



The Hit Count[®] Guide

for Parents, Coaches, Athletes, and Medical Professionals



Sports Legacy Institute
Waltham, MA

Table of Contents

Introduction	4
Precedents for Hit Count®	7
How Hit Count® Can Help	8
Fast Q&A on Hit Count®	10
How to Utilize Hit Count® to Protect Your Athlete	16
Closing Statement	17
Glossary of Key Terms	18
Disclaimer	23

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Introduction

For young people, participation in sports and recreational activities is an important part of physical, mental, and social development. While these endeavors are meant to promote health, sports carry an inherent risk of injury. Without the proper rules, training, equipment, or supervision, sports can put the health and well-being of young people at unnecessary risk.

Evidence is growing that the short and long-term health risks associated with brain trauma in sports are more serious than previously known. While concussions have been the primary focus of the medical community, the media, and the sports world, it appears they are only part of the problem. A growing number of studies show the risk of short-term and long-term brain damage, and neurodegenerative disease may be more closely related to an athlete's cumulative brain trauma over their lifetime. This brain

trauma includes both concussions and subconcussive impacts, which are rapid movements of the head that don't cause any concussion symptoms.

Studies are now finding that some athletes who have received subconcussive impacts, but have never shown any concussion symptoms, still have abnormal findings on certain tests of brain structure and function. It is not yet clear if these results were caused by too many impacts in a day, a season, a year, and even a lifetime, but one thing is clear:

No brain trauma is good brain trauma

The Hit Count[®] program is designed to allow parents, coaches, athletes, administrators, medical professionals, and researchers to directly measure brain trauma exposure in real time by counting the number of times an athlete receives significant brain trauma – their Hit Count[®].

New technology has given way to innovative, low-cost products that allow head acceleration to be accurately measured. Many companies have developed sensors small enough to be embedded in or on helmets, mouth guards, beanies, chinstraps, and headbands. These products provide a tremendous opportunity to record data that will allow us to monitor athletes and help them play smarter and safer.

Head Acceleration – a change in speed of the movement of the head.



The Role of the SLI

Sports Legacy Institute, a 501(c)(3) non-profit organization, launched the Hit Count® Initiative in February 2012. At that time, there were multiple companies selling or developing products designed to measure head acceleration. The primary function of the products was to measure acceleration, and the primary function was to provide an alert when an athlete suffered head acceleration that exceeded a threshold for concussion. However, because there is no specific threshold that leads to concussion, each product had a different threshold and a different level of accuracy. SLI recognized that each product could add a second function by measuring subconcussive impacts. To develop a metric that was simple and actionable, multiple devices would have to use the same threshold.

SLI Hit Count® collaborated with six companies in order to do the following:

1. Set a universal threshold for significant brain trauma – a “Hit”
2. Develop a test protocol to certify that the products are accurately measuring Hits
3. Educate the public on the advantages of a Hit Count®
4. Enable research on Hit Count® and the long term effects of repetitive brain trauma

Testimonial

“Washington Youth Soccer has been a leading advocate of concussion awareness and education for over 7 years, and is proud to support the Sports Legacy Institute and the Hit Count Initiative. Monitoring and regulating hits to the head in youth sports is the next step in preventing long term concussion effects in children. The Hit Count initiative is at the forefront of player safety and will help keep our youth soccer players safely on the field.”

*- **Doug Andreassen**, State President, Washington Youth Soccer*



Precedent for a Hit Count®

There are many precedents throughout sports, health, and fitness that make Hit Count® a logical solution to reducing the risk of brain trauma.

One of the major inspirations for Hit Count® came from the widely utilized Pitch Count program which is believed to have reduced the number of arm injuries in youth baseball. Under the system, youth baseball players are prohibited from throwing unlimited pitches in games. Instead, they are restricted to a specific number of pitches per day, according to age, and required to not pitch for a specific number of days so their arm may recover.

Hit Count® is a natural extension of this concept. If we monitor pitch counts to protect a child's elbow, we must monitor athletes' Hit Counts® to protect their delicate brains.

How Hit Count® Can Help

There are many reasons why monitoring and limiting an athlete's Hit Count® should lead to better outcomes and healthier brains. Below are 5 ways a Hit Count® can help.

1. Fewer Hits should mean fewer concussions

a. If all other things remain equal, a 50% reduction in Hits will lead to a 50% reduction of concussions

2. Fewer Hits should mean fewer subconcussive injuries

a. A growing body of evidence has revealed that impacts to the head that do not result in any signs or symptoms of concussion, and are never diagnosed as a concussion, can still cause temporary or potentially permanent brain damage

3. Fewer Hits should mean fewer cases of Second Impact Syndrome

a. Second-Impact Syndrome is a catastrophic brain injury that occurs in fewer than ten American athletes a year. About half of athletes die from SIS, and the survivors are usually permanently and significantly impaired. It is believed to occur when an athlete sustains an initial head injury and then suffers a second head injury before the symptoms associated with the first impact have cleared. This can cause rapid brain swelling requiring neurosurgical intervention.

4. Fewer Hits should mean fewer cases of Chronic Traumatic Encephalopathy

a. Chronic Traumatic Encephalopathy (CTE) is a progressive, degenerative brain disease found

Testimonial

"As a league we are committed to providing the safest possible environment for our players. Our partnership with the Sports Legacy Institute has helped in the assessment and prevention of concussion related injuries. We believe that the Hit Count® program can be instrumental in protecting our players' long-term health, ensure longevity of their careers as well as assist youth and college sports programs to make concussion care and training a priority."

- David Gross, Commissioner, Major League Lacrosse

in athletes and others who have suffered significant brain trauma. The risk of having CTE, as well as the severity of CTE, appear to be associated with an athlete's total lifetime brain trauma. Reducing the number of Hits may reduce risk of CTE.

5. Fewer Hits should mean less brain damage following concussions
 - a. Up to 90% of concussions are never diagnosed, and most concussions that are diagnosed are not detected until after the game is over. Additional Hits immediately following an undiagnosed concussion are believed to increase the severity of the brain injury

Hit Count® is an Active Tool to Change Behavior

When used properly, Hit Count® can provide real-time feedback that can be used to change the behavior at both the team and individual levels to lower risk of negative outcomes.

1. Team Hit Count® (primarily monitored by coaches, sports administrators, and athletic trainers): Football studies using sensors have revealed a wide range of brain trauma exposure. Coaches have to be aware of multiple variables, not limited to:
 - a. The number of games and contact practices
 - b. The types of drills used
 - c. The number of repetitions of contact drills for each player
 - d. Technique

Some teams may end up with a Hit Count® that is twice or three times as high as other teams. Hit Count® allows teams to monitor their exposure and learn how to play the game more safely.

Case Study

In 2012 a team of researchers from Virginia Tech and Wake Forest Universities studied three youth football teams, consisting of 9 to 12 year olds, with sensors (teams A, B, and C) ². Only one team, Team A, set restrictions on the amount of full-contact practice and made other changes to limit exposure to brain trauma.

¹ Cantu, RC, Gean, AD. Second-Impact Syndrome and a Small Subdural Hematoma: An Uncommon Catastrophic Result of Repetitive Head Injury with a Characteristic Imaging Appearance. *J Neurotrauma*. 2010 September; 27(9): 1557–1564.

At the end of the season, the average player on team A had a Hit Count® of 61. The average player on team B had a Hit Count® of 145. The average player on team C had a Hit Count® of 106. Some in the football community have voiced concerns that if we limit contact in football practice, players will be unprepared for the game and will suffer more injuries. This recent evidence refutes this theory, as team A did not suffer more injuries overall than teams B and C.

This leads to the conclusion that all three teams could have had a Hit Count® of 61 or below, and players on teams B and C suffered thousands of unnecessary hits.

Which team do you want your child to play for?

2. Individual Hit Count® (primarily monitored by parents, athletes, coaches and athletic trainers): Some players are exposed to more brain trauma than others. The difference may be caused by playing time, technique, or many other variables. Hit Count® allows for athletes at the higher end of the spectrum to be identified early, and a plan to reduce an individual's exposure to be implemented before extreme numbers are reached.

Case Study

In the Virginia Tech-Wake Forest study, while the average Hit Count® among the teams was 128, some players had a HC below 40, while others were above 300.

What do those players do differently? What changes can you make to their technique? Can we limit exposure in practice?

Testimonial

"Hit Count® data helps me to work in partnership with my coaches to design safer practices, as well as identify athletes who may need personal attention on technique or other modifications. Hit Count® is core part of our efforts to help athletes excel on the field while protecting their futures."

*- **John Pizzi**, Athletic Director, The Riverdale Country School*

² Cobb et. Al. Head impact exposure in youth football: elementary school ages 9-12 years and the effect of practice structure. *Ann Biomed Eng.* 2013 Dec;41(12):2463-73.

³ 10's is not the Hit Count® threshold. On average, about 50% of football impacts are between 10 and 20 g's.

Fast Q & A on Hit Count®

1. Which sports is this appropriate for?

Hit Count® is appropriate for any activity that involves exposure to repetitive brain trauma including football, soccer, ice hockey, lacrosse, wrestling, rugby, skiing, snowboarding, and action sports.

2. What is the sensor measuring?

Hit Count® certified products are designed to measure acceleration of the brain. Sensors attached to the helmet, chinstrap, mouthpiece, and against the skull in headbands or beanies measure movement of the head from a fixed point or multiple fixed points.

3. What is the threshold for a Hit?

SLI and a group of volunteer medical advisors reviewed the published literature and theory on brain trauma, and determined that a 20 g linear acceleration in a 50 millisecond window was the most logical threshold to determine a “Hit” based on current science.

An acceleration or deceleration of the head that reaches 20 g’s is not known to occur with normal activities associated with sports, like running and jumping. It represents an abnormal movement of the head that is associated with direct impact to the head or an impact to the body that causes a whiplash like movement. Learn more in the Hit Count® White Paper at HitCount.org.

4. Why is there only one threshold for a Hit?

There is only one threshold for a Hit because the goal of Hit Count® is to create a simple, actionable metric for brain trauma exposure. That may change as more is learned about brain trauma. Learn more in the Hit Count® White Paper.

5. What is a safe Hit Count® for a season or for a year?

There is not a definitive number. But we expect that programs will use Hit Count® as a behavior modification tool, assessing each athlete’s Hit Count® every day and using the Hit Count® Calculator along with the Hit Count® Comparison Tool to project an athlete’s Hit Count® at the end of the season, and make appropriate adjustments during the season. The SLI Medical Advisory Board regularly reviews new research and will update Hit Count® guidelines accordingly. To learn the latest updates, subscribe to the newsletter at HitCount.org and follow us on Facebook and Twitter.

4 Broglio SP et al. Cumulative head impact burden in high school football. J Neurotrauma. 2011 Oct;28(10):2069-78.

6. What is the Hit Count® Calculator?

The Hit Count® Calculator is a tool that allows you to enter Hit Count® data at any point during the season and project forward to a full season Hit Count® and full year Hit Count®. SLI recommends using the Hit Count® Calculator in conjunction with the Hit Count® Comparison Tool.

7. What is the Hit Count® Comparison Tool?

The Hit Count® Comparison Tool is way to compare your Hit Count® data to that of other athletes and teams in the same sport. For example, in the Virginia Tech-Wake Forest study referenced on page [insert page number when finalized], three different teams had average Hit Counts® of 61, 106, and 145. Therefore, a team of 9 to 12 year olds might use this as a frame of reference to set a goal to be close to or below a Hit Count® of 61. In general, the lower the Hit Count®, the better.

8. How should I set a Hit Count® goal for a season?

There is currently no scientific way to determine a Hit Count® goal. SLI recommends utilizing the Hit Count® Comparison Tool to evaluate peer players and teams. SLI is constantly reviewing research publications and available data on brain trauma exposure in each sport to share how some sports manage to play successfully and safely with a lower Hit Count®.

9. What sports and positions are the most dangerous?

Sensors have only been used in a limited number of sports, so it is too soon to say which sports and positions are associated with the highest Hit Count®. The most important variable may be how the particular sport is practiced, played, and coached.

10. Who is responsible for counting Hits?

1. Parents

Parents have an important role in advocating for greater safety in youth sports. They are encouraged to monitor their child's Hit Count® on a daily basis, use the Hit Count® Calculator and Hit Count® Comparison Tool, and work with their child and his/her coach to identify ways to minimize Hit Count®.

2. Coaches

Coaches should monitor their athletes' Hit Count® and play an important role in reducing Hit Count® through changes in practice planning, teaching technique, and changing

dangerous behaviors.

3. Athletic Trainers

Athletic trainers, who are vital resources for teams, should work with all parties to monitor Hit Count® and eliminate unnecessary brain trauma.

4. Sports Administrators

Administrators are the ultimate decision makers on Hit Count®. We encourage them to learn about Hit Count®, the science behind it, and adopt it for their contact sports.

5. Athletes

Athletes can take an active role in reducing their risk of negative outcomes by monitoring their Hit Count® and taking personal responsibility for their future.

11. Does it matter how many Hits one has in a single day?

Yes, there is pilot data showing that high levels of brain trauma exposure in a single day has been associated with increased risk of brain damage. However, few studies have looked at this phenomenon, and we hope Hit Count® leads to more research on the effects of one day's worth of repetitive subconcussive brain trauma.

12. Are there differences by age or gender?

There are probably differences, but there hasn't been enough research to provide guidelines.

13. Does SII make Hit Count® products?

No, SII does not make Hit Count® products. SII certifies Hit Count® products.

14. What does it mean if a product is Hit Count® certified?

If a product is Hit Count® Certified, it has passed the Hit Count® Certification Test. This means that a product meets a standard for accurately measuring acceleration at the Hit Count® threshold.

15. How do I know if my product is Hit Count® Certified?

Look for the Hit Count® Certified Mark.





16. How can I access my data?

Every Hit Count® Certified product is unique. Check with the manufacturer.

17. Does my Hit Count® data remain private or can it be accessed by anyone?

Check with the manufacturer. Personal medical information is protected by HIPAA laws. Data collected by a company should not be associated with any identifying information, like your name, and should not be able to be tracked back to you.

18. If my data is collected, what would it be used for?

Hit Count® and other sensor data is being collected so that researchers can help identify safer ways to play sports and understand how certain levels of trauma can affect the brain.

19. What is SLI's relationship with the Hit Count® Companies?

Hit Count® Companies must pass the Hit Count® Certification Test. In addition, the company must become a licensee of the Hit Count® program. Licensing fees are used to advance research and education.

20. What if I cannot afford a Hit Count® product?

It is SLI's goal that by understanding the effects of brain trauma, we can learn safer ways to play sports. We hope that as we discover safer ways to play, the changes will be adopted by all sports programs, whether or not they use Hit Count® products.

How to Utilize Hit Count® to Protect Your Athlete

Hit Count® is an important part of a comprehensive safety strategy. The SLI Concussion Checklist (ConcussionChecklist.org) includes ten areas that every program, coach, and parent should focus on in order to provide the safest possible environment for their athletes.

A key to making Hit Count® an effective prevention tool is to assess an athlete's Hit Count® every day and at the end of every season.

The daily Hit Count® should be reviewed and entered into the Hit Count® Calculator, which helps turn a daily Hit Count® into a season total.

The projected season Hit Count® can then be reviewed alongside the Hit Count® Comparison Tool to how the Hit Count® compares to other players and teams.

Learn more at HitCount.org

Closing Statement

There is no dispute that repetitive brain trauma can be dangerous for an athlete. While participation in sports and recreational activities is an important part of physical, mental, and social development, concussions and Chronic Traumatic Encephalopathy can tragically derail an athlete's otherwise promising future.

Hit Count® is the best way to ensure that your athlete is minimizing his or her risk of brain trauma in sports.

We owe it to youth athletes to do more to keep them safe.

Glossary of Key Terms

1. **Sensors** – a device that can measure impacts.
2. **Impact** – a collision that causes an athlete’s head to accelerate (begin moving, like being hit by a moving object) or decelerate (stop moving, like hitting the ground)
3. **Sensor Device** – a product with an embedded sensor or sensors to measure impacts.
4. **Hit Count® Certified Device** - a product that meets a certification standard established by SLI that measures a sensor product’s ability to accurately measure acceleration of the head at the Hit Count® Threshold of 20 g’s of linear acceleration.
5. **Hit Count® company** – a company that makes Hit Count® Certified Devices
6. **Brain Trauma** – acceleration or deceleration of the head that causes the brain to move within the skull
7. **g’s** – a measure of acceleration relative to the acceleration of gravity (g) at sea level. 20 g’s equals twenty times the acceleration of gravity
8. **Threshold** – the magnitude or intensity that must be exceeded for a certain reaction, phenomenon, result, or condition to occur or be manifested
9. **Hit Threshold** – a peak acceleration of at least 20 g’s in a 50 millisecond window of time
10. **Hit** – any Impact that causes acceleration that meets or exceeds the Hit Threshold
11. **Hit Count®** – the number of Hits an athlete receives in a specific time period
 - a. Daily Hit Count®
 - b. Weekly Hit Count®
 - c. Monthly Hit Count®
 - d. Season Hit Count®
 - e. Annual Hit Count®
 - f. Lifetime Hit Count®
12. **Cumulative brain trauma** – a measure of the number of impacts and the magnitude of each impact. Also known as total brain trauma exposure
13. **Concussion** – according to CDC, a concussion is a type of traumatic brain injury, or TBI, caused by a bump, blow, or jolt to the head that can change the way your brain normally works. Concussions can also occur from a blow to the body that causes the head to move rapidly back and forth
14. **Subconcussive impact** – an impact that causes the head to accelerate, but does not cause any signs or symptoms of concussion

15. **Signs & symptoms of concussion** – Signs of a concussion are defined as changes in brain functions that can be seen by an observer. According to CDC, signs of concussion include:

- a. Appears dazed or stunned
- b. Is confused about assignment or position
- c. Forgets an instruction
- d. Is unsure of game, score, or opponent
- e. Moves clumsily
- f. Answers questions slowly
- g. Loses consciousness (even briefly)
- h. Shows mood, behavior, or personality changes
- i. Can't recall events prior to hit or fall
- j. Can't recall events after hit or fall

Symptoms of a concussion are changes in brain function that can be noticed by an athlete. According to CDC, symptoms include:

1. Headache or "pressure" in head
2. Nausea or vomiting
3. Balance problems or dizziness
4. Double or blurry vision
5. Sensitivity to light
6. Sensitivity to noise
7. Feeling sluggish, hazy, foggy, or groggy
8. Concentration or memory problems
9. Confusion
10. Does not "feel right" or is "feeling down"

16. **Chronic Traumatic Encephalopathy** – a progressive, degenerative brain disease linked to brain trauma, and once known by the names "punch drunk" and "dementia pugilistica"

17. **Linear acceleration** – the rate of change of velocity without a change in direction

18. **Rotational (or angular) acceleration** – the rate of change of angular velocity with respect to time. Angular acceleration is measured in revolutions per minute squared or in radians per second squared

19. **Force** – a measure of mass times acceleration

20. **Velocity** – a measure of distance divided by time

21. **Acceleration** – the rate of change in velocity with respect to time

22. **Hit Count® Limit** – a theoretical number of Hits that should be the maximum number allowed in a specific time period. There is not yet enough evidence to support specific limits

23. **Hit Count® Comparison Tool** – a tool that uses published data to tell a team or an athlete how his or her Hit Count® compares to other people. Provides the relative risk of exposure
24. **Hit Count® Calculator** – a tool that allows users to enter Hit Count® data to project an athlete's Hit Count® in a longer period of time, like a season or a year

Disclaimer

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