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# Let's Get the Head Further Out of the Game: A Proposal for Reducing Brain Injuries in Helmeted Contact Sports

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Sports-related brain injuries rapidly are reaching epidemic levels, with an estimated incidence range of 1.6 to 3.8 million in the United States per year (7,17). These values likely underestimate the true incidence because of under-reporting by athletes (18), and the limitations of current national injury databases (7,17) have prompted Congress to mandate the U.S. Centers for Disease Control and Prevention (CDC) to determine how best to measure the rate of new cases (7). Concussion rates in 15 sports at the collegiate level have increased at an estimated rate of 7% per year over the last two decades (14). Men's football consistently has one of the highest concussion rates per athletic-exposure (AE) (5) ($0.37{\cdot}1000^{-1}$AE during fall and $0.54{\cdot}1000^{-1}$ AE in spring). Men's ice hockey poses a similar risk of concussion injury ($0.41{\cdot}1000^{-1}$ AE), whereas data from women's ice hockey, collected over a much shorter time period, reported rates more than twice these, at $0.91{\cdot}1000^{-1}$ AE (14). At the youth level, the incidence of concussion injury is not as well established, but existing data from emergency department and hospital admissions indicate that the injury rate may be several times higher among children than in the general adult population (15). New technology capable of measuring head impacts during practices and games allows head impact exposure to be defined more fully by recording the severity of each head impact, the location of the impact on the helmet, and the number of head impacts individual players receive over the course of a season, and potentially throughout their career (4).

There also is a growing concern that repetitive impacts to the head, which are clinically subconcussive and not associated with acute symptoms, may result in long-term neurological injury (9,10,12). Additionally, a study on a cohort of collegiate football players found that approximately 50% of asymptomatic athletes demonstrated a clinically relevant cognitive impairment 24 to 48 h after their last head impact exposure. These cognitive impairments typically return to baseline levels in both clinically diagnosed and asymptomatic athletes 7 to 10 d after the cessation of head impacts (1). The extent of this finding in a broader population of athletes currently is under investigation, but it raises the potential of short-term impairment in athletes who are continuing to play with these deficits and the specter of more significant intermediate and long-term consequences of repeated head impacts. Collectively, these findings and observations lead us to conclude that a practical approach for reducing brain injuries is to reduce the exposure to head impacts.



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In the late 1960s and early 1970s, more than 30 deaths per year occurred in American football from severe brain injury, primarily subdural hematomas (19). Shortly thereafter, the National Operating Committee on Standards for Athletic Equipment (NOCSAE) was formed. Working in conjunction with manufacturers and governing bodies, NOCSAE developed standards to evaluate the ability of a helmet to absorb the energy of an impact to the head to prevent skull fractures and subdural hematomas using well-defined laboratory testing methods (13,20) for football, and later for lacrosse and baseball. Concurrently, the American Society for Testing and Materials (ASTM) developed similar laboratory tests for other types of sports helmets, including hockey, equestrian, and numerous other helmeted sports. At present, many governing bodies for sports require that all helmets worn by athletes meet NOCSAE or ASTM standards. With the implementation of these standards, as well as rules prohibiting “spearing” (tackling techniques using the top of the helmet), there was a significant reduction in deaths and severe head and neck injuries in helmeted contact sports (19). It is important to appreciate that all existing standards for sports helmets are formulated specifically to reduce the severe and sometimes fatal injuries associated with skull fractures and subdural hematoma. In contrast, there are no current standards or laboratory tests that assess a helmet’s ability to prevent concussion injury. The lack of a helmet standard for concussion injury is a direct result of the lack of sufficient data surrounding the biomechanical variables that cause a concussion injury, although substantial efforts toward this goal are currently in progress (2,8,11).

What can be done now to prevent concussions? We propose further rule changes and targeted educational training to reduce the number of impacts to the head that athletes receive. Recent data on the number of head impacts players at the high school (3) and college level (4) receive demonstrate that the number of head impacts can exceed 1,400 each season. More importantly, both impact exposure and impact severity are correlated positively with neurocognitive deficits based on preliminary research (1). When taken together, we hypothesize that reducing or limiting the number and severity of head impacts would result in a decrease in the incidence and severity of clinically relevant cognitive deficits and in the incidence of clinical diagnosis of concussion. The extent of the reduction in head impacts that is required to reduce injury rates is unknown and must be evaluated in well-designed, population-based outcomes studies of athletes.

The concept of limiting overuse or overexposure is not new to sports. Studies have shown that the number of baseball pitches correlates with the incidence of elbow pain, injury, and surgery (6,16). To address this, governing bodies of youth baseball in the United States adopted a pitch count rule to prevent overuse injuries, with specific guidelines on pitches per game, per week, per season, and per year for different ages. A similar approach to reducing head impacts certainly should be considered and is practical, as the technology for monitoring head impact exposure is available.

We propose the adoption of rules — or in some sports, we champion the enforcement of existing rules — that eliminate intentional head contact in helmeted sports. When coupled with education that leads to modified tackling, blocking, or checking techniques, these rules will reduce head impact exposure and have the potential to reduce the incidence and severity of brain injury in these sports, without the need to change existing practices and games schedules. The National Football League (NFL) has enforced rules that address the more flagrant use of the helmet, where intentional contact to the helmet of quarterbacks or other vulnerable players, such as wide receivers, is illegal and carries substantial financial penalties. The National Hockey League (NHL) recently adopted a new rule, effective immediately for the rest of the 2010 season, that bans intentional blows to the head. In the 2009 to 2010 rule book for collegiate football players, the National Collegiate Athletic Association (NCAA) emphasized rule Article 3.a: “No player shall initiate contact and target

an opponent with the crown (top) of his helmet." Similar but less direct wording can be found in the National Federation of State High School Association rule book. It is interesting to note that in 1981, the NCAA rules had a broader rule: "No player shall deliberately use his helmet to butt or ram an opponent."

These recently implemented rules are an important and appropriate step, but they do not go far enough, in our opinion, to reduce significantly, potentially injurious and intentional head impacts. Certainly, head impacts will occur in all sports, helmeted or unhelmeted, and a certain percentage of these head impacts are unavoidable. However, the intentional use of the helmet to contact another player is not and never has been inherent to any sport. Our observations indicate that a significant number of head impacts in helmeted team sports appear to be intentional. Many of the impacts occur to helmet locations other than the top, and impacts to other locations are known to cause concussion injuries (21). Further, the intentional use of the helmet by offensive or defensive players generally is considered poor technique. The governing bodies, together with researchers, leagues, coaches, and parents should work towards the development of educational programs and techniques for communicating to players the importance of reducing all impacts to the head.

This proposal is relatively simple to implement and is not intended to alter the competitive elements of the various sports. Current rules in the helmeted sports of football, lacrosse, and ice hockey should be modified so that intentional use of the helmet to contact another player is illegal and enforced rigorously. As our understanding of the clinical consequences of repeated head impacts improves, further modifications to the rules can be examined and implemented. While such a rule change will not eliminate unintentional head impacts or all brain injuries, the goal of the proposed rule change is to reduce the number of intentional head impacts, the number of diagnosed concussions, and the potential deleterious effects over time associated with repetitive head impacts in contact sports.

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