REPORT 3 OF THE COUNCIL ON SCIENCE AND PUBLIC HEALTH (A-15)
Concussion and Youth Sports
Resolutions 401, 410, and 412-A-14
(Reference Committee D)

EXECUTIVE SUMMARY

Objective. To develop a comprehensive report with recommendations to aid physicians in efforts aimed at reducing the risk of concussion as a result of participation in youth sports.

Methods. English-language articles were selected from searches of the PubMed and Google Scholar databases from January 2010 to January 2015. Internet sites managed by federal agencies, applicable health professional organizations, and youth sports advocacy organizations also were reviewed for relevant information. Additional articles were culled from reference lists contained in pertinent articles and other publications. Recognizing the dynamic nature of research being published on this topic, the Council on Science and Public Health deemed it most appropriate to summarize the findings and conclusions of a recent authoritative review on this topic published in 2014 by the Institute of Medicine and National Research Council. Available guidelines and consensus position statements on this topic also were reviewed.

Results. Concussions may be caused either by a direct blow to the head, face or neck; or elsewhere on the body with an impulsive force transmitted to the head. The result is a rapid onset of short-lived impairment of neurologic function that usually resolves spontaneously. Concussion may or may not involve loss of consciousness. A concussion can affect memory, judgment, reflexes, speech, balance, and muscle coordination. Estimates of sports-related concussions provided by existing surveillance systems are most likely conservative, given that many concussions are unreported. Among high-school- and college-age males, football, ice hockey, lacrosse, wrestling, and soccer are consistently associated with the highest rates of reported concussions. For female athletes, high school and college sports associated with the highest rates of concussion are soccer, lacrosse, and basketball. Concussion rates appear to be higher during competition than during practice. Available data indicate that young female athletes and youth with a history of prior concussion have higher rates of reported sports-related concussions. Determining the severity of a concussion has shifted from using loss of consciousness as the primary criterion to evaluation of the number of signs and symptoms that an athlete experiences along with the length of time that the athlete experiences the symptoms. While various tools are available to facilitate concussion diagnosis and management, current evidence is insufficient for validation of these assessment tools and for determining the best combination of measures to utilize for acute and baseline testing. Return-to-play decisions are currently based on clinical judgment, informed by neurocognitive tests and self-report symptom metrics rather than on evidence-based biomarkers.

Conclusion. Athletes who are not fully recovered from an initial concussion may be significantly vulnerable for recurrent, cumulative, and even catastrophic consequences of a second concussion. Such consequences can be prevented if the athlete is allowed time to recover and return to play decisions are made carefully. No athlete should return to sport or other at-risk participation when symptoms of concussion are present and recovery is ongoing. Consultation with a neurologist or primary care sports medicine physician is indicated for patients who have prolonged symptoms. Neuropsychologic consultation also may be considered to document any deficits that may interfere with the athlete's return to school or play. Even mild concussions should not be taken lightly -- although some concussions are less serious than others, there is no such thing as a "minor concussion."

REPORT OF THE COUNCIL ON SCIENCE AND PUBLIC HEALTH

CSAPH Report 3-A-15

Subject: Concussion and Youth Sports
(Reolutions 401, 410, and 412-A-14)

Presented by: Stuart Gitlow, MD, Chair

Referred to: Reference Committee D
(Peter H. Rheinstein, MD, JD, Chair)

INTRODUCTION

The following resolutions were referred by the House of Delegates in June 2014:

- Resolution 401-A-14, "Heading in Youth Soccer," introduced by the Indiana Delegation, asks our American Medical Association (AMA) to: (1) discourage "heading" of the ball while playing soccer until the athlete is playing in an organized league, once in high school, and has been trained in the proper technique based upon contemporaneous standards; (2) recommend that individuals trained in heading the ball similarly train athletes when they are old enough; and (3) encourage continued investigation by local sports medicine, pediatric and neurological colleagues, into the potential consequences of nonconcussive heading involved with soccer participation.

- Resolution 410-A-14, "Evaluating and Reducing the Risk of Youth Sports Concussion," introduced by five medical specialty societies, asks the Council on Science and Public Health (CSAPH) to prepare a report summarizing the existing data on the risk of concussion in youth sports; and to develop specific recommendations to aid physicians in efforts aimed at reducing the risk of concussion as a result of participation in youth sports. The resolution also asks the AMA work with all appropriate state and specialty societies to: (a) enhance access to appropriate continuing education for physicians emphasizing evolving literature on the diagnosis and management of concussion resulting from participation in youth sports; and (b) help educate the general public about the established risks of concussion associated with participation in youth sports, as well as theoretical risks under study.

- Resolution 412-A-14, "Management of Concussion Guidelines," introduced by the California Delegation, asks our AMA to promote awareness of the "Evaluation and Management of Concussion in Sports: Report of the Guideline Development Subcommittee of the American Academy of Neurology."

The resolutions were assigned to the Council on Science and Public Health (CSAPH) for consideration. The CSAPH deemed that a comprehensive report summarizing the epidemiology, risks, and potential consequences of concussion in youth sports would provide a useful resource to help educate physicians on this important and evolving topic. Recommendations in the report

consolidate, expand, or reaffirm numerous AMA policies relevant to sports-related concussion, which are listed in Appendix A.

METHODOLOGY

English-language articles were selected from searches of the PubMed and Google Scholar databases from January 2010 to January 2015 using the search terms "concussion," "mild traumatic brain injury," "youth sports," "athletic injuries," "sports-related injuries," "children," "adolescent," and "pediatric" in the article title and/or abstract. Internet sites managed by federal agencies, applicable health professional organizations, and youth sports advocacy organizations also were reviewed for relevant information. Additional articles were culled from reference lists contained in pertinent articles and other publications.

The literature search revealed an extensive list of peer-reviewed publications on concussions in youth sports published since 2010. Most of these studies have focused on high school and college age athletes. Recognizing the dynamic nature of research being published on this topic, the Council deemed it most appropriate to summarize the findings and conclusions of a recent authoritative review and to evaluate any recent pertinent literature. In 2014, the Institute of Medicine (IOM) and National Research Council published a 336-page report to review the science of sports-related concussions in youth.[1] The report, largely funded by the Centers for Disease Control and Prevention (CDC) and in part by the National Football League, examined a broad array of issues affecting children and youth aged five to approximately 21 years (i.e., elementary school through college age) who are at risk of concussion through participation in organized sports and other physical activities. In its deliberations, the IOM committee considered available guidelines and consensus position statements on the diagnosis and management of sports-related concussions published by the Fourth International Conference on Concussion in Sport (ICCS),[2] the American Academy of Neurology (AAN),[3] the American Medical Society for Sports Medicine (AMSSM),[4] and the American Academy of Pediatrics.[5] The CSAPH reviewed these documents along with consensus statements published in 2014 by the National Athletic Trainers' Association[6] and the Canadian Pediatrics Society;[7] as well as a joint statement published in 2011 by the AMSSM, the American Academy of Family Physicians, the American Academy of Orthopedic Surgeons, the American College of Sports Medicine, the American Orthopedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine.[8] High-quality systematic and narrative reviews identified from the literature search also were considered.

BACKGROUND

Regular physical activity during childhood and adolescence is promoted widely for improving overall health and fitness and reducing the risk of various chronic diseases later in life.[9] Organized sports provide an opportunity for increased physical activity and an opportunity to learn sport- and team skills in an environment in which risks of participation can usually be controlled. In organized football alone, in 2013-2014, there were approximately 71,000 college players,[10] 1.1 million high school players,[11] and an additional 250,000 children competing at the Pop Warner level.[12] The increased involvement of children and adolescents in organized sports has raised concern about the risk and severity of sports-related injury. Young athletes may be particularly vulnerable to such injury because of the physical and physiological processes associated with growth and development.

One type of sports injury–concussion–has become an important focus of health professionals, the media, policymakers, and the public. Sports-related concussions occur relatively frequently in children and adolescents, and primary care physicians are often responsible for coordinating

clinical management. Historically, most concussions were not considered serious, and athletes who sustained them might be said to have been "dinged" or had their "bell rung." The injured player would "shake it off" and return to play. While this notion is no longer valid, confusion and controversy persist in many areas, including how to define a concussion and how multiple concussions affect the vulnerability of athletes to future injury, when it is safe for a player to return to sports, and the effectiveness of protective devices and other interventions in reducing the incidence and severity of concussive injuries. Concern that head impact exposure and recurrent concussions contribute to long-term neurological sequelae has increased. Cognitive sequelae of concussion, including impaired memory, poor attention, and lack of concentration may negatively impact a child's ability to function at school, at home, and with friends. Subconcussive impacts, which do not produce any identifiable symptoms, occur much more frequently than concussions and are now understood to alter neurophysiology, potentially leading to chronic cumulative neurocognitive impairments.[13]

Increased knowledge about concussions, with growing recognition that concussions involve some level of injury to the brain, support the need for prompt diagnosis and appropriate management. Despite this reality, there exists a culture among athletes that resists both the self-reporting of concussions and compliance with appropriate concussion management plans. In a recent study, almost 59% of middle school female soccer players reported playing with concussion symptoms, with less than half (44%) having been evaluated by a physician or other qualified health professional.[14] A study of concussed high school athletes found that 15% returned to play prematurely, and almost 16% of football players who sustained a concussion that resulted in loss-of-consciousness returned to play in less than 1 day.[15] A focus group study found that although high school football and soccer players understood the symptoms and potentially severe complications of playing with a concussion, most would continue to play despite symptoms.[16] Concussed players often ignore concussion symptoms and resist being evaluated.[17,18] Players who return to play while suffering from concussion symptoms are vulnerable to sustaining another concussion or potentially more catastrophic injury.

DEFINITIONS[1-5,7]

A concussion is a type of mild traumatic brain injury (mTBI) that is generally self-limited, caused by an impact or jolt to the head. Essentially, the brain is "concussed" inside of the skull from either a direct impact (i.e., hit by a ball) or a whiplash-type motion in which the brain is concussed through the accelerated motion of the head when the head is snapped forwards and/or backwards. The terms *concussion* and *mild traumatic brain injury* (mTBI) overlap, as both terms represent the less-severe end of the TBI spectrum, where acute neurologic dysfunction generally recovers over time and occurs in the absence of significant macrostructural damage. Although a TBI can be diagnosed as "mild," the effects on the individual can be long lasting. mTBI can be easily missed because the person may look normal and the symptoms may be subtle. Symptoms may also be delayed and not appear until days after the initial injury. Concussion may or may not involve loss of consciousness.

Consensus on a definition for concussion does not exist. The terms mTBI and concussion are often used interchangeably in the sporting context and particularly in the United States. According to the IOM committee, the published literature includes numerous working definitions of "concussion" and exhibits an inconsistent use of terminology (e.g., confounding concussion and mild TBI even though the latter includes more severe brain injuries). These differences pose challenges for interpreting and comparing findings across studies on concussion. For a specific definition of

concussion, the IOM committee chose to follow the ICCS definition.* The committee deemed that this definition captures and provides more detail on the common elements of concussion, and appreciated that the definition was developed through a formal consensus process, subject to review and revision on a regular basis, which has permitted it to evolve along with the science of concussion. It is the committee's expectation that this definition will continue to evolve.

BIOMECHANICS AND PATHOPHYSIOLOGY[1,4,5,8,19]

The precise mechanism of concussion is unknown. The biomechanics and pathophysiology of the brain tissue damage in concussion have been investigated in animal models; however, it is still unclear whether these results can be applied to clinical concussions. It is hypothesized that concussion results from acceleration-deceleration and rotational forces on the brain, causing deformation of the brain through compressive, tensile, or shearing forces. This transient deformation may alter the function in astrocytes and neurons through various proposed mechanisms, including abrupt neuronal depolarization, ionic shifts, release of excitatory neurotransmitters, altered glucose metabolism and cerebral blood flow, and impaired axonal function, which allow for initiation of biochemical pathways leading to cell death within hours to days. Axon tearing occurs in more severe brain injuries, but evidence is lacking for this mechanism in concussion.

Research has delineated a pathophysiology of concussion referred to as the "neurometabolic cascade" characterized by a stepwise process of ionic shifts, altered brain metabolism, impaired neuronal connectivity, and disruption of normal neurotransmission. The time course of return to normal cerebral function after the metabolic cascade induced by concussion is not entirely clear, but evidence suggests a gradual reversal of physiological abnormalities and return to normal brain metabolic function within days to weeks after concussion.

The skull protects the brain against penetrating trauma, but does not absorb all the impact of a violent force. The brain is cushioned inside the skull by the surrounding cerebrospinal fluid, but an abrupt blow to the head, or even a rapid deceleration, can cause the brain to contact the inner side of the skull. There is a potential for tearing of blood vessels, pulling of nerve fibers and bruising of the brain substance. Sometimes the blow can result in microscopic damage to brain cells without obvious structural damage visible on a computerized tomography (CT) scan. In severe cases, the brain tissue can begin to swell. Since the brain cannot escape the rigid confines of the skull, severe swelling can compress the brain and its blood vessels, limiting blood flow, and reducing the necessary flow of oxygen and glucose to the brain. Brain swelling after a concussion has the potential to amplify the severity of the injury. A relative decrease in cerebral blood flow coupled

*The ICCS statement defines a concussion as "a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces," characterized by the following features: (1) concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an ''impulsive" force transmitted to the head; (2) concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. However, in some cases, symptoms and signs may evolve over a number of minutes to hours; (3) concussion may result in neuropathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury and, as such, no abnormality is seen on standard structural neuroimaging studies; and (4) concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course. However, it is important to note that in some cases symptoms may be prolonged.[2] The AAN provides a more succinct definition of concussion, defining it as a "clinical syndrome of biomechanically induced alteration of brain function, typically affecting memory and orientation, which may involve loss of consciousness."[3]

with an increased requirement for glucose (i.e., increased glycolysis) may result in cell dysfunction and increase the vulnerability of the cells to a second insult.

Although total brain size is about 90 percent of adult size by six years of age, the brain continues to undergo dynamic changes throughout adolescence and into young adulthood. A growing body of literature, including studies of more severe TBI indicates that the immature brain is more vulnerable than the adult brain to diffuse injury. Children's heads are proportionally larger and heavier in relation to their bodies than adults, the occiput and forehead are more prominent, and the facial bones are proportionally smaller. The pediatric skull is more compliant than the adult skull, thus it can absorb more force without a fracture, but also is more susceptible to increased shearing forces between the skull, dura, subdural vessels, and brain. Children also have relatively weaker necks than adults, which allows more movement of the head when forces are applied to the torso. The pediatric brain has higher water content and lesser degree of myelination, so it is less dense and may sustain more acceleration-deceleration injury than adults.

The mechanisms of injury for concussion are unique to each sport. Some common causes of concussions are head-to-head contact, head-to-body contact, head-to-ground contact, and ball-to-head contact. Collisions associated with tackling place football and rugby among the sports with the highest incidence of concussion. In soccer, concussions are most commonly caused from head-to-head collisions when two athletes are competing for the same ball. Baseball and softball pitchers are at risk for concussion because of their proximity to the plate. Falls can be another cause of concussion as seen in basketball, diving, and cheerleading. Due to modifying factors (e.g., concussion history; neck strength; anticipatory reaction; and varying magnitudes, frequency, and locations of impact), there is currently no known threshold for concussive injury.

SPORTS INJURY SURVEILLANCE SYSTEMS[1]

According to CDC data, between 1.6 million and 3.8 million sports- and recreation-related TBIs, including concussions and other head injuries, occur in the United States each year. Concussions represent about 9% of all high school athletic injuries and 6% of all collegiate athletic injuries. The CDC estimates that between 2001 and 2009 the number of children and adolescents age 19 years and younger in the United States who were treated in emergency departments (EDs) for concussions and other nonfatal, sports- and recreation-related TBIs increased from approximately 150,000 to 250,000. The rate of ED visits for such injuries increased 57 percent, from 190 to 298 per 100,000 population during the same time period. Important contributing factors to recent increases in reported concussion rates include greater awareness and recognition of such injuries.

The IOM committee found that the lack of large epidemiologic studies and comprehensive injury surveillance systems created significant challenges to a comprehensive assessment of concussion in youth sports. Currently, three well-established sports injury surveillance systems provide epidemiologic data to calculate injury rates, monitor patterns of injury, and identify risk factors related to concussion and other injuries in young athletes.[**] Estimates of sports-related concussions

[**]Three commonly cited surveillance systems for data on youth sports injuries:

- The National Collegiate Athletic Association Injury Surveillance System (NCAA ISS) provides data on injuries that occur in collegiate athletics but does not account for recreational activities. (see http://www.ncaa.org/health-and-safety/medical-conditions/sports-injuries)
- The High School RIO (Reporting Injuries Online), commissioned by the National Federation of State High School Associations (NFHS), is an Internet-based injury surveillance system for high-school athletics but does not account for recreational activities or private sports (see

provided by these systems are most likely conservative, given that many concussions are unreported. A major limitation to existing data on sports-related concussions in youth is a lack of research on the incidence of such injuries in nonacademic settings, such as in intramural and club sports, and for athletes younger than high school age. To help address limitations and gaps in existing surveillance systems, the IOM committee recommends that the CDC establish and oversee a national surveillance system with specified data elements to accurately determine the incidence of sports-related concussions, including youth between the ages of five and 21 years.

RISK FACTORS

Type of Sport and Level of Competition[1,3-5,8,20]

Current data indicate that, while concussions can occur in any sport, contact or collision sports pose the highest risk, with player-to-player contact responsible for the majority of injuries. In the United States, the incidence of reported concussions varies substantially by sport:

- Among male athletes at the high school and collegiate levels, football, ice hockey, lacrosse, wrestling, and soccer consistently are associated with the highest concussion rates (typically reported as the number of concussions per 1,000 athletic encounters). In certain sports (e.g., football, rugby), the risk of injury may be more dependent on the position played.

- Among female athletes, high school and collegiate sports associated with the highest rates of concussions are soccer, lacrosse, and basketball. Women's ice hockey at the collegiate level has the highest rate of reported concussions. Data on the incidence of concussions for female ice hockey players at the high school level are currently unavailable.

In general, reported concussion incidence is consistently higher in competition than in practice for both male and female athletes across all sports and age groups.

Sex[1,3-5,8,20]

Overall, the incidence of concussion is greater for males than females because of the greater number of male participants in sports. In sports with similar playing rules, such as soccer and basketball, the reported incidence of concussion is higher in females than males at both high school and collegiate levels. Data are insufficient to conclude whether sex is a risk factor for concussion or chronic post-concussive problems. The extent to which these findings are due to physiological, biomechanical, and other factors is not yet well understood. As previously mentioned, a culture among athletes that resists self-reporting of concussion symptoms and/or compliance with return to play protocols applies to both sexes.

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http://www.ucdenver.edu/academics/colleges/PublicHealth/research/ResearchProjects/piper/projects/RIO/Pages/default.aspx). The NFHS also works with the National Center for Catastrophic Sports Injury Research at the University of North Carolina-Chapel Hill to collect catastrophic injury data on all sports.

- The Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS; see http://www.cpsc.gov/en/research--statistics/neiss-injury-data/) collects information from emergency departments in registered hospitals involving consumer products (e.g., a lacrosse helmet or a baseball). The NEISS provides more data about recreational activities than the NCAA or High School RIO, but is limited by its focus on emergency department visits. The NEISS does not provide information about injuries treated by primary care physicians, at home, or by school- or club-based athletic trainers.

Age[1,3-5,8,20]

In more severe TBIs, earlier age has been associated with increased vulnerability to the effects of brain injury and prolonged recovery. While it has been suggested that the physiological and biomechanical risks for concussion may differ between younger children and older youth and adults, data are lacking from various sports to calculate and compare rates of sport-related concussions across the age spectrum. Based on comparative studies, the younger the age of the child, the more vulnerable the brain is to concussion and the longer the time required for a return to cognitive baseline; however, the IOM committee cautions that more research is necessary to draw significant conclusions. This includes further research to define the various thresholds for linear and rotational accelerations associated with concussions in youth. These thresholds may differ between youth and adults and may vary across the pediatric age spectrum. Until further empirical studies are available to refute an age difference in symptom and neurocognitive recovery post-concussion, expert consensus opinion calls for a more cautious and conservative approach for the management of concussions in pediatric athletes.

Premorbid Conditions[1,3-5,8]

Knowledge of preexisting conditions such as attention deficit/hyperactivity disorder, and other learning, cognitive, psychiatric, and behavioral difficulties is crucial in understanding the context of concussion symptoms and tailoring an appropriate management plan. Some premorbid conditions, such as migraine and mood disorders, may affect baseline cognitive functioning and confound postconcussion symptoms. More research is needed to determine the impact of various premorbid conditions in children and adolescents on concussion risk and/or symptom persistence following a concussion.

Genetics[1,3-5,8,20]

Studies examining associations between genetic factors and the risk of concussion have been mixed, and their validity is limited by small sample sizes. Genetic factors have been identified recently in affecting how the brain responds to injury, which may have implications for outcomes following pediatric concussion. In adults, the apolipoprotein E allele 4 (*APOE4*) is associated with poorer outcomes from a variety of neurologic events including stroke and cardiopulmonary arrest, as well as earlier onset of Alzheimer's disease. Limited research also has linked the presence of *APOE4* to poorer broad functional outcomes from TBI in adults, including association with poorer acute outcomes from mild TBI in adults. While little research has been conducted to determine how genetic factors influence susceptibility to concussion, such findings suggest that children carrying *APOE4* may be at greater risk for poorer outcomes from milder brain injury.

History of Concussion and Repetitive Head Impacts[1,3-5,8,13,20]

Concussion can cause a wide range of short- and long-term complications affecting cognition, sensation, language, or emotions. Potential adverse or long-term effects of concussion include persistent deficits in memory and visual processing, decline in academic performance, depression, dementia, and postconcussion syndrome (concussion symptoms lasting longer than three months). General agreement exists that multiple concussions are associated with increased risk for long-term neurocognitive and emotional/behavioral sequelae. Preliminary evidence suggests that, in addition to the number of concussions an individual sustains, the number and duration of symptoms and the time interval between concussions may be important factors in the risk for and the severity of subsequent concussions, as well as predictors of prolonged recovery. Although quite rare,

concussive blows can be associated with serious pathology including cervical spinal injury, skull fracture, and intracranial hemorrhage.

According to the IOM committee, studies of the shorter-term effects of multiple concussions and repetitive head impacts (sometimes called "subconcussive" impacts) have had mixed results; some studies show an association between such impacts and functional or cognitive impairments, and others show no effect. Preliminary imaging research suggests that changes in brain white matter may appear after repetitive head impacts; this preliminary finding is supported by the animal literature.

Second-Impact Syndrome (SIS) [1,3-5,8]

SIS is a complication of concussion that occurs when an athlete who is still experiencing symptoms receives a second blow to the head before the brain has fully recovered from the first injury, triggering rapid brain swelling that is frequently fatal. This syndrome is rare, and almost all cases have involved teenagers or young adults. The exact mechanism is unknown but is considered to be due to loss of autoregulation of cerebral vasculature in an already injured brain resulting in cerebral swelling, raised intracranial pressure, and subsequent brain herniation. While significant controversy exists over the etiology of SIS, it is widely accepted that cerebral swelling can develop in concussed athletes after a latent period. This syndrome can be minimized by removing concussed athletes from play while symptomatic, with no return until a specified recovery protocol has been completed.

Chronic Neurodegenerative Disease[1,3-5,8,21]

Chronic traumatic encephalopathy (CTE), described as a syndrome of progressive neurodegeneration that shares some features of Alzheimer's dementia has emerged as a public health concern. CTE is characterized by a number of neurological and physiological changes in the brain including the buildup of an abnormal protein called tau, which disrupts brain function. Whether repetitive head impacts and multiple concussions sustained in youth lead to long-term neurodegenerative diseases remains unclear. Additional research is needed to determine whether CTE represents a unique disease entity. Risk factors that have been linked to chronic neurobehavioral impairment in professional athletes include a history of head injury, longer exposure to the sport, and carrying *APOE4*.

DIAGNOSIS AND MANAGEMENT

Clinical Considerations[1-8]

The diagnosis of concussion involves the assessment of a range of domains, including somatic and cognitive symptoms, physical signs, emotional and behavioral changes, and sleep disturbances. Signs and symptoms of concussion can be subtle and easily overlooked. The diagnosis can be made only clinically, based primarily on the symptoms reported by the individual rather than on objective diagnostic markers. Many athletes report an associated headache and dizziness. Visual complaints may include "seeing stars," blurry vision, or double vision. Loss of consciousness (which once was considered a hallmark symptom for concussion) occurs in less than 10 percent of patients. Younger children may present with even more subtle signs, such as abdominal pain or behavioral changes. Patients may initially be asymptomatic and then develop symptoms several hours after the episode, and many young athletes may not be forthcoming of their symptoms as they fear activity restrictions. The evaluation of children at various ages requires an approach that is sensitive to the developmental differences in injury manifestation and recovery, and to developmental differences in the child's ability to engage effectively in the evaluation and treatment process. Clinical evaluation can be challenging in young patients because they may be unable to provide a history of

the event and may not always cooperate with the physical examination. While clinical guidelines are available for adults with mild TBI, guidance for managing children and teens with mild TBI is lacking at a time when the numbers of children and teens in the U.S. seeking care for mild TBI continues to increase markedly. To help fill this void, the CDC's National Center for Injury Prevention and Control established the Pediatric Mild Traumatic Brain Injury Guideline Workgroup. It is anticipated that this workgroup will create a multi-organizationally endorsed guideline for managing acute mild TBI among children and teens that occurs both on and off the sports field.

Determining the severity of a concussion has shifted from using loss of consciousness as the primary criterion to evaluation of the number of signs and symptoms that an athlete experiences along with the length of time that the athlete experiences the symptoms through the use of various assessment tools. An important aspect of the evaluation of a patient with a possible concussion is discussion with eyewitnesses to the injury and parents or coaches to determine whether the patient has improved or deteriorated since the time of injury.

Assessment Tools[1-8,22]

Recognition and initial assessment of a concussion can be guided by the use of multiple evaluation tools such as standardized symptom scales and checklists, balance testing, and neurocognitive evaluation (including orientation, past and immediate memory, new learning, and concentration). (see Appendices B and C) Graded symptom checklists provide an objective tool for assessing a variety of symptoms related to concussions, while also tracking the severity of those symptoms over serial evaluations. While the use of such tools may increase the sensitivity and specificity of concussion identification, current evidence is insufficient for validation of these assessment tools and for determining the best combination of measures to utilize for acute and baseline testing. The AAN suggests that individual baseline scores on concussion assessment tools may have utility for younger athletes, those with prior concussions, or those with pre-existing learning disabilities to facilitate interpretation of post-injury scores. The IOM committee found that, although baseline neuropsychological testing is a common practice, studies provide mixed (and limited) evidence concerning the utility and cost-effectiveness of such testing to improve short- or long-term outcomes.

Diagnostic Imaging[1-8,23]

Traditional structural neuroimaging techniques such as CT, magnetic resonance imaging (MRI), and electroencephalography are typically unremarkable or normal in concussions that are uncomplicated by a skull fracture, contusion, or hematoma. Neither CT nor MRI alone can detect the microstructural damage associated with concussion. A head CT should be considered in athletes with a suspected concussion when intracerebral bleeding or skull fracture is suspected, and for patients who have loss of consciousness, posttraumatic amnesia, persistently altered mental status, severe headache, focal neurologic deficit or seizure, or experience worsening symptoms or fail to improve. MRI may be useful in monitoring for structural change over time or for evaluating concurrent pathology that may complicate concussion management. Emerging neuroimaging technologies (e.g., magnetic resonance spectroscopy, positron emission tomography, single-photon emission CT, functional MRI, and diffusion tensor imaging) show promise and may further advance scientific understanding of concussion but additional research is required to determine the clinical utility of these technologies in the diagnosis and management of concussion.

Biomarkers[1,2,8,24]

Investigation of serum and cerebrospinal fluid biomarkers (e.g., S-100 proteins, neuron specific enolase, tau protein, genetic markers) is inconclusive for identifying and monitoring individuals with concussion. Limited evidence suggests that normal levels of S-100B protein following head injury may predict individuals who do not have intracranial injury.

Treatment and Recovery[1-8,25,26]

Concussion management is unique to each individual. Regardless of age, the specific symptom pattern may vary with each concussion sustained, and no two injuries are exactly alike. Clinical care needs to be matched to the particular person and his or her own unique circumstances to ensure that medical, cognitive, emotional, social, athletic, school, and family issues are addressed adequately.

After an individual is diagnosed with a concussion, consensus opinion calls for a minimum of daily monitoring. Most young patients can be managed at home under the care of a responsible adult for at least 24 hours; and, preferably, throughout the time that the individual experiences concussion symptoms. Patients and families must be educated about the importance of close monitoring for potential neurologic deterioration in the following hours and days. It is widely accepted that concussion symptoms are aggravated by both physical and mental exertion. Consensus opinion calls for physical and cognitive rest (i.e., rest from school and homework) until symptoms resolve. More urgent evaluation, including the need for conventional neuroimaging, may be indicated for patients with certain immediate symptoms (such as prolonged loss of consciousness, seizures, neck pain, and focal neurologic signs) or persistent severe symptoms (such as worsening headache, repeated vomiting, behavior change, persistent drowsy appearance, increased confusion or irritability, and slurred speech). At the present time, there is no evidence-based pharmacological treatment to improve recovery after concussion.

The majority of children recover from concussion within days to weeks of the initial injury. A subset will experience a longer recovery period and the physician needs to be alert to the potential for persistent physical, emotional, and cognitive complaints. More aggressive medical management of symptoms typically does not begin until three to four weeks post injury, when an athlete may be said to be experiencing prolonged recovery.

Specific factors that can require modification of concussion management include medications; high initial symptom load; a history of multiple prior concussions; younger age; and co-morbid conditions such as mental illness, attention deficit/hyperactivity disorder, headache disorder, and learning disabilities. The presence of modifying factors may predict the potential for prolonged recovery and require additional management considerations, including formal neuropsychological testing and diagnostic imaging. Referral to a neurologist, neuropsychologist, sports medicine physician, or other specialist with expertise in head injury should be considered for complex or atypical concussions, prolonged symptoms, or for patients who have suffered multiple concussions.

<u>Return-to-Play</u>[1-8]

As the athlete's symptoms begin to dissipate, he or she can gradually begin increasing cognitive and physical activities. This includes adherence to a graded return-to-play protocol that progresses through a series of steps, moving to the next step only when all activities in the current step are tolerated without recurrence of symptoms. If any symptoms return, the athlete should rest until symptoms resolve and then try going back to the previous asymptomatic step and be reassessed by a physician. If the symptoms return, the athlete needs to reduce activity until the symptoms dissipate again. During this time, communication between the athlete and medical staff is essential.

Because each athlete and each concussion are unique, there is no set timeframe for recovery and return to participation. Return-to-play before full recovery from a concussion is a risk factor for recurrent concussions, and for worse or prolonged post-concussion symptoms. The potential for other occult injuries also must be considered in the decision-making process.

The decision to return a player who has had a concussion back to practice and games resides with a team physician or other health care professional designated to manage the concussion protocols specifically for the player. Little empirical evidence exists to indicate the optimal degree and duration of physical rest needed to promote recovery or the best timing and approach for returning to full physical activity, including the use of graded return-to-play protocols. For example, a recent study of the benefits of strict rest for 5 days versus usual care (1-2 days of rest, followed by stepwise return to activity) after acute concussion found no added benefit of strict rest and actually this approach was associated with an increase in symptom reporting.[27] Nevertheless, evidence indicates that the brain is more susceptible to injury while recovering; thus, common sense dictates the need to reduce the risks of a repeat injury. Adherence to the adage "When in doubt, sit them out!" should be accepted practice.

Return-to-School[1,4-7,28]

Little evidence exists regarding the efficacy of cognitive rest following concussion or to inform the best timing and approach for return to cognitive activity following concussion, including protocols for returning students to school. Nevertheless, "return-to-learn" is a vital component of concussion management in children and adolescents. Generally, cognitive rest is achieved by eliminating or decreasing activities that require concentration, including schoolwork and mental stimulation, as these may exacerbate symptoms and prolong recovery. Because concussion symptoms may resolve before full cognitive recovery, students who are recovering from a concussion may require short-term accommodations upon returning to school.

RISK REDUCTION STRATEGIES

Protective Equipment[1,2,4,5,7,8,20]

Limited evidence exists from epidemiological and biomechanical studies that current helmet designs reduce the risk of sports-related concussion. However, there is evidence that helmets reduce the risk of other injuries, such as skull fracture, and thus the use of properly fitted helmets should be promoted. There is currently no evidence that mouth guards or facial protection, such as facemasks worn in ice hockey, reduce concussion risk, although their use should be promoted to prevent other sport-related injuries, such as those to the eyes, face, mouth, and teeth. As for the playing surface, current evidence is inconclusive to determine whether concussion risks are higher on synthetic versus natural turf.

In recent years, research has increased to evaluate the use of sensors for monitoring head impacts during an athletic event for the purpose of reducing potential head injury. Impact monitoring systems (e.g., sophisticated motion sensors placed throughout a football helmet; sports headbands with strategically placed accelerometer devices) are being utilized to measure the number of "g-forces" exerted on the brain with each impact and can produce important and critical data to better understand the type of hits taken to the head under various exposure scenarios and the corresponding forces sustained by the brain.

Rule Changes and Rules Enforcement[1,2,4,5,7,8]

Limited studies have shown that enforcement of rules regarding return-to-play by coaches and officials (and adherence to these rules by players) may help reduce the incidence and severity of sport-related concussions. Although additional research across a variety of sports is needed, some studies involving youth football, ice hockey, and soccer have shown that the enforcement of rules and/or rule changes (e.g., limitation of full contact drills during practice in youth football, elimination of body checking in youth hockey), as well as fair play policies contribute to reductions in the incidence of sports-related injuries, including concussions. In response to concerns about the long-term consequences of repetitive head impacts, several organizations have called for a "hit count" in youth sports, which is defined as a limit on the amount of head contact a particular player experiences over a given amount of time. While the concept of limiting the number of head impacts is fundamentally sound, the IOM committee found that, based on the evidence available at this time, implementation of a specific threshold for the number of impacts or the magnitude of impacts per day, week, or season is not scientifically based.

Education[1,2,4,5,7,8]

Research suggests that concussion education programs are effective in improving concussion knowledge and awareness, although there is limited evidence about the effect of these programs on improving behavior, attitudes, and beliefs about concussions among athletes, coaches, and parents to improve concussion reporting among youth athletes. Limited studies have shown that properly taught sport-specific techniques by coaches (and adherence to these mechanics by players) may help reduce the incidence and severity of sport-related concussions. The IOM committee found that a major problem with concussions in youth sports is a "culture of resistance" that keeps young athletes from reporting injuries and coaches and parents from properly treating and managing these injuries. For nonmedical personnel, the goal is to recognize the concussion or, at the very least, suspect that it occurred, remove the child from further danger, and seek medical evaluation to determine whether a concussion has occurred. To help address this problem, the IOM committee specifically calls on the NCAA and the NFHS to lead national efforts to develop education programs for young athletes, parents, and coaches about how to identify, treat, and manage concussions.

Increasing concussion awareness in the medical community may be accomplished by targeting the medical school and residency curriculums as well as through continuing professional education venues. Recognizing that concussion research has changed significantly over the past several years, primary care physicians who do not specialize in sports medicine might not be aware of how to correctly diagnose a concussion using the latest guidelines, utilize the new diagnostic tools, and apply current treatment protocols. Informed clinicians can provide crucial anticipatory guidance for safe sport participation, like reminders to wear helmets and use the proper protective equipment; and ensure that athletes who sustain concussions are seen by qualified health care professionals who have experience treating concussions.

In collaboration with health, sports, and national organizations, the CDC created the "Heads Up: Concussion in Youth Sports" initiative in 2007 for a variety of stakeholders (see http://www.cdc.gov/concussion/sports/index.html). The initiative is centered on a toolkit designed to provide health professionals, coaches, school administrators, athletes, and parents with practical and easy-to-read information on concussions from a reliable source. "Heads Up: Brain Injury in Your Practice" provides materials on mTBI and concussion for physicians, including a booklet with information on concussion diagnosis and management, a care plan, patient assessment form, concussion prevention fact sheets, a palm card for on-field management, and a CD-ROM with downloadable kit materials and other resources. An online concussion training module for physicians also is available.

The Think First National Injury Prevention Foundation's mission is to prevent brain, spinal cord and other traumatic injuries through education, research and advocacy (http://www.thinkfirst.org). Accordingly, they maintain a youth concussion awareness program, with opportunities for physician and community involvement.

Legislation[1,2,4,5,7,8]

Since 2009, legislation has been adopted in all states mandating that athletes do not return to sport on the same day they are concussed and that they do not return to sport unless they have been cleared by a sports medicine professional.[***] Most state concussion laws include requirements for concussion education, criteria for removal from play, and standards for physicians and other health care providers who make return-to-play decisions. Given that most states are still in the early stages of implementing these laws, the IOM committee found very little evidence of the efficacy of these laws.

Variation exists among states in the specific educational requirements for coaches, student athletes, and parents; in the qualifications of providers who are permitted to make return-to-play decisions; and in the populations to which the legislation applies. States differ somewhat in the entities (e.g., public, charter, parochial, and private schools) that are covered by concussion laws. State concussion laws often cover only school athletic teams and include no specific requirements or guidelines for recreational leagues. College athletes are not affected by state concussion legislation, which leaves organizations such as the NCAA to implement concussion management policies at this level. State and local boards of education are the governing bodies most commonly cited as responsible for implementation of concussion laws across the country. Health departments are generally given supportive responsibility. Some state laws name coaches, officials, or athletic trainers as the parties responsible for removal of an athlete from play, while most say nothing about who has this authority.

Laws in several states specify that a licensed health care provider trained in concussion diagnosis and management may provide clearance for athletes to return to play. Other states allow any licensed health care provider to make such decisions, and still others say nothing about who is allowed to evaluate concussions. In states that are more specific about the types of health care providers who may make return-to-play decisions, all allow physicians to evaluate concussions, and many allow physician assistants and nurse practitioners to perform this function. Some states allow athletic trainers, psychologists with training in neuropsychology, or physical therapists to provide clearance for return to play. Although a provider would need experience managing concussions to provide clearance for return-to-play, the IOM committee found no consensus regarding what type of health professional should perform this function or whether one type of professional should be preferred over another.

CONCLUSION

While the health benefits of a physically active lifestyle including sports participation are undeniable, participants are at risk of injury because a certain endemic level of injury can be expected during any physical activity, especially those with a competitive component. Injury rates should be reduced to the lowest possible level without discouraging children and adolescents from engaging in this important form of physical activity. This goal can best be accomplished by monitoring injury rates and patterns over time; investigating the etiology of injuries; and

[***] A summary of existing state concussion laws is available on the web site of the National Conference of State Legislatures at http://www.ncsl.org/research/health/traumatic-brain-injury-legislation.aspx.

developing, implementing, and evaluating evidence-based injury reduction measures. Data regarding sports injury rates are generally lacking for this age group because no widespread injury surveillance systems in youth sports exist.

Injury surveillance efforts are complicated by the lack of reliable biomarkers for concussion and the reliance on subjective symptom-based definitions, combined with variations in terminology (e.g., concussion versus mTBI) and in the definition of those terms, as well as evolving descriptions of concussion severity. It is still uncertain where concussion occurs in the brain, or the exact origin of the symptoms of acute concussion. It is apparent that direct impact to the head is not required: concussion can occur with a blow to the chest, for example, that causes a whiplash effect on the brain. Concussion also can occur without loss of consciousness. Although some research indicates that a series of molecular and functional changes take place in the brain following injury, little research has been conducted specifically on changes in the brain following concussions in youth or on the differences in such changes between females and males.

Not all concussions can be prevented, but some may be avoided. Physicians have an important role in assessing a patient's readiness for a contact or collision sport, and potential risk of injury. Recognition of risk factors through a proper preparticipation evaluation should be promoted as a way to help prevent injury. Preparticipation medical contact should incorporate a history taken with both the parent and child, delineating the number of prior concussions, timing and severity of each, the duration and intensity of any resulting symptoms, and the presence of mood, learning, attention, or migraine disorders. Discussion of existing data on the risks of concussion, while simultaneously acknowledging the existence of clinical uncertainty, allows physicians to promote a more autonomous decision-making process by allowing the athletes and their parents to perform an informed risk-benefit analysis.

Physicians play a major role facilitating diagnosis, management, and recovery from concussion, especially in facilitating individualized timetables and activities for return to school and play. While the diagnosis of concussion continues to improve, treatment options remain limited and long-term implications of the diagnosis are relatively unknown. Current data gaps limit understanding of the true pathophysiology of concussion and contributing factors for permanent versus transitory physiological damage. There is no standard for how many concussions are too many or when treatment decisions should change from a focus on recovery with return to activity to avoidance of high-risk sport. To a large extent, clinical judgment, expert guidelines, and available assessment tools must be integrated to establish a diagnosis and facilitate recovery. The clinical decision-making process is more complicated in an athlete with prolonged unresolved symptoms, multiple concussions both with and without prolonged recovery, or a structural brain injury.

Expert consensus opinion is that an individualized treatment plan including physical and cognitive rest is beneficial for recovery from concussion, although current research is insufficient to identify the level and duration of physical and cognitive rest needed to promote recovery. Overarching mandates are no return to play on the same day as a concussion, no return to play with symptoms, and that all concussions need medical clearance prior to return to play. With proper management, most children and adolescents sustaining a sport-related concussion can be expected to recover fully without permanent damage. Athletes who return to play before their concussions have fully resolved may place themselves at increased risk for prolonged recovery or more serious consequences if they sustain a subsequent head injury.

Improving medical coverage at athletic competitions is critical, at least for all high-risk contact or collision sports. Many organized contact sports are played without trained medical personnel on the

sideline. While most colleges and many U.S. high schools have access to a full- or part-time athletic trainer, many club and private sports teams have no such affiliation. Even if available, a single athletic trainer would have difficulty covering all sports teams in the school. Similarly, most community- and park district-based youth sports leagues rarely have any type of on-site medical coverage. Coaches and referees typically preside over such events.

Physicians and their professional organizations can advocate for enhanced education and legislation to detect and prevent head injuries in sport and recreation. Concussion education should be mandatory for all athletes, parents, coaches, and health professionals involved in youth sports. Emphasis should be placed on the importance of removing an athlete experiencing any signs or symptoms of concussion immediately from the activity for further evaluation by a physician or other qualified sports medicine professional. Similarly, education must be provided for teachers, counselors, and other school personnel to help them understand how concussion adversely impacts cognitive and functional abilities. Current concussion laws are unique to each state and need to be understood by health care professionals, sports organizations, coaches, parents, and athletes.

Perhaps the most pressing challenge is a prevailing culture in sports that discourages athletes from reporting their injuries to avoid perceptions of being weak or "soft." Every athlete needs to know how crucial it is to let their coach, trainer, physician, teacher, or parent know if they have "hit their head" or have symptoms of a head injury—even if it means stopping play. A head injury should never be ignored, no matter how minor. Even mild concussions should not be taken lightly. Although some concussions are less serious than others, there is no such thing as a "minor concussion."

RECOMMENDATIONS

The Council on Science and Public Health recommends that the following recommendations be adopted in lieu of Resolutions 401, 410, and 412-A-14 and the remainder of the report be filed.

1. That Policies H-470.959 "Return to Play after Suspected Concussion" and H-470.966 "Harmful Practices for Child Athletes" be amended by substitution to read as follows:

   REDUCING THE RISK OF CONCUSSION AND OTHER INJURIES IN YOUTH SPORTS

   (1) Our AMA promotes the adoption of requirements that athletes participating in school or other organized youth sports and who are suspected by a coach, trainer, administrator, or other individual responsible for the health and well-being of athletes of having sustained a concussion be removed immediately from the activity in which they are engaged and not return to competitive play, practice, or other ~~physical~~ sports-related activity without the written approval of a ~~licensed~~ physician (MD or DO) or a designated member of the physician-led care team who has been properly trained in the evaluation and management of concussion. When evaluating individuals for return-to-play, physicians (MD or DO) or the designated member of the physician-led care team should be mindful of the potential for other occult injuries.

   (2) Our AMA encourages physicians to: (a) assess the developmental readiness and medical suitability of children and adolescents to participate in organized sports and assist in matching a child's physical, social, and cognitive maturity with appropriate sports activities; (b) counsel young patients and their parents or caregivers about the risks and potential consequences of sports-related injuries, including concussion and

recurrent concussions; ~~and~~ (c) assist in state and local efforts to evaluate, implement, and promote measures to prevent or reduce the consequences of concussions, repetitive head impacts, and other injuries in youth sports; and (d) support preseason testing to collect baseline data for each individual..

(3) Our AMA will work with interested agencies and organizations to: (a) identify harmful practices in the sports training of children and adolescents; (b) support the establishment of appropriate health standards for sports training of children and adolescents; and (c) promote educational efforts to improve knowledge and understanding of concussion and other sport injuries among youth athletes, their parents, coaches, sports officials, school personnel, health professionals, and athletic trainers. (Modify Current HOD Policy)

2. That Policies H-10.965 "Mild Traumatic Brain Injury Awareness," H-470.957 "Athlete Concussion Management and Chronic Traumatic Encephalopathy Prevention," and D-470.997 "Sports Injury Reduction" be amended by substitution to read as follows:

REDUCTION OF SPORTS-RELATED INJURY AND CONCUSSION

(1) Our AMA will: (a) work with appropriate agencies and organizations to promote awareness of programs to reduce concussion and other sports-related injuries across the lifespan; and (b) promote awareness that even mild cases of traumatic brain injury may have serious and prolonged consequences.

(2) Our AMA supports the adoption of evidence-based, age-specific guidelines on the evaluation and management of concussion in all athletes for use by physicians, other health professionals, and athletic organizations.

(3) Our AMA will work with appropriate state and specialty medical societies to enhance opportunities for continuing education regarding professional guidelines and other clinical resources to enhance the ability of physicians to prevent, diagnose, and manage concussions and other sports-related injuries.

(4) Our AMA urges appropriate agencies and organizations to support research to: (a) assess the short- and long-term cognitive, emotional, behavioral, neurobiological, and neuropathological consequences of concussions and repetitive head impacts over the life span; (b) identify determinants of concussion and other sports-related injuries in pediatric and adult athletes, including how injury thresholds are modified by the number of and time interval between head impacts and concussions; (c) develop and evaluate effective risk reduction measures to prevent or reduce sports-related injuries and concussions and their sequelae across the lifespan; and (d) develop objective biomarkers to improve the identification, management, and prognosis of athletes suffering from concussion to reduce the dependence on self-reporting and inform evidence-based, age-specific guidelines for these patients. (Modify Current HOD Policy)

3. That the following policies be reaffirmed:

H-10.982 Injury Prevention
H-470.956 Injuries in Cheerleading
H-470.958 Head Injury Prevention in Hockey
H-470.960 Soccer Injuries
H-470.963 Boxing Safety
H-470.967 Safety in Youth Baseball and Softball
H-470.971 Athletic Preparticipation Examinations for Adolescents

H-470.974 Athletic Helmets
H-470.984 Brain Injury in Boxing
H-470.995 Athletic (Sports) Medicine
(Reaffirm HOD Policy)

Fiscal Note: Less than $500

APPENDIX A

Current AMA Policy

H-10.965 Mild Traumatic Brain Injury Awareness
Our AMA will promote awareness that even mild cases of traumatic brain injury may have serious and prolonged consequences. (Res. 418, A-12)

H-10.982 Injury Prevention
Our AMA (1) supports the CDC's efforts to (a) conduct research, (b) develop a national program of surveillance and focused interventions to prevent injuries, and (c) evaluate the effectiveness of interventions, implementation strategies, and injury prevention programs; (2) supports a Public Health Service public information campaign to inform the public and its policymakers of the injury problem and the potential for effective intervention; (3) supports the development of a National Center for Injury Control at the CDC; and (4) encourages state and local medical societies to support, in conjunction with state and local health departments, efforts to make injury control a priority, and advise the leadership of the United States Congress of this unqualified support; and the AMA remains open to working with all interested parties in efforts to deal with and lessen the effects of violence in our society. (Res. 410, A-92; Reaffirmed by BOT Rep. 19 - I-94; Reaffirmed by BOT Rep. 34, A-95; Modified and Reaffirmed by BOT Rep. 52, I-95; Reaffirmed: CSA Rep. 8, A-05)

H-470.956 Injuries in Cheerleading
Our AMA: (1) supports the designation of cheerleading as a sport; and (2) recognizes the potential dangers of cheerleading, including the potential for concussion and catastrophic injury, and supports the implementation of recommendations designed to improve its safety equivalent to those that apply to other athletic activities formally recognized as “sports” by appropriate accrediting bodies. These include proper training of coaches, avoidance of inappropriate surfaces when performing stunts and adherence to rules for the proper execution of stunts. (BOT Rep. 9, A-14)

H-470.959 Return to Play after Suspected Concussion
Our AMA: (1) promotes the adoption of requirements that athletes participating in school or other organized youth sports and who are suspected by a coach, trainer, administrator, or other individual responsible for the health and well-being of athletes of having sustained a concussion, should not return to play or practice without the written approval of an MD or DO; and (2) encourages educational efforts designed to improve the understanding of concussion by athletes, their parents, coaches, and trainers. (Res. 910, I-10; Reaffirmed: BOT Rep. 9, A-14)

H-470.957 Athlete Concussion Management and Chronic Traumatic Encephalopathy Prevention
Our AMA: (1) supports the adoption of evidence-based guidelines for the evaluation and management of concussions by all athletic organizations; and (2) encourages further research in the diagnosis, treatment, and prevention of chronic traumatic encephalopathy. (Res. 905, I-13)

H-470.958 Head Injury Prevention in Hockey
Our AMA will encourage that all levels of hockey effectively prevent head hits and dangerous checking. (Res. 425, A-12)

H-470.960 Soccer Injuries
Our AMA recognizes the problem of injuries in soccer and encourages additional studies into the incidence of soccer-related injuries and methods to reduce those injuries. (Sub. Res. 404, A-09)

H-470.963 Boxing Safety
While the AMA recognizes that boxing is a violent sport associated with brain and eye injuries, we recommend the following preventive strategies to reduce such injuries in boxers: (1) Relevant regulatory bodies are encouraged to: (a) require the use of objective brain injury risk assessment tools to exclude individual at-risk boxers from sparring or fighting. (b) develop and enforce standard criteria for referees, ringside officials, and ringside physicians to halt sparring or boxing bouts when a boxer has experienced concussive or subconcussive blows that place him or her at imminent risk of more serious injury. (c) encourage implementation of measures advocated by the World Medical Boxing Congress designed to reduce the incidence of brain and eye injuries. (d) require initial and repeat eye examinations for amateur and professional boxers and mandate suspensions from sparring or boxing for specific ocular pathology according to recommendations of the American Academy of Ophthalmology. (2) Our AMA promotes the concept that the professional responsibility of the physician who serves in a medical capacity at a boxing contest is to protect the health and safety of the contestants. The desire of spectators, promoters of the event, or even injured athletes that they not be removed from the contest should not be controlling. The physician's judgment should be governed only by medical considerations. (CSA Rep. 3, A-99; Reaffirmed: Res. 412, A-02; Modified: CSAPH Rep. 1, A-12)

H-470.966 Harmful Practices in Child Athletics
The AMA will (a) work with all interested organizations to identify harmful practices in the sports training of children and adolescents; and (b) support the establishment of appropriate health standards for sports training of children and adolescents. (Res. 417, A-96; Reaffirmed: CSAPH Rep. 3, A-06)

H-470.967 Safety in Youth Baseball and Softball
The AMA: (1) urges youth baseball and softball organizations to adopt policies for the use of protective equipment; (2) will create greater public awareness regarding the potential dangers of using baseballs and softballs with children; and (3) encourages sponsors of organized youth sports activities to adopt written emergency and a first responder plans. (Res. 408, I-95; Reaffirmed: CSA Rep. 8, A-05)

H-470.971 Athletic Preparticipation Examinations for Adolescents
To promote the health and safety of adolescents, our AMA recommends that state medical societies work with appropriate state and local agencies to promote the following: (1) The development of standards for preparticipation athletic examinations that are consistent with consensus recommendations of the American Academy of Family Physicians, American Academy of Pediatrics, American Medical Society for Sports Medicine, American Orthopedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine. (2) Only licensed MDs, DOs, and licensed physician extenders practicing under the supervision of licensed MDs and DOs perform preparticipation examinations. (3) The decision of whether or not an adolescent is healthy and physically mature enough to participate in a particular sport is made by a qualified physician. (4) The decision of when an injured athlete resumes participation is made by a qualified physician. (5) The most current guidelines established by the American Academy of Pediatrics, American College of Cardiology, American College of Sports Medicine, and other appropriate medical specialty societies are used to determine eligibility for sports participation. (BOT Rep. R, A-90; Amended: CSA Rep. 5, I-99; Reaffirmed: CSAPH Rep. 1, A-09; Reaffirmed: BOT Rep. 9, A-14)

H-470.974 Athletic Helmets
(1) Our AMA urges the Consumer Product Safety Commission and other appropriate agencies and organizations to establish standards to ensure that athletic and recreational equipment produced or

sold in the United States provide protection against head and facial injury. (2) Our AMA: (a) supports requiring the use of head and facial protection by children and adolescents while engaged in potentially dangerous athletic and recreational activities; (b) encourages the use of head and facial protection for adults while engaged in potentially dangerous athletic and recreational activities; (c) encourages physicians to educate their patients about the importance of head and facial protection while engaged in potentially dangerous athletic and recreational activities; and (d) encourages the availability of rental helmets at all commercial settings where potentially dangerous athletic and recreational activities take place. (Sub. Res. 16, I-88; Res. 419, A-93; Reaffirmed: CSA Rep. 8, A-03; Appended: Sub Res. 911, I-10; Modified: Res. 404, A-12)

H-470.984 Brain Injury in Boxing

The AMA supports the following series of steps designed to protect amateur and professional boxers from injuries: (1) Encourage the establishment of a "National Registry of Boxers" for all amateur and professional boxers, including "sparring mates," in the country. The proposed functions of a computer-based central registry would be to record the results of all licensed bouts, including technical knockouts, knockouts, and other boxing injuries, and to compile injury and win/loss records for individual boxers. (2) Recommend to all boxing jurisdictions that the ring physician should be authorized to stop any bout in progress, at any time, to examine a contestant and, when indicated, to terminate a bout that might, in his opinion, result in serious injury for either contestant. (3) Urge state and local commissions to conduct frequent medical training seminars for all ring personnel. (4) Recommend to all boxing jurisdictions that no amateur or professional boxing bout should be permitted unless: (a) the contest is held in an area where adequate neurosurgical facilities are immediately available for skilled emergency treatment of an injured boxer; (b) a portable resuscitator with oxygen equipment and appropriate endotracheal tubes are available at ringside; and (c) a comprehensive evacuation plan for the removal of any seriously injured boxer to hospital facilities is ready. (5) Inform state legislatures that unsupervised boxing competition between unlicensed boxers in "tough man" contests is a most dangerous practice that may result in serious injury or death to contestants, and should be condemned. (6) Urge state and local boxing commissions to mandate the use of safety equipment, such as plastic safety mats and padded cornerposts, and to encourage continued development of safety equipment. (7) Urge state and local boxing commissions to extend all safety measures to sparring partners. (8) Urge state and local boxing commissions to upgrade, standardize and strictly enforce medical evaluations for boxers. (CSA Rep. F, A-82; Reaffirmed: A-83; Reaffirmed: CLRPD Rep. A, I-92; Reaffirmed: Sub. Res. 408, I-93; Reaffirmed: CSA Rep. 3, A-99; Modified and Reaffirmed: CSAPH Rep. 1, A-09)

H-470.995 Athletic (Sports) Medicine

Our AMA believes that: (1) the Board of Education and the Department of Health of the individual states should encourage that an adequate Athletic Medicine Unit be established in every school that mounts a sports program; (2) the Athletic Medicine Unit should be composed of an allopathic or osteopathic physician director with unlimited license to practice medicine, an athletic health coordinator (preferably a NATABOC certified athletic trainer), and other necessary personnel; (3) the duties of the Athletic Medicine Unit should be prevention of injury, the provision of medical care with the cooperation of the family’s physician and others of the health care team of the community, and the rehabilitation of the injured; (4) except in extreme emergencies, the selection of the treating physician is the choice of the parent or guardian and any directed referral therefore requires their consent; (5) the Athletic Medicine Units should be required to submit complete reports of all injuries to a designated authority; (6) medical schools, colleges, and universities should be urged to cooperate in establishing education programs for athletic health coordinators (NATABOC certified athletic trainers) as well as continuing medical education and graduate programs in Sports Medicine; (7) high school administrators, athletic directors, and coaches to

work with local physicians, medical societies, and medical specialty societies, as well as government officials and community groups to undertake appropriate measures to ensure funding to provide the services of a certified athletic trainer to all high school athletes; and (8) not all high schools have the resources to procure the services of a certified athletic trainer and further recognizing that athletic trainers cannot be present at all practices and competitions, that the AMA encourage high school administrators and athletic directors to ensure that all coaches are appropriately trained in emergency first aid and basic life support. (Res. 112, A-69; Reaffirmed: CLRPD Rep. C, A-89; Modified and Reaffirmed by Ref. Cmt. D, I-96; Amended and Appended by CSA Rep. 5, A-98; Reaffirmed: CSAPH Rep. 2, A-08)

D-470.997 Sports Injury Reduction
Our AMA will work with members of the Federation to promote awareness of programs to reduce injuries in contact sports. (Res. 402, A-01; Modified: CSAPH Rep. 1, A-11)

APPENDIX B

Table. Assessment Tools to Facilitate Concussion Diagnosis and Management*

TOOL	EXAMPLES	COMMENTS
Symptom Scales	• Acute Concussion Evaluation tool • Concussion Symptom Inventory • Graded Symptom Checklist • Post-Concussion Symptom Inventory • Post-Concussion Symptom Scale	•Most commonly used concussion assessment tool. •Simple, cost-effective tool with good sensitivity and high specificity. •Allows athletes to self-report symptoms. •Cautions: symptoms may be delayed, may not be reported, or already present at baseline. •Most checklists developed using clinical judgment; the Concussion Symptom Inventory is the only empirically derived symptom checklist.
Neuro-psychological Tests	<u>Written</u>: • Controlled Oral Word Association Test • Digit Symbol Substitution Test • Learning Test • Stroop Color and Word Test • Trail Making Test <u>Computer-based</u>: • Automated Neuropsychological Assessment Metrics • CogSport • Concussion Resolution Index (HeadMinder) • Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT)	• Designed to identify subtle cognitive deficits. • Both types generally require a neuropsychologist for interpretation, although the tests may be administered by a non-neuropsychologist. • Written tests are labor intensive, whereas computer-based tests can be administered rapidly and to multiple patients simultaneously. • Results best interpreted when compared with baseline data; affected by psychiatric disorders, physical symptoms, cultural factors, and motivation/effort. • These tests are not yet validated, no data exist to demonstrate that they affect outcomes when used to guide return-to-play decisions. • Limited data for use in children younger than 12 years of age; child-specific computerized tests are under development.
Postural Stability Tests	• Balance Error Scoring System (BESS) • Sensory Organization Test (SOT)	• Data limited for use in monitoring recovery. • Impaired balance usually lasts three to five days after concussion occurs. • Low to moderate sensitivity; good specificity.

Sideline Assessment Tools	• Standardized Assessment of Concussion (SAC) • Sport Concussion Assessment Tool v 3.0 (SCAT3) • Child SCAT3 • King-Devick Test	• A single, simple tool to assess a variety of domains in the initial concussion assessment. • Often used to monitor the recovery process. • More research is needed to determine the efficacy of sideline tools to help diagnose concussion. • SAC can be used immediately after injury to evaluate orientation, memory, concentration, and delayed recall; validated as a sideline tool for athletes of junior high school age and older; a version for use in emergency departments is validated in adults. • SCAT3 combines multiple assessment tools (symptom checklist, concentration and memory tasks [i.e., Maddock's questions], SAC, BESS, and Glasgow Coma Scale) for use in children 13 years of age and older; it is not validated but is widely used and the most sophisticated sideline tool available. Child SCAT3 is available for children between 5 and 12 years of age. • King-Devick Test assesses eye movements, speech, language, and concentration; all of which can be impaired as a result of concussion.

*Adapted from References 1, 3, and Scorza KA, Raleigh MF, O'Connor FG. Current concepts in concussion: evaluation and management. *Am Fam Physician.*2012;85(2):123-132.

APPENDIX C

The *Acute Concussion Evaluation* form is an example of a patient assessment tool. It is available on the CDC website at http://www.cdc.gov/concussion/headsup/pdf/ACE-a.pdf.

ACUTE CONCUSSION EVALUATION (ACE)
PHYSICIAN/CLINICIAN OFFICE VERSION

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Patient Name:_____
DOB:_____ Age:_____
Date:_____ ID/MR#_____

A. Injury Characteristics Date/Time of Injury_____ Reporter: __Patient __Parent __Spouse __Other_____

1. Injury Description _____

1a. Is there evidence of a forcible blow to the head (direct or indirect)? __Yes __No __Unknown
1b. Is there evidence of intracranial injury or skull fracture? __Yes __No __Unknown
1c. Location of Impact: __Frontal __Lft Temporal __Rt Temporal __Lft Parietal __Rt Parietal __Occipital __Neck __Indirect Force
2. **Cause**: __MVC __Pedestrian-MVC __Fall __Assault __Sports (*specify*)_____Other_____
3. **Amnesia Before (Retrograde)** Are there any events just BEFORE the injury that you/ person has no memory of (even brief)? __Yes __No Duration
4. **Amnesia After (Anterograde)** Are there any events just AFTER the injury that you/ person has no memory of (even brief)? __Yes __No Duration
5. **Loss of Consciousness**: Did you/ person lose consciousness? __Yes __No Duration
6. **EARLY SIGNS:** __Appears dazed or stunned __Is confused about events __Answers questions slowly __Repeats Questions __Forgetful (recent info)
7. **Seizures**: Were seizures observed? No__ Yes__ Detail_____

B. Symptom Check List* Since the injury, has the person experienced any of these symptoms any more than usual today or in the past day?
Indicate presence of each symptom (0=No, 1=Yes). *Lovell & Collins, 1998 JHTR*

PHYSICAL (10)		COGNITIVE (4)		SLEEP (4)	
Headache	0 1	Feeling mentally foggy	0 1	Drowsiness	0 1
Nausea	0 1	Feeling slowed down	0 1	Sleeping less than usual	0 1 N/A
Vomiting	0 1	Difficulty concentrating	0 1	Sleeping more than usual	0 1 N/A
Balance problems	0 1	Difficulty remembering	0 1	Trouble falling asleep	0 1 N/A
Dizziness	0 1	COGNITIVE Total (0-4) _____		SLEEP Total (0-4) _____	
Visual problems	0 1	EMOTIONAL (4)			
Fatigue	0 1	Irritability	0 1		
Sensitivity to light	0 1	Sadness	0 1		
Sensitivity to noise	0 1	More emotional	0 1		
Numbness/Tingling	0 1	Nervousness	0 1		
PHYSICAL Total (0-10) _____		EMOTIONAL Total (0-4) _____			
(Add Physical, Cognitive, Emotion, Sleep totals) Total Symptom Score (0-22)		_____			

Exertion: Do these symptoms worsen with:
Physical Activity __Yes __No __N/A
Cognitive Activity __Yes __No __N/A

Overall Rating: How different is the person acting compared to his/her usual self? (circle)
Normal 0 1 2 3 4 5 6 Very Different

C. Risk Factors for Protracted Recovery *(check all that apply)*

Concussion History? Y___ N___	√	Headache History? Y___ N___	√	Developmental History	√	Psychiatric History
Previous # 1 2 3 4 5 6+		Prior treatment for headache		Learning disabilities		Anxiety
Longest symptom duration Days__ Weeks__ Months__ Years__		History of migraine headache __ Personal __ Family_____		Attention-Deficit/ Hyperactivity Disorder		Depression
						Sleep disorder
If multiple concussions, less force caused reinjury? Yes__ No__				Other developmental disorder_____		Other psychiatric disorder _____

List other comorbid medical disorders or medication usage (e.g., hypothyroid, seizures)_____

D. RED FLAGS for acute emergency management: Refer to the emergency department with sudden onset of any of the following:

* Headaches that worsen	* Looks very drowsy/ can't be awakened	* Can't recognize people or places	* Neck pain
* Seizures	* Repeated vomiting	* Increasing confusion or irritability	* Unusual behavioral change
* Focal neurologic signs	* Slurred speech	* Weakness or numbness in arms/legs	* Change in state of consciousness

E. Diagnosis (ICD): __Concussion w/o LOC 850.0 __Concussion w/ LOC 850.1 __Concussion (Unspecified) 850.9 __Other (854) _____
__No diagnosis

F. Follow-Up Action Plan **Complete *ACE Care Plan* and provide copy to patient/family.**
___ **No Follow-Up Needed**
___ **Physician/Clinician Office Monitoring**: Date of next follow-up_____
___ **Referral:**
___ Neuropsychological Testing
___ Physician: Neurosurgery____ Neurology____ Sports Medicine____ Physiatrist____ Psychiatrist____ Other_____
___ Emergency Department

ACE Completed by:_____

This form is part of the "Heads Up Brain Injury in Your Practice" tool kit developed by the Centers for Disease Control and Prevention (CDC).

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