CONCUSSION LegacyFoundation

BU CTE Center

CTE PREVENTION PROTOCOL

A game plan for preventing CTE

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INTRODUCTION

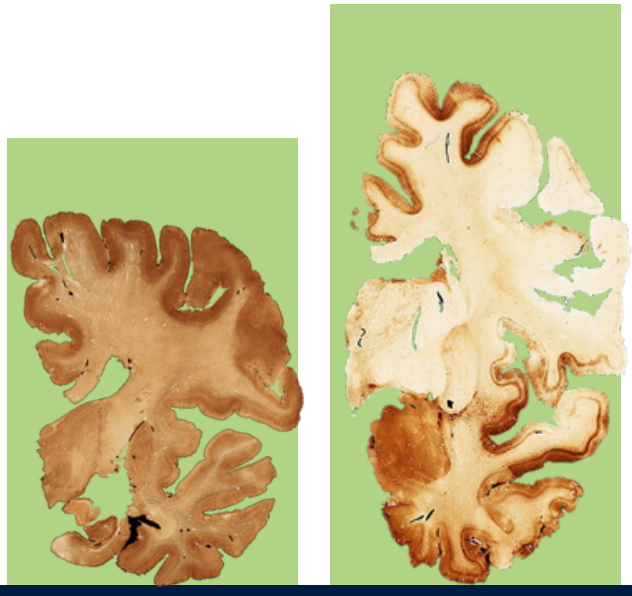
Chronic traumatic encephalopathy (CTE) is a degenerative brain disease caused by repeated head impacts (RHI).[1][2] CTE has been diagnosed most often in athletes who participated in contact and collision sports.

CTE has been diagnosed in athletes who played American football, Canadian football, Australian rules football, ice hockey, rugby union, rugby league, soccer, boxing, mixed-martial arts, extreme sports, and wrestling, among others.

CTE has been diagnosed in athletes as young as 17 years old. It appears progressive in most cases. Advanced cases of CTE cause dementia. Unfortunately, because we cannot yet accurately diagnose CTE in living athletes, we do not know how many athletes have it.

In the two largest brain banks studying contact-sport athletes, more than 80% of brain donors who played professional American football, Canadian football, soccer, rugby, and ice hockey have been diagnosed with the disease, suggesting CTE is not rare in those with exposure to RHI.[3] CTE has also been found in amateur athletes.

CTE is not just about concussions. Research-to-date suggests an athlete's risk of CTE is related to how many times they are hit in the head and the strength of those hits.



CTE, as shown in these images, causes the brain to become deformed and brittle. (Credit: Dr. Ann McKee, Boston University)

INTRODUCTION

To prevent CTE, we have to limit how many times, and how hard, athletes are hit in the head.

Sports organizations began implementing a Concussion Protocol around 2009 to reduce harm from concussions. [4] While concussion protocols are essential for protecting athletes from concussions, they will not prevent CTE.

It is time for sports organizations to commit to prevention and create CTE Prevention Protocols. There is not a cure for CTE. Once CTE begins, we do not know how to stop or slow down the progression of the disease.

We can prevent CTE. We encourage every sports organization to adopt a CTE Prevention Protocol.

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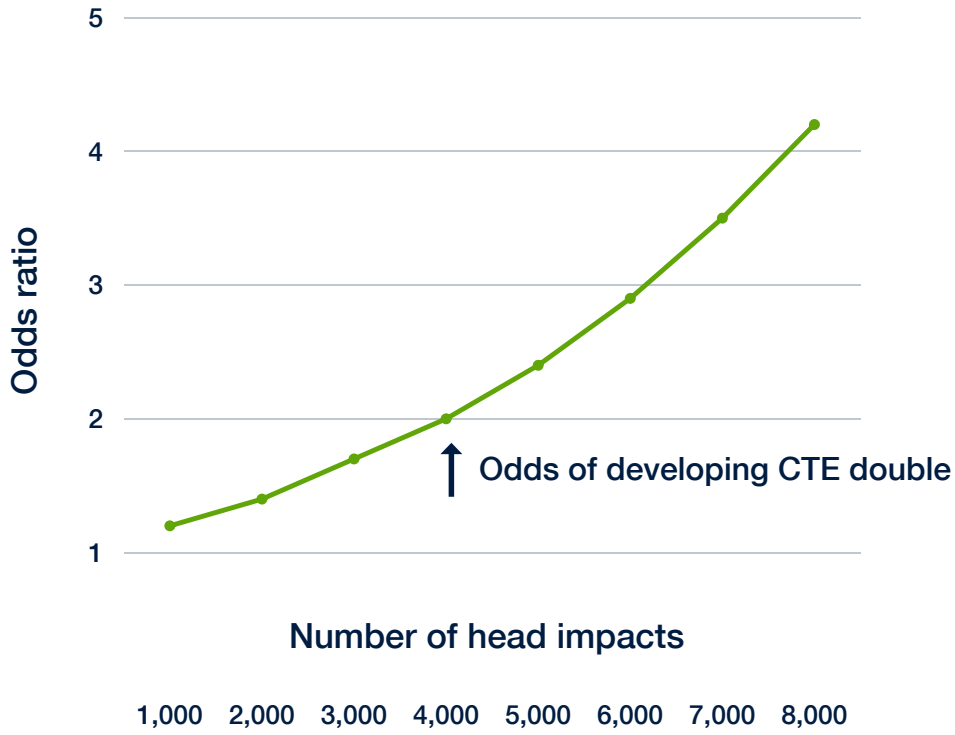
SCIENCE OF CTE PREVENTION

Research-to-date shows that an athlete's odds of developing CTE are not correlated with their number of concussions. A new study on deceased American football players revealed that two head impact variables are most associated with the development of CTE: the number of hits to the head, and the strength of hits to the head.[5]

1. Number of hits

Studies show that the number of head impacts is correlated with the odds of developing CTE and CTE severity. The largest study on CTE in American football players estimates that for every 1,000 head impacts, the odds of developing CTE increase by about 20%. Similar analyses have not yet been conducted on other sports.

However, there is no magic number of impacts that will cause CTE. Like smoking and lung cancer, the number of cigarettes that cause lung cancer is different for everyone and based on many other genetic and environmental factors.



SCIENCE OF CTE PREVENTION

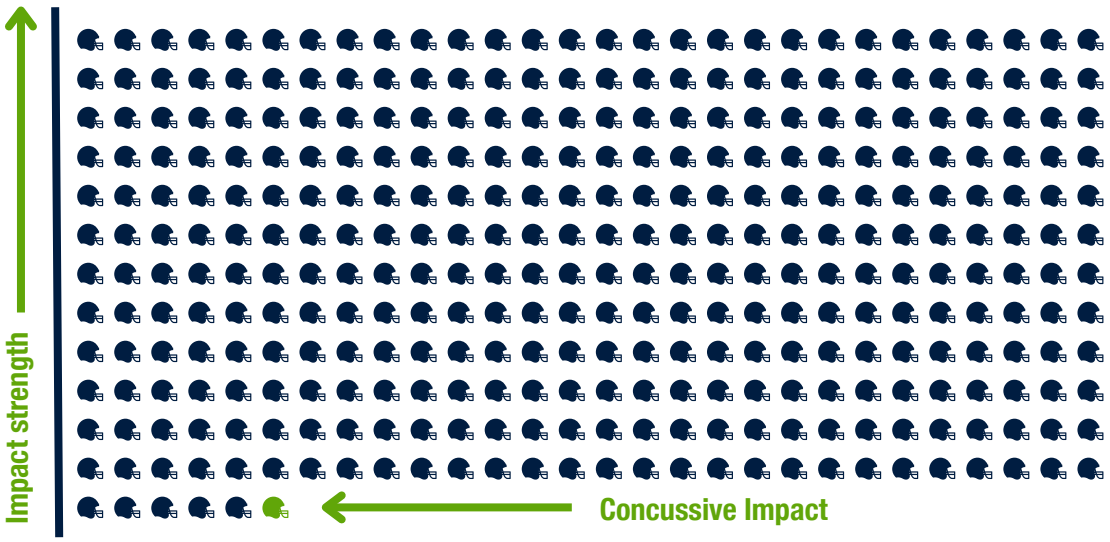
2. Strength of hits

Also known as magnitude, strength of hits refers to the maximum linear or rotational acceleration experienced by the head. The greater the strength of an impact, the more likely it is to cause a traumatic brain injury (TBI), either as a concussion or a subclinical TBI.

A subclinical TBI is silent. Not every brain injury will damage an area that triggers symptoms (such as headache or double vision), or cause signs (like loss of consciousness or loss of balance).

There is no known minimum strength threshold that causes a TBI. While small bumps to the head likely do not increase CTE risk, the force where head impacts begin to increase CTE risk is unknown.

Football players are exposed to more hard head impacts than you might think. One study of college football players found that for every concussion a player had diagnosed, they averaged 341 head impacts of greater strength than the concussion. [1] [2]



Consider the number and strength of hits as total force. [6] Among football players, lifetime total force has been shown to be most correlated to CTE risk.

The goal of a CTE Prevention Protocol should be to meaningfully reduce both the number of hits to the head, as well as the strength of hits.

A CTE Prevention Protocol based on these principles is also a concussion prevention protocol. The fewer hits to the head, and the fewer hard hits, the fewer concussions will be caused.

SCIENCE OF CTE PREVENTION

Case study in American Football

A high school offensive lineman averages 734 head impacts a season with an average strength of 26 g's.

Reduce number of hits

Because most hits occur in practice, if a coach changed practice to cut head impacts by half, it would eliminate about one-third of the overall head impacts (246, or ~15-20/week).[7] This change to practice throughout high school could lower a player's odds of developing CTE by 21%.

The table to the right shows how reducing 50% of head impacts in practice in high school and college would be expected to prevent 2,345 head impacts for an offensive lineman, potentially reducing their odds of developing CTE by more than 50%.

Overall head impacts

Level	Year	Current	Modified Practice*	Practice Impacts Eliminated
High School	Freshman	734	489	246
	Sophomore	734	489	246
	Junior	734	489	246
	Senior	734	489	246
College	Redshirt Freshman	545	272	272
	Freshman	815	542	272
	Sophomore	815	542	272
	Junior	815	542	272
	Senior	815	542	272
Total		6,741	4,396	2,344

*Redshirt year assumed 100% of practice participation and 0% of game participation.

SCIENCE OF CTE PREVENTION

Case study in American Football

The table below shows how eliminating the hardest 10% of impacts in high school and college would be expected to reduce the cumulative acceleration that an offensive lineman experiences by more than 40,000g, potentially further reducing the odds of CTE by 50%.

Reduce the strength of hits

If steps are taken to reduce the strength of impacts, the risk of CTE would be reduced even further. In practice, that might mean eliminating Oklahoma drills and doing fewer reps of high intensity drills. In games, that could mean fewer kickoffs, penalties for targeting or hitting defenseless players in the head and eliminating blindside blocks on punts.

The hardest 10% of impacts average more than 60 g's. Eliminating those impacts, about 75 per year, would cut more than 20% of the cumulative acceleration per season, independently reducing the odds of developing CTE.

Total force

Level	Year	Current	Modified Practice*	Total Force Eliminated
High School	Freshman	19,084 g	14,651 g	4,433 g
	Sophomore	19,084 g	14,651 g	4,433 g
	Junior	19,084 g	14,651 g	4,433 g
	Senior	19,084 g	14,651 g	4,433 g
College	Redshirt Freshman	12,710 g	9,758 g	2,952 g
	Freshman	17,115 g	12,046 g	5,069 g
	Sophomore	17,115 g	12,046 g	5,069 g
	Junior	17,115 g	12,046 g	5,069 g
	Senior	17,115 g	12,046 g	5,069 g
Total		157,506 g	116,546 g	40,960 g

Data from Broglio et al 2016 show that the average of the top 10% of hits experienced by a high school offensive lineman is at least 60.4g, resulting in a force of 4,433g per season. Data from Crisco et al. 2012 show that the average of the top 10% of hits experienced by college offensive lineman is at least 62.2g, resulting in a force of 5,069g per season.

PROVIDING CTE EDUCATION

To prevent CTE, athletes and coaches must lower the number and strength of hits to the head. Therefore, it is essential to teach people what CTE is, what it is not, and why it is worth preventing.

A CTE education program should include information on:

01

Causation

CTE is caused in part by repetitive TBIs which are usually caused by repetitive head impacts.

02

Pathology

CTE is a unique disease, with a specific pattern, that starts in specific parts of the brain, before spreading to other areas. It usually continues to spread after head impacts stop.

03

Symptoms

Current evidence suggests that CTE can cause problems with thinking and memory, as well as control of emotions and behavior.

04

CTE is different than concussions

Scientists have yet to identify any statistical relationship between CTE risk and the number of diagnosed concussions, self-reported concussions, or the management of concussions.

05

Case studies

It is important to put faces to the disease to understand how it impacts individuals as well as their families.

It is unclear when to initiate CTE education. Children and teenagers may not be able to understand the concept. The ability to understand long-term risk is not fully developed until early adulthood. Critically, most athletes being exposed to the risk of developing CTE are not old enough to provide informed consent.

PLAYBOOK FOR CTE PREVENTION

1 Change practice

To prevent CTE, coaches should consider whether they can teach skills:

1. Without creating head impacts
2. With fewer head impacts
3. With head impacts of lesser strength

Reduce number of hits by:

- Reducing the number of days that involve head impacts
- Reducing repetitions of drills that result in head impacts
- Replacing drills with different drills that involve fewer or no head impacts
- Eliminating out-of-season contact
- Teaching tackling or blocking techniques that lower the risk of a head impact

Reduce strength of hits by:

- Reducing repetition of drills that result in head impacts of greater strength
- Replacing drills with different drills that are less likely to result in high magnitude impacts
- Teaching tackling or blocking techniques that lower the strength of impacts to the head

Practice ALARA:

- ALARA is an acronym used to guide clinical decision making that stands for “as low as is reasonably achievable.” The ALARA principle recognizes that risk cannot be eliminated, but the benefits associated with risk should be obtained with the absolute minimum risk.
- As an example, football players and rugby players must learn to tackle a person to the ground safely to play the game and to minimize spinal cord and other injuries. They should be exposed to enough tackling training to reasonably minimize their risk of these injuries, but once that is achieved, the benefits of additional head impacts in tackling should be weighed against the costs of a greater risk of developing CTE.

PLAYBOOK FOR CTE PREVENTION

2 Change games

→ Reduce number of hits by:

- Changing the rules.
- Examples include:
  - In baseball, banning collisions at home plate
  - In the NHL, eliminating fighting

- Reducing the number of games
  - Place limits on the number of games per season

- Shortening games
  - In games that involve stopping the clock, consider letting the clock run in some situations to reduce the number of head impact exposures
  - Reduce the length of games

→ Reduce strength of hits by:

- Changing the rules.
- Examples include:
  - The NFL reduced the number of kickoff returns by moving up the kick line
  - The Metropolitan Independent Football League (USA) eliminated kickoffs completely at the high school level
  - Soccer could ban headers after punts and goal kicks

- Increasing the number and severity of penalties for hits to the head.
- Examples include:
  - The NFL now penalizes hits to the head on defenseless players
  - The NFL now penalizes “blindside blocks” on punts
  - World Rugby introduced a head contact framework that increased the number and sanction for high tackles that hit the head

PLAYBOOK FOR CTE PREVENTION

3 Change the age at which preventable repetitive head impacts are introduced

→ Raise the age of first exposure to activities that result in repetitive head impacts

- Delaying the introduction of aspects of the sport that result in repetitive head impacts (RHI) would reduce the number and severity of RHI, and thus would be expected to reduce CTE risk. Delaying RHI until age 14 is a reasonable goal. The majority of youth athletes will not play sports involving RHI beyond the high school level, meaning exposure to RHI from organized sports could be limited to only four years for most athletes.

- Some governing bodies have already begun to implement this change:

Case Study #1: USA Hockey and Hockey Canada have both delayed the introduction of body checking until age 13.

Case Study #2: The Football Association (UK) has delayed the introduction of heading in soccer (football) until age 12.

Case Study #3: If youth tackle football players were to transition to flag, they'd be expected to go from a median of 378 head impacts per season to 8.

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