselves from brain trauma.

- While negotiating the collective bargaining agreement in 2011, the National Football League Players Association and National Football League agreed to reduce the amount of full-contact practices, with the goal of reducing brain trauma exposure. Teams are permitted a total of 14 full-contact practices for the year with 11 of those practices conducted during the first 11 weeks of the season. Youth football has no regulations, and some teams scrimmage four times a week and play two games on weekends.

- The NFL and NFLPA recently added an athletic trainer to the press box during games to help identify concussions.
- The Ivy League recently voted to limit brain trauma exposure, stating "Because of the seriousness of the potential consequences, the presidents determined the league needed to take proactive steps in protecting the welfare of our student-athletes." Teams are only allowed two full-contact practices a week (rather than the NCAA limit of 5) and two-a-day full-padded practices were banned.

No such changes have been proposed or launched in youth football, youth soccer, or rugby, the three sports with arguably the most repetitive brain trauma risk. No one has asked football coaches to reduce hitting in practice, or soccer coaches to consider reducing or tracking the frequency of headers, especially in practice.

It is important to recognize that the people making the decisions about how much brain trauma we expose children to are not the individuals receiving the brain trauma.

When those athletes have been consulted, they have asked for greater protections against repetitive brain trauma.

Consider that NFL players, some of the toughest athletes in world, have asked to be hit in the head less frequently. We imagine if we asked children if they wanted to be hit in the head fewer times, they would say YES!

Yet the children have no voice.

To Act or Not to Act

The decision now is to choose whether or not to establish regulations. The risk of inaction is that we continue to diminish the futures of athletes through unregulated and unnecessary brain trauma. Some experts have stated that we should not act until we know the incidence and prevalence of CTE to ensure we do not overreact.

We believe the true incidence and prevalence of CTE in the population to be irrelevant to this policy decision. What percentage of youth football players with greater than four years of experience, e.g. high school seniors, developing CTE is acceptable in our culture? I challenge anyone to propose a non-zero number. Two players, one 17 and 18 one years-old, have already been identified. A younger athlete who played multiple years of contact sports has yet to be studied.

Implementation

There are technological and monetary limitations to a pure ***Hit Count*™**, as ***Hit Count*™** systems currently are only sold for helmeted sports, and there are costs involved. A ***Hit Count*™** is not as simple as a pitch count, where coaches only need a pencil and paper.

However, hits to the head can be accurately estimated, and methods can be developed to approximate the brain trauma exposure during games and during practice based on known variables, like position. With these estimations, rule changes and practice guidelines can be provided to ensure few, if any, athletes exceed a proposed limit.

Little League pitch counts are limits on the number of "pitches thrown per day" and mandate up to three days of rest after exposure to elbow trauma to allow the ulnar collateral ligament to recover.

A ***Hit Count™*** should explore the following guidelines:

1. Minimum threshold to be considered a "Hit"
2. Maximum Hits per day (all counts stratified by age)
3. Maximum Hits per week
4. Maximum Hits per season
5. Maximum Hits per year
6. When the technology is available, should there be a "Total Force" threshold derived from number of hits times mean force per hit
7. Minimum required days of rest after a minimum brain trauma exposure

In football, a ***Hit Count™*** might lead to fewer practices that involve helmets and pads or the limits on the use of high impact drills. In soccer practice, it may mean tracking headers in practice and games. This policy is probably most critical to the youngest athletes, who may be at the greatest risk, and should receive less brain trauma than older athletes.

Goals

The goal of this proposal is to have a ***Hit Count™*** adopted by major youth sports organizations by 2013.

The next step will be to convene a meeting of experts, sports organizations, thought leaders, and industry to explore the current state of knowledge and the steps that would need to be taken to establish, adopt, and measure a ***Hit Count™.***

To start the conversation, we would like to propose that no athlete under 18 years-old be exposed to more than 1,000 hits to the head exceeding 10 g's of force in a season, and no more than 2,000 times in a year. Many youth athletes already exceed this high threshold, and would not be allowed to finish a season.

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