The Effect of Chronic Traumatic Encephalopathy (CTE) on Elementary and Secondary Student Football Players and Preventive Guidelines

M Lee, B Eck, P A Clark, B Edmonds

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Abstract

The death of (American) high school football players following an on-field collision during a game (according to media, eight in 2013, five in 2014, seven in 2015, and at least three in 2016) has alarmed us that we should make serious adjustments or improvements on the way the sport is currently practiced. Parents are increasingly worried whether they should allow their children to play football, some school districts have entirely shut down their football programs, and the number of male high school football players has continuously fallen to about 1.08 million in 2015, a 2.4% decline from 2010.[1] On the other hand, college and professional football leagues (NCAA Football and NFL) which are the preeminent games in the U.S, let alone the NFL the most watched sport followed by Major League Baseball (14 %). And youth and high school football programs are the gateways leading to as well as a nursery for the college and professional leagues. Thus, the warning signs are taken as great threats to hurt the football organizations' lucrative business, so they have systematically downplayed and denied the seriousness of the players' brain injuries and politically lobbied against the scientific research on the link between paying football and head injuries, though they recently admitted some truths about the danger of the sport. This paper, focusing on traumatic brain injury (TBI) and its degenerative kind, chronic traumatic encephalopathy (CTE), will survey the historical and medical narratives about head injury and contact sports, particularly American football; examine the current controversies and difficulties that occurred with research procedures and results of the scientific communities on head injury and football; investigate the currently proposed football practice-guidelines and game-rules by football organizations; lastly, propose recommendations which may serve as rather concrete and exhaustive guidelines for the elementary and secondary student football programs.

[1] Ken Belson, "As Worries Rise and Players Flee, a Missouri School Board Buts Football," The New York Times, Sep. 28, 2015, accessed Oct. 18, 2016, http://www.nytimes.com/2015/09/29/sports/football/As-Worries-Rise-and-Players-Flee-a-Missouri-School-Board-Cuts-Football.html.

INTRODUCTION

American Football, a high contact sport, requires players to wear full protective padding, including helmets. Despite these precautions, players are repeatedly subject to intense blows to the head that can cause mild traumatic brain injury (MTBI), or concussions, which range in severity. A more severe concussion is classified as a traumatic brain injury (TBI), and many concussions can lead to the degenerative condition known as chronic traumatic encephalopathy (CTE). CTE was initially thought to have been a disease primarily associated with boxing, and was originally named "dementia pugilistica" or "punch-drunk syndrome." This life-changing and currently untreatable disease can cause loss of memory, difficulty controlling impulsive or erratic behavior, aggression, depression, impaired judgment, and the gradual onset of dementia.[1]

According to Brain Injury Research Institute (BIRI), approximately 1.6-3.8 million sports and recreation-related concussions are reported each year. About 60% of these are due to playing football.[2] As of 2015, the total of 87 out of 91 deceased NFL players has been tested positive for CTE according to new figures from the nation's largest brain bank focused on the study of traumatic head injury[3] The CTE

must have begun at some point in a player's career, but it is almost impossible to pinpoint when exactly it does. However, it is presumed that the CTE begins early on, as we observe the fact that a player such as Tyler Sash, a former NFL Giants safety, died at the young age of 27 years old. Tyler Sash played for 16 years when his brain exhibited the level of CTE comparable to that of the late Hall of Famer, Junior Seau, who committed suicide when his age was 43-year-old. For a young player to display the symptom at such an advanced stage, he would have had to experience MTBI starting perhaps when he was in elementary school.[4]

It is reported that the incidence of concussion in high school sports is .24 per 1000 between years 1997-2008.[5] Of all concussions here, more than half were reported in the sport of football (incidence .60), and girls soccer had the second highest rate (incidence .35). And most significantly, the concussion rate has increased 4.2-fold over the 11 years (15.5% annual increase). The top four sports with an increased incidence of concussion include football, soccer, lacrosse, and wrestling.[6] A recent report from a Canadian study shows a similar finding with top sports including rugby, hockey and American football (incidence 4.18, 1.2 and .53 respectively) and an overall incidence of concussion as .23 per 1000.[7] The BIRI also reported that a concussion suffered by a high school student has much more of an impact than one by a college student. Lack of proper diagnosis and management of a concussion may result in serious long-term consequences or risk of coma or death.[8]

Boxing is banned in elementary and secondary schools and at most colleges because medical evidence is clear that chronic brain damage was prevalent among most fighters. Unless we do something drastically to protect our children who play the sport from getting concussions, the fear is that elementary schools and high schools will place a ban on football as well. This ban could be forced upon the schools by lawyers and even insurance companies. Or the cost of educating our children could become greatly expensive by the cost of insurance premiums for children who play football.

In 2013, eight high school students die directly from on-field injuries in a game, five in 2014, seven in 2015, and at least three died in 2016.[9] These incidents lead a number of school districts to shut down their football programs because of safety concerns.[10] The number of male high school football players has fallen to about 1.08 million in 2015, a 2.4% decline from five years ago.[11] And the case reported about youth football or "pee-wee football" whose players are primary school students (the age of 5 to 15) is even worse. When Dr. Ann McKee, the neuropathologist and head of Chronic Traumatic Encephalopathy Center (CTE Center) at Boston University, testified before a House Judiciary committee on football brain injuries in 2009, she said that "because a young athlete's brain is still developing, the effects of a concussion, or even many smaller hits over a season, can be far more detrimental, compared to the head injury in an older player."[12] A recent statistical data, seen as confirming McKee's view, indicate that the rate of concussions in elementary level football games has been much higher than both high school and college football. Youth football players (ages 8-12) were 26 times more likely to receive a concussion in a game than in practice.[13]

There are numerous youth/pee-wee leagues among which the largest league is Pop Warner, which boasts over 400,000 boys and girls participating in its programs and over 5,000 football teams in the United States today.[14] And most high school football programs, whether the schools are public or private, are governed by the National Federation of State High School Associations (NFHS), as the NFHS writes rules for the football programs' practices and games. It seems as if these organizations began to address the safety concerns and propose various programs and rules. However, it seems far from that their guidelines or protocols are concrete enough or effective to protect these young players from the known dangers of the sport, particularly from developing CTE. Thus, we propose our own rather concrete and exhaustive recommendations which can serve to be included as part of their guidelines or procotocols and to set some research directions for the scientific community dedicated to preventive pediatric sports health related to football. The methodological approach we take in proposing our recommendations is creative as well as eclectic, in the sense that we will investigate other organizations' suggestions and, when evaluated as viable, include them as our own. To proceed now, this paper, focusing on TBI and CTE, will survey the historical and medical narratives about head injury and contact sports, particularly American football; examine the current controversies and difficulties that have occurred with research procedures and results of the scientific communities on head injury and football; investigate the currently proposed football practice-guidelines and game-rules by football organizations; lastly, propose recommendations.

[1] "What You Need to Know About Brain Injuries & Concussions," Brain Injury Research Institute, accessed Oct. 18, 2016, http://www.protectthebrain.org/FAQs.aspx.

[2] Ibid.

[3] Jason M. Breslow, "New: 87 Deceased NFL Players Test Positive for Brain Disease," PBS Frontline, Sep. 8, 2015.

[4] Lindsay Gibbs, "Former NFL Player Who Died At 27 Had Brain Disease Believed To Be Caused By Head Trauma" Think Progress, Jan. 27, 2016, accessed Oct. 18, 2016, https://thinkprogress.org/former-nfl-player-who-died-at-27-had-brain-disease-believed-to-be-caused-by-head-trauma-46d556b886d5#.wbxu0bcos

[5] A. E. Lincoln et al, "Trends in Concussion Incidence in High School Sports: A Prospective 11-Year Study," American Journal of Sports Medicine 39 (2011): 958, accessed Oct. 18, 2016, doi: 10.1177/0363546510392326.

[6] Ibid.

[7] T. Pfister et al, "The Incidence of Concussion in Youth Sports: a Systematic Review and Meta-analysis," British Journal of Sports Medicine 50/5 (2016): 292-7, accessed Oct. 18, 2016, doi: 10.1136/bjsports-2015-094978.

[8] "What You Need to Know About Brain Injuries."

[9] Alan Neuhauser, "Sudden Death," U.S. News, Aug. 11, 2016, accessed Jan. 2, 2017, http://www.usnews.com/news/articles/2016-08-11/sudden-death-the-mysterious-brain-injury-killing-young-football-players; Jacqueline Howard, "High School Football Player Dies Two Days After Injury in Game," CNN, Sept. 27, 2016, accessed Jan. 2, 2016, http://www.cnn.com/2016/09/26/health/high-school-football-player-death-ohio/.

[10] Edwim Riosoct, "We Had No Idea This Many Kids Have Died Playing High School Football This Year," Mother Jones, Oct. 21, 2015, accessed Dec. 15, 2016, http://www.motherjones.com/media/2015/10/high-school-football-death-camron-matthews.

[11] Ken Belson, "As Worries Rise and Players Flee, a Missouri School Board Buts Football."

[12] Allen Barra, "America's Most Dangerous Football Is in the Pee-Wee Leagues, Not the NFL," The Atlantic, Aug. 31, 2013, accessed Dec. 20, 2016. http://www.theatlantic.com/entertainment/archive/2013/08/americas-most-dangerous-football-is-in-the-pee-wee-leagues-not-the-nfl/279229/.

[13] Lindsey Straus, "Youth Football Concussion Study Criticizing Limits on Contact Practices As 'Shortsighted' Generates Controversy." MomsTeam.com, 16 Dec. 2016, accessed Dec. 20, 2016, http://www.momsteam.com/health-safety/youth-football-concussion-study-generates-controversy-over-suggestion-that-limiting-contact-practices-mistake

[14] "History of Pop Warner," Pop Warner, accessed Dec. 20, 2016, http://www.popwarner.com/about_us/history.htm.

THE CONTROVERSY OF NATIONAL FOOTBALL LEAGUE (NFL) OVER PLAYERS' HEAD INJURY

The clinical significance and negative impact that CTE brings to the athletes have been downplayed for years in contact sports in our society. Terms like "Punch Drunk Syndrome" and "Boxer's Dementia" have been used to describe CTE merely as a risk of playing such sports.[1] This attitude was, in fact, propagated through medical expert's opinions. In 1994, the NFL doctor, Elliot Pellman stated in his interview with the popular sports magazine, Sports Illustrated, "Concussions are part of the profession, an occupational risk."[2] However, as more and more clinical studies have been conducted while showing strong clinical ties between the repeated brain injuries of the football players and CTE, the NFL's denial has turned into a large settlement for thousands of players.[3] Dr. Pellman, now stigmatized as "Dr. Evil of the NFL" has been forced into retirement after nearly 30 years of service at the league.[4]

The NFL controversy had been simmering for decades, but it was the 1993 NFL championship game which took place in January 1994 that a quarterback, Troy Aikman, suffered a traumatic concussion which caused the NFL acknowledge a concussion problem and thus developed the Mild Traumatic Brain Injury Committee led by Dr. Pellman in the same year, 1994. Aikman was seen as the poster child for concussions, a term he "has really tried to distance [himself] from" following the 1994 concussion that landed him in the hospital over night.[5] Aikman explained that his experience with concussions is much less severe than players before him, and that "there has certainly been a lot more attention paid to it right now." Later in 1994, severe concussion incidents drove a running back, Merrill Hoge, to retire from the game completely. Hoge could not even recall that he had a wife, brother, or newborn child.[6] However, in 1995 the former NFL commissioner, Paul Tagliabue, rejected the link between CTE and football, calling it a "pack journalism issue."[7] Tagliabue also stated that "it's probably just a big coincidence that so many former football players have both the disease and the same symptoms, and an even bigger coincidence that CTE has never been found in someone who didn't experience brain trauma." This denial is what led to thousands of lawsuits form former NFL players who feel that the NFL has been hiding the effects of concussions from them. However, more recently in 2016, the league vice president of health and safety, Jeff Miller, admitted the link between football and the development of the degenerative brain disorder, CTE.[8]

With this admittance, many of the settlements that were to be given have been no longer in place. The settlement which the NFL has agreed upon will only effectively compensate those players that exhibit symptoms of diseases such as Alzheimer and Parkinson's. This is due to the scientific community's inability to provide the rather clear evidence that links repeated head trauma and CTE. Meanwhile, the Boston University CTE center, particularly, the team led by Dr. Robert Stern, had been conducting a major research to

find the link. However, it turned out that, to prevent the research, the NFL "pressured the National Institutes of Health to strip the $16 million project from" the team and "decided to throw in a $2 million payment to help reduce any criticism they would receive."[9] Co-chairman of the NFL's committee on brain injuries, Dr. Richard Ellenbogen even fought Robert Stern by saying that Stern had a "conflict of interest" and that the "grant application process had been tainted by bias."[10] This statement was the result of Ellenbogen's own conflict of interest as both a researcher and NFL advisor. It was also proven that Ellenbogen had applied for the same $16 million grant from the NIH and did not receive it. On the other hand, the NFL Commissioner, Roger Goodell, asked Dr. Elliot Pellman to retire after a 30-year career, as Goodell has announced that the new Chief Medical Officer, Pellman's replacement, would "help ensure that our clubs have access to the most up-to-date information, that our research funds are spent in an effective and targeted way, and that our players and team staffs receive timely and thorough information on injuries and injury prevention."[11]

[1] "Boxing's History with CTE," Neurologic Rehabilitation Institute at Brookhaven Hospital, accessed Oct. 18, 2916, http://www.traumaticbraininjury.net/boxings-history-with-cte/.

[2] Lauren Ezell, "Timeline: The NFL's Concussion Crisis," Frontline, Oct. 8, 2013, accessed Oct. 18, 2016, http://www.pbs.org/wgbh/pages/frontline/sports/league-of-denial/timeline-the-nfls-concussion-crisis/. Also, Michael Farber, "The Worst Case: Doctors Warn that Repeated Concussions Can Lead to Permanent Brain Dysfunction," Vault, Sep. 19, 1994, accessed Oct. 18, 2016, http://www.si.com/vault/1994/12/19/132920/the-worst-case-doctors-warn-that-repeated-concussions-can-lead-to-permanent-brain-dysfunction.

[3] On the other hand, the sport such as rugby still struggles over the same level of acknowledgement as that of the NFL. Under the heavy legal scrutiny, in 2015 the England Professional Rugby Injury Surveillance Project (PRISP) and Premiership Rugby and the Rugby Players' Association declared a significant increase in MTBI since 2014 [Tom Soulsby "Professional Rugby Injury Surveillance Project Report published for 2014/15," RPA, March 24, 2016, accessed Oct. 18, 2016, http://therpa.co.uk/professional-rugby-injury-surveillance-project-report-published-for-201415/]. The report shows that professional players in the Premiership league received 59% more concussions in the 2013-2014 season as compared to the stable rate in the 2012-2013 season [Daniel Schofield, "Rugby Concussions Soar by 59 Per Cent, Says Report," Feb. 11, 2015, accessed Oct. 18, 2016, http://www.telegraph.co.uk/sport/rugbyunion/premiership/11407436/Rugby-concussions-soar-by-59-per-cent-says-report.html]. Although this rising rate may be due to greater awareness and increased medical attention, many concern that this increase in the rate of concussions is so shocking in the relation to American Football. In the Premiership rugby, nearly one third of the injuries sustained occur during training and at any one time it is not out of the ordinary for a club to be without one quarter of its players. The release of these skyrocketing statistics by PRISP places the Premiership rugby at a higher rate of injury than that of American football.

[4] Tom Pelissero, "Controversial NFL Dr. Elliot Pellman Forced into Retirement by Roger Goodell," USA TODAY, July 20, 2016, accessed Oct. 18, 2016, http://www.usatoday.com/story/sports/nfl/2016/07/20/elliott-pellman-concussions-roger-goodell-health-safety/87340872/.

[5] Bob Wolfley, "Fox's Aikman Takes a Pass on Concussion Issue," Journal Sentinel, Jan. 8, 2011, accessed Dec. 20, 2016, http://archive.jsonline.com/blogs/sports/113137639.html.

[6] "Concussions Force Merril Hoge to Retire," Deseret News, Oct. 18, 1994, accessed Dec. 20, 2016, http://www.deseretnews.com/article/383760/CONCUSSIONS-FORCE-MERRIL-HOGE-TO-RETIRE.html.

[7] Lauren Ezell, "Timeline: The NFL's Concussion Crisis," Frontline, October 8, 2013, accessed Dec. 20, 2016, http://www.pbs.org/wgbh/pages/frontline/sports/league-of-denial/timeline-the-nfls-concussion-crisis/.

[8] Des Beiler, "In Stunning Admission, NFL Official Affirms Link Between Football and CTE," The Washington Post, March 14, 2016, Dec. 20, 2016, https://www.washingtonpost.com/news/early-lead/wp/2016/03/14/in-stunning-admission-nfl-official-affirms-link-between-football-and-cte/?utm_term=.3aec4ccbfb52.

[9] Steve Fainaru and Mark Fainaru-Wada, "OTL: Report Lambasts NFL for Vast Overreach," ESPN, May 24, 2016, accessed Dec. 16, 2016, http://www.espn.com/espn/otl/story/_/id/15667689/congressional-report-finds-nfl-improperly-intervened-brain-research-cost-taxpayers-16-million.

[10] Ibid.

[11] "Controversial NFL Dr. Elliot Pellman Forced into Retirement by Roger Goodell."

COLLEGE SPORTS AND HEAD INJURY

The athletes' repeated head injury is not the concern existing only in the professional sphere. In the mid 1900's, National College Athletic Association (NCAA) is evaluated to have provided college boxers with the maximum level of protection by their rules and regulations. The NCAA required 12-ounce gloves (compared to 8 and 6 ounces as standards in professional boxing), the padded headgear, and the thick-felted canvas flooring which were relatively sufficient guarantees against most extraordinary cases of serious injury. Perhaps even more important than protective equipment, college referees stopped bouts as soon as a boxer seemed to be definitely outclassed, let alone in danger of a severe beating."[1] Nevertheless, throughout the 1950s the NCAA and colleges participating in the sport of boxing received much criticism and speculation, as boxing was "attacked as barbaric and inappropriate for good universities."[2] In 1959, Sports Illustrated ran a segment on "the problems facing college boxing" which was titled "You could blame it on the moms."[3] Eddie Sulkowski, the Penn State's boxing coach from 1949 to 1985, agreed that college boxers should not have the goal of injuring their opponents, and rather would have them box just enough within regulations to win the bout without destroying their opponent.[4] At the end of the 1950 national championships, the NCAA Boxing Rules Committee expressed its concern for the welfare of its participants by announcing that they were planning to eliminate brute strength and slugging as key factors by placing a "higher premium on skill and perfection in the art of boxing."[5] The goal in doing so would be to minimize knockouts by rendering no value or weight in scoring to power blows and giving body blows the same scoring value blows to the head and face. This new rule and overall expectation of a new, more skillful form of

boxing actually seemed to help collegiate boxing stay in existence despite great opposition. However, this all came to a halt on April 9, 1960, when NCAA boxer Charlie Mohr passed away after losing the championship fight to Stu Bartell in the second round after a powerful blow from Bartell. It is reported that after the fight, Mohr slipped into a coma and died 8 days later.[6] The autopsy did not explain how "a healthy brain could have been so grievously injured by the blows college boxers are able to inflict through padded gloves striking a padded headgear."[7] Mohr had received brain damage in the left frontal area, which indicated that the fatal blow would have been a right-handed punch from Bartell. That Mohr had an aneurysm was suspected and accepted as plausible because "if had been a healthy artery it would not have burst under the impact of Stu Bartell's heavily padded fist against a padded headgear."[8] Although many proponents of the sport gathered in support of Mohr and all young men who practiced the sport, this episode directly caused college boxing to end, which is the reminiscent of the recent shutdown of the football programs by many school districts after the death of high school football players in recent years. Many suspect now that the boxer who died had already been suffering MTBI.

There is another NCAA sport, which was not banned like boxing but shows an increase in MTBI statistics. This sport is wrestling, and in recent years, per the NCAA reports, wrestling has been placed in the top tier of the concussion-producing sports that the association offers.[9] However, facing the rise of MTBI statistics among the college wrestlers, the NCAA has taken a progressive step to resolve the concussion problems. Over time, the NCAA wrestling has barred many of the moves deemed to be responsible for injury, such as throws, slams, and dangerous holds in the sport played by the athletes.[10] Also, the NCAA is reportedly in the process of changing time in which an official should assess an injury in wrestling; the change will allow the official to examine an athlete for an unlimited amount of time, rather than the previous 90-second limit.[11] In 2015 and 2016 the NCAA Wrestling Rules Committee "recommended a rule change that would allow medical personnel an unlimited and unimpeded amount of time for concussion evaluation of wrestlers, beginning in the 2016-17 season."[12] These recommended rules state that in cases of uncertainty, the medical staff is to be given the ability to remove participants from the wrestling area to perform a concussion evaluation. In order to allow proper time for evaluation, the match will be suspended until the medical professional renders a decision. In order to provide medical personnel "dedicated and uninterrupted time with the injured athlete so they can make a more accurate health and safety decision in an already limited timeframe," the referee, the coaches of both participants, and the non-injured wrestler would be required to remain on the mat during the evaluation.[13] In order to further relieve stress in this situation, a concussion evaluation timeout will not count as an injury timeout or recovery timeout.

We turn now to the NCAA's football. Recent years college football's reputation has been plagued by a sex scandal, corruption, etc. However, two concerns stand out as the arguments that college football should be banned. One is a concern for a head injury for the young athletes whose brains are still growing. It has been the established scientific fact that human brain continues developing until a person is around 25. Besides, typical college freshmen or sophomore, 17- or 18-year old persons are only "halfway through the process of brain development and change that began only with puberty."[14] The second concern is that the football program in most colleges is a billion-dollar business that has no place de facto in the institution of higher learning. Apart from the Ivy League Football, which declines to compete for a national title, the college football functions as a minor league for the NFL. The two concerns are inseparable in that it is extremely difficult for the college to give up this major business despite the growing evidence for the players' brain injury and elevated dementia rates.

After all, the NCAA has known about the danger of head trauma since before it's beginning in 1906. The association reacted partially via the creation of some safety rules intended to better protect the health and safety of the college football players. [15] However, it was not until 1916, over a decade after the tragic deaths of the eighteen college football players, that led to the intervention of President Roosevelt, that the first NCAA Football Rules Code was developed and published.[16] But still, the players were not required to wear helmets until 1939. And years later in 1976, the athletes were restricted from using their helmets to "deliberately and maliciously use his helmet or head to butt or ram an opponent"; instead, the players were urged to tackle with helmets up or to the side in order top prevent any severe impact to the head. [17] [18] In 1994 the NCAA Concussion Guidelines were published. In 2002 the association developed safety related rules such as "a

defenseless player"; more extensive medical examinations in 2003; completely clear eye shields for fast medical diagnosis of head injuries in 2006; and the "horse-collar tackle" declared illegal in 2008.[19] All of these rules have been designed to limit the amount of unnecessarily brutal impact seen in the sport of football. However, the players still seem to continue to experience a significant extent of brain injury.

[1] Martin Kane, "The End of College Boxing," Sports Illustrated Vault, April 25, 1960, accessed Dec. 16, 2016, http://www.si.com/vault/1960/04/25/589337/the-end-of-college-boxing.

[2] Doug Moe, "Doug Moe: 50 Years Ago, UW Athlete's Death Ended College Boxing," Wisconsin State Journal, April 8, 2010, accessed Dec. 18, 2016, http://host.madison.com/wsj/news/local/doug_moe/doug-moe-years-ago-uw-athlete-s-death-ended-college/article_4a56a5e8-012c-580d-bde9-21361d66b3a4.html.

[3] Ibid.

[4] E. C. Wallenfeldt, The Six-minute Fraternity: The Rise and Fall of NCAA Tournament Boxing, 1932-60 (Westport, Conn.: Greenwood Press, 1983), 205.

[5] Ibid., 229.

[6] "Doug Moe: 50 Years Ago, UW Athlete's Death Ended College Boxing."

[7] Ibid.

[8] "The End of College Boxing."

[9] John Keilman, "Studies Shine Harsh Light on Wrestling's Concussion Rate, Impact on Athletes," Chicago Tribune, Jan. 10, 2016, accessed Oct. 18, 2016, http://www.chicagotribune.com/news/ct-wrestling-concussions-met-20160110-story.html

[10] Ibid.

[11] Ibid.

[12] Greg Johnson, "Wrestling Rules Committee Recommends Concussion Evaluation Proposal" NCAA.com, April 15, 2016, accessed Dec. 18, 2016, http://www.ncaa.com/news/wrestling/article/2016-04-15/wrestling-rules-committee-recommends-concussion-evaluation.

[13] Ibid.

[14] "Brain Maturity Extends Well Beyond Teen Years" National Public Radio, October 10, 2011, accessed Oct. 18, 2016, http://www.npr.org/templates/story/story.php?storyId=141164708.

[15] NCAA Const. art. 1.3.1 reprinted in 2013–14 NCAA DIVISION I MANUAL 1 (effective Aug. 1, 2013), NCAAPublications.com, accessed Dec. 13, 2016, http://www.ncaapublications.com/.

[16] "Football Injuries: Data From the 2004/05–2008/09 Seasons," NCAA, accessed Dec. 13, 2016, http://cdn.ca9.uscourts.gov/datastore/library/2013/08/02/NCAA_Football%20Injuries.pdf

[17] Rodney K. Smith, "Head Injuries, Student Welfare, and Saving College Football: A Game Plan for the NCAA," Pepperdine Law Review 41/2 (2014): 267.

[18]"Football Injuries: Data From the 2004/05–2008/09 Seasons."

[19] "Head Injuries, Student Welfare, and Saving College Football"

ELEMENTARY AND SECONDARY SCHOOL FOOTBALL, AND HEAD INJURY

While professional and college footballs have been criticized for not being able to protect their players, elementary and secondary school football programs are experiencing the same level of criticism and scrutiny. However, before we proceed further on this subject, it seems interesting to pay attention to the following data analysis. An analysis of the U.S. national injury databases from 2002 to 2006 suggests that, among pediatric patients, sports-related concussion diagnoses result in a significant number of emergency department (ED) visits.[1] [2] It is reported that concussions in pediatrics between 8- and 19- year-olds resulted in more than 500,000 ED visits between 2001 and 2005, while 50% of these visits resulting from a sports-related mechanism. In the child patients between the ages of 8 and 13 years with concussion visits to the ED, sports-related mechanisms were the reasons for 58% of the visits, whereas these injuries accounted for 46% of all concussions in adolescents (14-19 years old). Also, according to the National Hospital Ambulatory Medical Care Survey conducted between 2002 to 2006, 144,000 ED visits for concussion were reported during the years. And the most common mechanism of concussion was sports related and accounted for 30% of all concussions in individuals between 5 and 19 years of age. 42% of these concussion visits were between the ages of 5 and 14 years, whereas those between 15 and 19 years of age accounted for 40%. Also, according to CDC report, from 2001 to 2009 an estimated 2.65 million adolescents, aged ≤19 years, sought treatment for sports and recreation-related injuries in emergency departments (EDs), and approximately 6.5%, or 173,285 of these injuries, were traumatic brain injuries (TBIs). During the years, the estimated number of sports and recreation-related TBI visits to EDs increased 62%, from 153,375 to 248,418, and the estimated rate of TBI visits increased 57%, from 190 per 100,000 population to 298. Activities associated with the greatest estimated number of sports and recreation-related TBI ED visits varied by age group and sex. For males and females aged ≤9 years, TBIs most commonly occurred during playground activities or when bicycling. For those aged 10-19 years, males sustained TBIs most often while playing football or bicycling, whereas females sustained TBIs most often while playing soccer or basketball, or while bicycling.

This report, however, is limited by only including TBIs that were the principal diagnosis and primary body part injured, but not TBIs that were secondary diagnoses (i.e. related to another injury or result of another injury, such as skull

fracture). It is admitted that there are no available assessments as to whether the increased number of ED visits from 2001 to 2006 resulted from an increase in incidence or an increase in awareness of TBI and concussion. However, many studies produced in recent years, as displayed in the foregoing sections, point to the plain facts that a greater rate of concussions exists among youth players and that the student athletes do suffer from TBIs which will advance or worse over the players' career especially if the players continue to play in high-risk positions.

To focus on youth football, youth/pee-wee football includes the student players whose ages range from 5 to 15 years old. And the acceptable weight of a player is from 35 to 160 lbs. Different organizations of youth football, though Pop Warner has the largest league, will allow for higher divisions for players that do not fit this specific criterion. As an athlete enters a high school football program, the athlete is introduced to a dramatic variety of players of different weight and ability. As to which level of football is more dangerous, it may depend on the league, gear, and specific regulations set in place. A 2013 study conducted by researchers from the University of Pittsburgh and Cornell University tracked 468 participants, 8-12 years of age, from 4 youth tackle football leagues in Western Pennsylvania over the course of a single season. The study was aimed at revealing information with regards to the amount of concussions received in football practices and how that number compared to the number received during football games using 20 medically diagnosed concussions from 20 different participants. Of the 20-recorded concussions among youth players, 15 occurred in players ranging from 11 to 12 years of age. According to the study, the "concussion injury rate for youth football games was 6.16 per 1,000 AEs (athletic exposures; 1 AE = participation in a game)."[3] The study compared this rate to that of high school and college football, and the rate of concussions in elementary level football games was much higher than both high school and college football. High school football exhibited the lowest rate at 1.55 and 1.29 per 1000 AEs, and college football exhibited a rate of 3.02 per 1000 AEs. Youth football players (ages 8-12) were 26 times more likely to receive a concussion in a game than in practice. High school and college players were about 7 times more likely to receive a concussion in a game than in practice. Players at skilled positions such as linebacker, running back, and quarterback received 19 out of the 20 medically diagnosed concussions, giving these skilled positions the highest risk factor for concussion injuries.[4]

This above study is to prove that limiting contact in practice would reduce the overall amount of concussions received, while it should be emphasized that teaching youth players how to tackle properly in order to prevent such concussion injuries in a game setting is greatly important. Besides, there has been recent advancements in protective equipment for the student athletes and in the ability to test for concussions after the athletes have already sustained concussions.[5] To introduce some of the key improvements, the American Academy of Pediatrics (AAP)'s policy statement stands out.

The AAP's statement consists of seven recommendations. Concluding that concussions and catastrophic injuries to the head and neck are associated with player-to-player contact and tackling improperly, the Academy suggested that efforts should be made "to improve the teaching of proper tackling technique and enforce existing rules prohibiting the use of the improper technique."[6] The first recommendation addresses the responsibility of officials and coaches in properly enforcing the rules of the game, eliminating the culture of tolerance of illegal hits, and establishing a new culture, which should possess stronger sanctions for contact to the head. Second, the Academy suggests that the overall removal of tackling from football would result in a certain decrease in the incidence of all tackling related injuries and thus that the participants in football must choose whether the recreational benefits associated with proper tackling will outweigh the inevitable injuries which accompany the action of tackling properly. Third, football organizations should consider forming non-tackling leagues to allow young athletes to play the sport and stay active, while virtually eliminating the risks associated with tackling. Forth, coaches and officials should be responsible for reducing incidents of subconcussive blows to the head by limiting helmet-to-helmet contact, thereby reducing the athlete's risk of developing long-term health problems. Fifth, to the issue that the delay in the age at which tackling should be allowed may result in even more damage when athletes finally reach tackling age, the Academy has responded with uncertainty. However, it suggests that during the period in which athletes are too young to tackle, coaches should teach them to properly tackle and evade tackles. Regardless, the Academy opines that, though tackling in a game has not been experienced, an increase in a concussion and other related injuries may still result once players reach the suggested age at which they would be able to tackle. Sixth, physical

therapists, athletic trainers, or strength and conditioning specialists are needed to provide expert training for pediatric athletes, specifically focusing on cervical muscular development which would serve in slowing acceleration of the athletes' head after impact. The seventh and last recommendation is that the football organizations should have athletic trainers on sidelines during games and practices, thus increasing the availability and immediacy of proper treatment of sport-related injuries such as concussions[7].

Meanwhile, the NFL and i9 Sports have proposed their own youth program to assure that the game is becoming less dangerous. They have run the program which exhibits a form of football that involves detachable flags instead of tackling. The common age range for this "Flag Football" is from 4-17 years old, but many players move on to tackle football at around 5th grade. The game is usually played with a smaller squad of about 6 players instead of 11, and a smaller field that is about 60-70 yards in length. This structure helps players learn the sport of football in a non-intimidating way. The flag football not only does this drastically reduce the chances of injury, but also, according to i9 Sports president Brian Sanders, "teach good sportsmanship."[8] The flag football run by the NFL and i9Sports has seen an increase in participation by 52% and 40% respectively, which suggests that more parents have become aware of the dangers of tackle football.[9] And the parents who are unsure if they should allow their children to play tackle football seem to have found refuge in the Flag Football.[10]

Also, the youth football league, Pop Warner, has introduced "Heads Up Football" program in partnership with USA Football, the governing body for American amateur football. The Heads Up Football is designed to drastically reduce full-contact practice time by prohibiting head-on blocking and tackling drills so that there can be a significant decrease in injuries and concussions.[11] The actual figures after adopting these rules showed a 63% decrease in practice injuries and 45% decrease overall including games.[12]

The Heads Up Football was first developed by USA Football in 2013 in consultation with the N.F.L. in response to an 800,000 participant decline, which was generally attributed to the prevalence of brain injuries. This program was designed primarily to "improve safety and reassure parents." The program requires one "player safety coach" per team. Each "player safety coach" is required to attend "a clinic that focuses on concussion recognition and response, blocking and tackling techniques, proper hydration, and other safety topics."[13] The regular coach of a team within this program is also required to receive an education in these areas via an online course.

However, a controversy arose over the USA Football's funded research. The NFL donated $45 million to USA Football in order to build the program. USA Football then gave a $70,000 grant to the Datalys Center for Sports Injury Research and Prevention who was also in charge of the NCAA's injury research. And on February 2015, Datalys gave U.S.A. Football false results that were immediately published. These preliminary results concluded, "leagues that used Heads Up Football had 76 percent fewer injuries, 34 percent fewer concussions in games and 29 percent fewer concussions in practices."[14] However, it was discovered that the only Heads Up leagues that have shown any effect on such injuries have been the programs that have adopted Pop Warner practice rules.[15] Also, the paper disguised a Nervous System (stinger), when "a blow to the spine causes extreme pain and numbness through the arms," as "Wind knocked out" with the defense that more parents would recognize "Wind knocked out."[16] This replacement of terms may seem insignificant, but it reduces the severity of injuries to the readers of the paper. All this has given the NFL, USA football, and Datalys an untrustworthy status, and the lead Datalys researchers, Zachary Kerr and Thomas Dompier, took the blame for that.[17]

However, despite the mistake, research outside of Datalys reveals data in strong support of the Heads Up Football program. Bill Curran, the director of Activities and Athletic Programs at Fairfax County Public Schools, Virginia, explains that Heads Up Football has proven to reduce overall injuries by 24% and concussions by 43% since its implementation in 2013. The catch, however, is that the county has reduced contact practices from about 90 minutes per practice to 90 minutes spread across one week's worth of practices. Curran also explains that he gives USA football a great amount of credit for the Heads Up program, "but it takes a hell of a lot more than going to their website and taking the online courses and getting accreditation." [18]

Nevertheless, although programs such as Flag Football and Heads Up Football and other hybrid programs have developed with various guidelines, they do not provide universal guidelines for the contact sport of football.

We intend to propose our own recommendations which may

serve as the universal guidelines for the youth and high school football. However, it seems, first, crucial for us to further understand medical indications about MTBI and CTE, for we know that CTE does not occur over night for most players but develops over time starting from MTBI when the players were elementary and secondary student athletes. Thus, we turn now to medical analysis.

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MEDICAL ANALYSIS

Head trauma, with or without loss of consciousness, is an acute biomechanical process that alters neurological function on the cellular level. Typically, patients experience short-term changes in memory and orientation and then have the return of normal function. When patients suffer repeated brain injury associated with moderate or severe trauma, with or without loss of consciousness, the process of recovery can be more prolonged and even not be fully recovered. However, studies show that children and adolescents may be more susceptible to concussion than adults[1] and thus require a longer and more conservative treatment approach to treat them.[2]

The first clinical investigation on repeated brain trauma may be the pathologist H. Martland's 1928 study on the progressive neurological deterioration prevalent among boxers, otherwise known as "punch drunk."[3] As describing the clinical symptoms associated with this deterioration, he noted that boxers, even years after retiring from the sport, experience memory loss, aphasia, dysarthria, and tremors. In 1937, J.A. Millspaugh termed "dementia pugilistica" as the first clinical recognition to refer to a symptom prevalent almost solely in boxers, "pugilists."[4] He explained that dementia pugilistica (DP) was a progressive neurological and psychiatric decline in athletes subjected to repeated bouts of head trauma. Though now known as a subtype of CTE, DP is a clinically unique disease with key features and pathological changes that help further to understand the spectrum of CTE.[5] Later in 1954, W. Brandenburg and J. Hallvorden came to identify, as the pathological symptom, "senile" plaques and cortical atrophy in boxers suffering "punch drunkenness."[6] Then in 1957 M. Critchley coined the term "chronic progressive traumatic encephalopathy" (CPTE) as he highlighted the clinical characteristics of the symptom among a group of boxers.[7] However, perhaps due to the symptom's association with only one sport, CPTE gained little attention over the proceeding years.[8] But in the last several years, as the athletes participating in American football, hockey, rugby, wrestling, rodeo, mixed martial arts, and even the extreme, bmx bicycling, as well as the professionals such as military personnel and stunt performers claimed to exhibit the same or similar kind of progressive neurological deterioration, the known symptom gained wider attention in our society now with a more general term, "chronic traumatic encephalopathy" (CTE). [9] [10]

In the last several years, there has been a significant development in the study of the brain trauma. The CTE Center at Boston University School of Medicine, established in 2008, has run various research projects, ranging from the "brain bank" project which aims to collect and study post-mortem human brain and spinal cord issues to understand the effects of the trauma, to the study looking to develop diagnostic criteria for CTE.[11] Now thanks to the works of

many researchers including the Boston CTE team, we have far better knowledge about head injuries and brain trauma such as MTBI and CTE.

From the perspective of clinical medicine, CTE is the syndrome which involves a spectrum of neurological adaptations present years after the patient's traumatic event(s). These adaptations occur due to the compounding effects of changes in the brain, particularly the progressive neuro-degeneration characterized by the deposition of hyperphosphorylated tau (p-tau) as neurofibrillary tangles.[12] From the standpoint of medical science, CTE is defined as the presence of the followings: (i) perivascular foci of p-tau immunoreactive astrocytic tangles and neurofibrillary tangles; (ii) irregular cortical distribution of p-tau immunoreactive neurofibrillary tangles and astrocytic tangles with a predilection for the depth of cerebral sulci; (iii) clusters of subpial and periventricular astrocytic tangles in the cerebral cortex, diencephalon, basal ganglia and brainstem; and (iv) neurofibrillary tangles in the cerebral cortex located in the superficial layers.[13]

Resulting from these neuropathological changes, patients begin to develop symptoms as these deposits progress. Based on the classification for CTE developed by McKee and his colleagues at the CTE center, there exist different pathological findings in four distinct stages, and each stage correlates with progressive clinical signs and symptoms. Though many patients may not experience the symptoms for eight to ten years after their history of repetitive mile traumatic brain injury (MTBI).[14] Patients in stage one can be asymptomatic or present with nonspecific symptoms including headaches, mild mood swings, and irritability. As the disease progresses, stage two manifests impulsivity, aggression, depression, short-term memory loss, and even heightened suicidality.[15] In stage three, the patient exhibits the onset of severe neurological changes including dementia, gait and speech abnormalities and parkinsonism.[16] Due to this reason, this stage is often mistakenly diagnosed as Alzheimer's disease.[17] Patients at the advanced, stage four, are subject to profound loss of attention and concentration. The symptoms may include a severe decline in executive dysfunction, language difficulties, exclusivity, aggressive tendencies, paranoia, depression, gait and visuospatial difficulties. Overall approximately 20% of CTE cases admit to some form of substance abuses[18] and 31% of patients are suicidal at some point in this course.[19]

From the standpoint of researchers, a few years ago the largest barrier to recognizing the true prevalence of CTE was considered the selective bias that individual researchers had.[20] little medical scientific evidence pointed to identifiable risk factors associated with the development of CTE beyond a history of repetitive mild brain trauma.[21] The severity of head trauma, frequency, and associated findings was documented but unknown contributions to the development of CTE. Genetic factors had also been purported but not substantiated as well.[22] However, in recent years a great research development was made in the field. The Boston CTE team was able to show, based on post-mortem brain examination, that elevated levels of tau proteins were found in "blood samples of 96 former football players between 40 and 69 years old," which suggests that "absorbing repeated head hits earlier in life can lead to higher concentrations of tau in the blood later."[23] Of course, the research does not lead to the conclusion that repeated brain hits are the clinical causes of CTE because the finding is only the total amount of tau in the blood, not that of the specific tau linked to CTE. Further tests are currently underway to "determine the amount of the CTE-related tau in the blood samples."[24] Nevertheless, it is evaluated to have closed the gap further between the repeated head hits and CTE.

One area of particular interest because of this research is the child and adolescent athletes who sustain MTBI injuries. However, before proceed further, it should be noted that from a clinical standpoint "pediatric brain" and "pediatric patient" are referred to as ones under the age of 18, so the terms, "pediatric" and "adolescent," are understood under the same pediatric category. In this paper, we will follow the common medical parlance unless otherwise specified.

Pediatric patients (<18 years of age) present some complex features and symptoms that clinicians and medical scientists should pay special attention to when examine and treat traumatic brain injury, mainly due to the fact that their brains are still developing.[25] Their development not only includes neurological development but simultaneous musculoskeletal growth that plays an important role in the biomechanics of the young person's brain. The pediatric brain differs in water content, degree of myelination and vasculature, compared to the adult brain.[26] [27] Biomechanical differences including head to trunk ratio, cervical muscle strength, locomotor and vestibulomotor activity play important roles and slowly develop to reach to adult levels around the age of 7-10 years.[28] Also,

emotional and cognitive maturity do not even develop well into 20's.[29] These facts are highly important to consider when pediatric patients suffer head trauma.

M. Kennard may be the first person who performed some of the known physiologic research on the plasticity of the neurologic system. Her 1930 work to show that the pediatric brains are more "plastic" is still considered a landmark in the field to this day[30] The plasticity of the pediatric brains refers to the fact that the brains recover better from injury when having undergone neurologic injury at an earlier age, compared to adult brains.[31] When minor injuries are done, pediatric brains recover better than adult brains.

On the other hand, when it comes to repeated or severe injuries, the pediatric brain is more vulnerable. Due to its small size and underdeveloped parts, the young brain is not better at handling the injuries at an early age.[32] [33] Particularly, the brain size is a significant concern. Since the pediatric brain occupies less space in the cranial vault and has a higher brain to water ratio, the relative impact force needed to cause a similar brain injury to that of an adult is higher. [34] [35] This puts pediatric patients at higher risk for cerebral swelling and cellular damage that may not be readily apparent.[36] [37] Specifically, at the cellular level, higher sensitivities to glutamate and N-methyl-d-aspartate have been shown in the pediatric population and both are known to have increased release when a head injury occurs.[38] Glutamate itself is the most abundant neurotransmitter in the brain, and a synergistic effect has been postulated between its receptors and cytokines that can increase neuronal injury and possibly chronic neurodegeneration.[39] Thus, if symptoms are the result of higher traumatic forces due to the biomechanical properties of the pediatric skull, brain to water ratio, head to trunk ratio, and cervical muscle strength, the effect of multiple asymptomatic or sub-concussive impacts on brain development can be detrimental.[40] [41]

These are important implications on MTBI in the child and adolescent patients including how the brain is affected by such an injury, what alterations could possibly occur, and the speed at which recovery is achieved compared to an adult brain. [42] [43] [44] In brief, despite the plasticity, the physical vulnerability makes the recovery from MTBI, in the pediatric population, longer than in the case of most adult populations.[45] [46] [47] [48] Because of this prolonged recovery the pediatric brain is also thought to be more vulnerable to further injury after already sustaining even an MTBI.[49] [50] [51]

However, today's society has set the standard at which children and teens should perform academically at a high level of cognitive demand. Even with normal cognitive function and development, their school work is an exhausting and stressful task for many students. Thus, demanding that a concussed student performs at a similar level of function before they recover is not only unfeasible but also further prolonging recovery and increasing vulnerability for long-term sequela.[52] [53] To add, athletes asymptomatic with a history of two MTBIs at least six months prior to neuropsychological testing were shown to perform similarly to athletes who sustained a concussion the week prior. As mentioned above, the athletes with greater than two MTBIs exhibited significantly lower grade point averages than did matched students with no concussion history. [54] It should also be noted that pediatric patients suffering recurrent MTBI, accumulating effects, or moderate to severe TBI have higher rates of attention deficit disorder, conduct disorder, depression, substance abuse and antisocial behaviors including arrests, violent and property offenses. [55] [56] [57] [58] [59] In conclusion, the pediatric brain is complex and vulnerable compared to adult brain. The consequences and long term sequela of those sustaining even MTBI have only just started to be revealed and there is still a great deal of research to be done.

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RECOMMENDATIONS

a. Well-Designed Medical Research to Help Parental Informed Decisions

Above all, a new research is needed to identify how the milder form of concussions, e.g., MTBI, on the brains of the children who played the sports such as football over a shorter period of time impact on their mental and physical health when they become adults. The most recent research development to explore the relationship between ex-players and CTE is, as mentioned earlier, the Boston CTE team's finding which suggests that "repeated head hits earlier in life can lead to higher concentrations of tau in the blood later."[1] However, setting aside the fact that further tests are needed to "determine the amount of the CTE-related tau in the blood samples" because the research shows not the amount of the specific tau linked to CTE but only the total amount of tau in the blood,[2] the issue here is that this research is about adult athletes who played for many years since they were very young, not about the children paying the sports over a short period of time.

Today, there is an excessive fear of concussions among parents, teachers, and school administrators. Due to the fears about head injuries, we do not easily let our children play the sports.[3] However, we confuse ourselves with the conflict message that we should encourage our children to play the sports more than ever because of the child obesity pandemic partly caused by lack of physical activities. The recent report from the Centers for Disease Control and Prevention (CDC) that one third of American children are overweight justifies the spread of the idea.[4]

The ultimate decision on the children must come from the children's parents. However, for the parents to make informed decisions about whether their child should play a contact sport, the well-designed study should be implemented that addresses what severity or recurrence of head injury is needed to cause C.T.E.[5] This scientific information needs to be initiated now.

b. New Additional Research in Post-Concussion Syndrome (PCS).

Currently, the standard treatments for PCS are rest, limiting exposure to possible additional brain injury, and treatment of symptoms as they occur. The standard of care is supportive and primarily focused on ameliorating the symptoms. "There is research going on that has shown supplementation with omega-3EFAs in the form of fish oil supplements may offer a viable alternative to the current watchful-waiting techniques currently used. Additional research is needed in this area, however, before standard use can be recommended in all cases."[6] More research in this area should be advanced.

c. The Recommendations by American Academy of Pediatrics (AAP) Implemented.

"The most common injured body in football at all ages" include knee, ankle, hand, and back, and the head and neck injuries sustain relatively a small proportion of overall injuries, ranging from 5% to 13%.[7] However, the risk of catastrophic damage is largely related to the head and neck injuries, many cases of which lead to concussions. And the injuries mostly result from tackling. And particularly "spear tackling, or leading with the crown of the helmeted head while tackling by defensive players," is the predominant cause of the injuries including quadriplegia and concussions.[8] So, the recommendations by American Academy of Pediatrics is largely focused on prevention of the dangerous types of tackling that occur during the practices and games. Among the list of recommendations, the following key points stand out.

1. While teaching proper tackling techniques, officials and coaches must enforce the rules for the licit tackling, including zero tolerance for the illegal, head-first/helmet-to-helmet hits. To expanse AAP's recommendation here, we suggest that coaching staff. To expand the AAP's recommendation here, we emphasize that head injuries can be significantly reduced in youth football through, we add, teaching proper tackling techniques and maintaining drills that involve full contact, instead focusing on practicing

fundamental skill sets needed in football at young ages.
2. It should be informed and reminded that the players must decide whether the benefits of playing outweigh the risks of possible injury.
3. Non-tackling leagues should be expanded so that athletes can choose to participate without the injury risks associated with tackling.
4. Skilled athletic trainers should be available on the sidelines, as evidence shows they can reduce the number of injuries for players.
5. Delaying the age at which tackling is introduced to the game, i.e., 14 years of age, should be promoted since it would likely decrease the risk of head injuries for the age levels at which tackling would be prohibited.[9]

d. The Presence of Trained Medical Professionals on the Field.

Medical professionals trained in concussion injuries must be present on the field for every elementary/secondary football game to examine any player who may have a suspected head injury. These medical professionals should be given professional prerogatives to remove a player from the field over the objection of the coach if they suspect the player has sustained a serious head injury. There must be the establishment of strict "return to play" guidelines. Medical studies have shown that high school athletes who stayed in the game after head trauma took an average of 44 days to recover. By comparison, athletes who left the game immediately after signs of concussion took an average of 22 days to recover.[10]

e. New Rules for Youth Football.

Youth Football should adopt the new rules issued by the Pop Warner Football League. According to a recent study, "only leagues that adhered to Pop Warner's rules saw a meaningful drop in concussions.[11] The new rules include the following:

1. "No full speed head-on blocking or tackling drills in which the players line up more than three yards apart are permitted. (Having two linemen in stances immediately across the line of scrimmage from each other and having full-speed drills where the player approach each other at an angle, but not straight ahead in to each other are both permitted.) However, there should be no intentional heads-to-head contact."[12]
2. "The amount of contact at each practice will be reduced to a maximum of 1/3 of practice time (Either 40 minutes total of each practice or 1/3 of total weekly practice Time). In this context, "contact" means any drill or scrimmage in which drills; down line vs. down line full-speed drills; and scrimmage."[13]
3. "In addition to other specific prohibitions in the National Federation and NCAA rulebooks, no butt blocking, face tackling or spearing techniques shall be permitted."[14]

Note that the league has also implemented a new Health & Safety section on popwarner.com to keep our members abreast of current issue sin concussion awareness and other health and safety matters.

f. Equipment and Design Safety.

American Academy of Pediatrics (AAP) show the following safety tips concerning equipment and design safety. A. Shoes. "Football shoes should be appropriate for the surface (turf versus cleats). Laces should be tied securely." B. Pads. "Shoulder pads should be sized by chest measurement. They must be large enough to extend ¾ to 1 inch beyond the acromioclavicular joint. Athletes should have adequate range of motion, and the pads should not ride up into the neck opening when raising the arms." C. Helmets. "The helmet should be fitted so that the eyebrows are 1 to 1 ½ inches below the helmet front rim. The back of the helmet should cover the back of the head, and the athlete's ear openings should be in the center of the helmet ear openings. Jaw pads should be snug against the athlete's jaw. The chin strap should be centered over the chin and tightened to prevent movement of the helmet on the head. The helmet padding and chin strap should be tight enough to prevent any rotation of the helmet on the head. Face masks should to attached to the helmets. Additional protection can be provided by a clear Plexiglas shield." C. Mouth Guards. "Mouth guards can help prevent oral and facial injuries but not concussions."[15]

g. Helmet Design Research

Since head and neck injuries are the most concerning damage, there should be research funding dedicated to helmet design which would minimize concessions. "Currently, youth football helmets are remarkably similar to adult helmets in relation to size, mass, and design materials."[16] "In the past, researchers have used data collected from instrumented college football players to develop the STAR evaluation system that assesses the helmet's overall ability to reduce the probability of concussion."[17] This evaluation system is based on measuring "quantified head impact exposure in college football . . . Furthermore, the STAR evaluation system provides manufacturers with design guidelines to improve future helmet safety. Unfortunately, the system cannot be extrapolated to youth football helmets because the head

impact exposure of youth football is different than that of college football."[18] Neck muscles and brain development are very different in 7 or 8-year-old children when compared to college students and adults. What is needed is further research and design in youth-specific football helmets.

h. Football Field Design Research

Material designs should be researched that decrease the impact of head injuries on the turf. A new report by the Concussion Legacy Foundation calls attention to a link between head injuries and poorly maintained fields, especially the growing number of fields made of synthetic turf. The vast majority of fields are natural grass but the number of synthetic fields has grown to more than 12,000 nationally. Just as routine maintenance is not a priority for grass fields; it is also not a priority for synthetic fields. Routine maintenance includes raking of rubber pellets and tilling the sand is required to ensure the field does not get too hard. Research shows that 15.5% of concussions in high school sports is the result of hitting the head on the playing surface. "New technology such as adding high-tech cushioning to dampen the impact of head injuries needs to be advanced to help cushion the synthetic turf fields."[19] Companies like Viconic Sporting, General Electric, and Under Armour are developing padding technology to stall under turf fileds. Viconic Sporting has received $1.25 million from the N.F.L.[20] More grants need to be given to companies to devise additional protections in this area.

[1] The emphasis is by the authors of the paper. Ken Belson, "Researchers Make Progress."

[2] Ibid.

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Author Information

Marvin Lee, Ph.D.
Bioethics Consultant, Institute of Clinical Ethics, Saint Joseph's University
Philadelphia, Pennsylvania

Brandon Eck, D.O.
Family Practice Resident, Suburban Community Hospital
Norristown, Pennsylvania

Peter A. Clark, S.J., Ph.D.
Professor of Medical Ethics, Director-Institute of Clinical Ethics, Saint Joseph's University
Philadelphia, Pennsylvania

Brant Edmonds
Research Fellow, Institute of Clinical Ethics, Saint Joseph's University
Philadelphia, Pennsylvania