

Current Recommendations for the Diagnosis and Treatment of Concussion in Sport: A Comparison of Three New Guidelines

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Abstract

Currently, there is considerable debate within the sports medicine community about the role of concussion and the risk of chronic neurological sequelae. This concern has led to significant confusion among primary care providers and athletic trainers about how to best identify those athletes at risk and how to treat those with concussion. During the first quarter of 2013, several new or updated clinical practice guidelines and position statements were published on the diagnosis, treatment, and management of mild traumatic brain injury/concussion in sports. Three of these guidelines were produced by the American Medical Society for Sports Medicine, The American Academy of Neurology, and the Zurich Consensus working group. The goal of each group was to clearly define current best practices for the definition, diagnosis, and acute and post-acute management of sports-related concussion, including specific recommendations for return to play. In this article, we compare the recommendations of each of the three groups, and highlight those topics for which there is consensus regarding the definition of concussion, diagnosis, and acute care of athletes suspected of having a concussion, as well as return-to-play recommendations.

Key words: concussion; guidelines; mild traumatic brain injury; post-concussion syndrome; return to play

Introduction

THE CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)¹ reports that three traumatic brain injuries (TBIs) occur every minute, 5.3 million persons live with disabilities related to brain injury, and that TBIs cost Americans \$76.5 billion in medical care, rehabilitation, and loss of work every year. Multiple reports note that sports participants, including pediatric, college, and professional, sustain a large number of TBIs annually. The majority (75–85%)¹ of TBIs are mild (mTBI), also known as concussion. Current epidemiological reports find that girls' soccer, American football, and ice hockey have the highest incidence of concussion.² As a preventable injury, concussion remains a public health concern as well as a common clinical concern for primary care and specialty care providers alike.

The sports medicine communities have responded by developing and updating clinical practice recommendations for the assessment, diagnosis, management, and prevention of concussion in sport. This article discusses and compares three recently published concussion guidelines: The American Medical Society for Sports Medicine position statement: Concussion in sport,³ The American Academy of Neurology Summary of evidence-based guideline update: Evaluation and management of concussion in sports,⁴ and The Consensus statement on concussion in sport: the 4th Interna-

tional Conference on Concussion in Sport held in Zurich, November 2012.⁵ The three guideline groups included between 10⁴ and 28⁵ nationally and internationally recognized experts in sports-related concussion, and two of those experts participated in the crafting of all three guidelines. Authors of these guidelines represent all sports-medicine-related specialties and are physicians, athletic trainers and physical therapists, and consultants for all levels of sport from high school to professional.

In this article, we provide a comparison and discussion of the similarities among the three guidelines as well as areas identified by each group that remain uncertain. For reference and as a further summary, specific information from each source has been compiled in Table 1.

Background

The American Medical Society for Sports Medicine (AMSSM): Concussion in Sport³ document is an original position statement on concussion in sport. The guideline group set the purpose of the position statement as providing evidence-based best practices as a summary to aid providers in the evaluation and management of concussion, as well as to identify any gaps in current information needing more focused research. The position statement was developed using a systematic literature search, review, and evidence

TABLE 1. COMPARISON OF 2013 MILD TRAUMATIC BRAIN INJURY GUIDELINE UPDATES

Source	American Medical Society for Sports Medicine position statement: Concussion in sport ¹	American Academy of Neurology summary of evidence-based guideline update: Evaluation and management of concussion in sports ²	Consensus statement on concussion in sport: The 4th International Conference on Concussion in Sport held in Zurich, November 2012 ³
Definition	A traumatically induced transient disturbance of brain functions and involves a complex pathophysiological process.	A clinical syndrome of biomechanically induced alteration of brain function, typically affecting memory and orientation, which may involve LOC.	A complex pathophysiological process affecting the brain, induced by biomechanical forces. Several common features that incorporate clinical, pathologic, and biomechanical injury constructs that may be used in defining the nature of a concussive head injury. 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. Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously. In some cases, however, symptoms and signs may evolve over a number of minutes to hours. 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. Concussion results in a graded set of clinical symptoms that may or may not involve LOC.
Incidence	Estimated that as many as 3.8 million concussions occur in the United States per year; as many as 50% may go unreported.	Estimates of sports-related mTBI range from 1.6–3.8 million in the United States, many of whom do not obtain immediate medical attention. College football reports the highest rate at 3.02 per/1000 games for males, and college soccer for females is highest at 1.80 per/1000 games.	Not discussed.
Risk factors	History of one concussion is associated with a higher risk of sustaining another concussion. In sports with similar playing rules, the reported incidence of concussion is higher in females than males. Youth athletes may have a more prolonged recovery and are more susceptible to a concussion accompanied by a catastrophic injury. A greater number, severity, and duration of symptoms after concussion are predictors of a prolonged recovery. Certain sports, positions, and individual playing styles have a greater risk of concussion. Pre-injury mood disorders, learning disorders, ADD/ADHD, and migraine headache complicate diagnosis and management of concussion.	Previous concussion exposure is highly likely to be a risk factor for chronic neurobehavioral impairment across a broad range of professional sports. A history of concussion is a highly probable risk factor for recurrent concussion. There is a high likelihood that history of concussion is associated with more severe/longer duration of symptoms and cognitive deficits. It is highly likely that there is an increased risk for repeated concussion in the first 10 days after an initial concussion, an observation supported by pathophysiologic studies. There is conflicting evidence as to whether female or male sex is a risk factor for more post-concussive symptoms, so no conclusion could be drawn. It is highly probable that females are at greater risk when playing basketball and soccer. Insufficient evidence to identify age as a risk factor. Data are insufficient to determine whether previous concussion exposure is associated with chronic cognitive impairment in amateur athletes.	Repeated concussions over time are a risk factor for subsequent concussion, which may occur with progressively decreased impact force and may be associated with slower recovery. No agreement that current published research evidence is conclusive enough for female sex to be a risk factor for injury and/or influence injury severity. There are data demonstrating that at the collegiate and high school levels, athletes allowed to RTP on the same day may demonstrate NP deficits post-injury that may not be evident on the sidelines and are more likely to have delayed onset of symptoms.

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TABLE 1. (CONTINUED)

Source	<p><i>American Medical Society for Sports Medicine position statement: Concussion in sport</i>¹</p> <p><i>American Academy of Neurology summary of evidence-based guideline update: Evaluation and management of concussion in sports</i>²</p> <p><i>Consensus statement on concussion in sport: The 4th International Conference on Concussion in Sport held in Zurich, November 2012</i>³</p>
Symptoms	<p>Recognition and initial assessment of concussion should be guided by a symptom checklist.</p> <p>Headache is the most common reported symptom, with dizziness the second most common.</p> <p>Several symptoms of concussion are nonspecific: e.g., nausea, vomiting, and headache.</p> <p>Some symptoms overlap with other disorders such as sleep disturbances, depression, and ADD. It is helpful to determine if these symptoms were present before the concussion.</p> <p>There have been no consistently demonstrated differences in the symptoms reported between males and females.</p> <p>Non-specific signs include vomiting, memory disturbance, balance, and vision problems as well as numbness and tingling.</p> <p>A clinical diagnosis ideally made by a health care provider familiar with the athlete and knowledgeable in the recognition and evaluation of concussion. A multidisciplinary approach to assessment and management is advocated.</p> <p>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.</p> <p>Recognition and initial assessment of concussion should be guided by a symptom checklist, a cognitive evaluation, balance test (e.g. BESS) to provide a helpful structure for the evaluation of concussion, although limited validation of these assessment tools is available.</p>
Signs	<p>Headache, fatigue/ fogginess, early amnesia, alteration in mental status, disorientation reported probable risk factors for persistent neurocognitive problems or prolonged RTP.</p> <p>LHCP caring for athletes might use individual baseline scores on concussion assessment tools such as symptom checklists, SAC, BESS, SCAT2, computerized and/or paper and pencil neurocognitive tests, and/ or sensory organization tests (SORT).</p> <p>In persons with suspected concussion, these tools should be used by sideline LHCPs and the results made available to clinical LHCPs who will be evaluating the injured athlete. A multidisciplinary approach to assessment and management is advocated.</p> <p>Athletes should be removed from play immediately if concussion is suspected.</p>
Diagnosis/initial evaluation	<p>Physical signs (e.g., LOC, amnesia)</p> <p>A variety of immediate motor phenomena (e.g., tonic posturing) or convulsive movements may accompany a concussion.</p> <p>Prolonged LOC (> 1 min) may be a factor that can modify management.</p> <p>The diagnosis of acute concussion usually involves the assessment of a range of domains including clinical symptoms, physical signs, cognitive impairment, neurobehavioral features, and sleep disturbance. A multidisciplinary approach to assessment and management is advocated.</p> <p>A SAC tool is useful in the assessment of the athlete with suspected concussion but should not take the place of the clinician's judgment. Additional neurocognitive or neuropsychological tests may also be considered.</p> <p>A determination of the need for emergent neuroimaging to exclude a more severe brain injury involving a structural abnormality</p> <p>A detailed concussion history is an important part of the evaluation both in the injured athlete and when conducting a pre-participation examination. The number, duration (> 10 days), and severity of symptoms as well as LOC, post-traumatic amnesia particularly if prolonged. In addition the presence of convulsive convulsions should be noted.</p> <p>When a player shows any features of a concussion:</p>

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TABLE 1. (CONTINUED)

Source	American Medical Society for Sports Medicine position statement: Concussion in sport ¹	American Academy of Neurology summary of evidence-based guideline update: Evaluation and management of concussion in sports ²	Consensus statement on concussion in sport: The 4th International Conference on Concussion in Sport held in Zurich, November 2012 ³
	<p>Any athlete suspected of having a concussion should be stopped from playing and assessed by a LHCP trained in the evaluation and management of concussions.</p> <p>Athletes suspected or diagnosed with concussion should be monitored for deteriorating physical or mental status.</p>		<p>The player should be evaluated by a physician or other licensed health care provider on site using standard emergency management principles, and particular attention should be given to excluding a cervical spine injury.</p> <p>The appropriate disposition of the player must be determined by the treating health care provider in a timely manner. If no health care provider is available, the player should be safely removed from practice or play and urgent referral to a physician arranged. Once the first aid issues are addressed, an assessment of the concussive injury should be made using the SCAT3 or other sideline assessment tools.</p>
Imaging studies	<p>Reserved for athletes where intracerebral bleeding is suspected</p>	<p>CT imaging should not be used to diagnose sports-related concussion, but might be obtained to rule out more serious TBI such as an intracranial hemorrhage in athletes with a suspected concussion who have LOC, post-traumatic amnesia, persistently altered mental status (Glasgow Coma Scale score 15), focal neurologic deficit, evidence of skull fracture on examination, or signs of clinical deterioration.</p>	<p>Brain CT (or where available an MRI brain scan) contributes little to concussion evaluation but should be used whenever suspicion of an intracerebral or structural lesion (eg, skull fracture) exists.</p> <p>Currently, there is insufficient evidence to recommend routine clinical use of advanced neuroimaging techniques or other investigative strategies.</p>
Balance testing	<p>Balance disturbance is a specific indicator of concussion but is not very sensitive.</p> <p>Balance testing on the sideline may be substantially different than baseline tests because of differences in shoe/cleat-type, or surface, or use of ankle tape or braces or the presence of other lower extremity injury.</p>	<p>The BESS assessment tool is likely to identify concussion with low to moderate diagnostic accuracy (sensitivity 34–64%, specificity 91%).</p>	<p>It appears that postural stability testing provides a useful tool for objectively assessing the motor domain of neurological functioning, and should be considered as a reliable and valid addition to the assessment of athletes with concussion, particularly where the symptoms or signs indicate a balance component.</p>
NP testing	<p>Most concussions can be managed appropriately without the use of NP testing. CNAT should be interpreted by health care professionals trained and familiar with the type of test and the individual test limitations, including a knowledgeable assessment of the reliable change index, baseline variability, and false-positive and false-negative rates.</p>	<p>Paper and pencil as well as computerized tests generally require a neuropsychologist for accurate interpretation, although they may be administered by a non-neuropsychologist. It is likely that NP testing of memory performance, reaction time, and speed of cognitive processing, regardless of whether administered by paper-and-pencil or computerized method, is useful in identifying the presence of concussion (sensitivity 71–88% of athletes with concussion).</p>	<p>There is insufficient evidence to recommend the widespread routine use of baseline neuropsychological testing.</p> <p>Sideline evaluation of cognitive function is an essential component in the assessment of concussion.</p> <p>Brief NP test batteries (i.e., SCAT3) that assess attention and memory function have been shown to be practical and effective. It is worth noting that standard orientation questions (e.g., time, place, and person) have been shown to be unreliable in the sporting situation when compared with memory assessment.</p>

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TABLE 1. (CONTINUED)

<p><i>American Medical Society for Sports Medicine position statement: Concussion in sport¹</i></p>	<p><i>American Academy of Neurology summary of evidence-based guideline update: Evaluation and management of concussion in sports²</i></p>	<p><i>Consensus statement on concussion in sport: The 4th International Conference on Concussion in Sport held in Zurich, November 2012³</i></p>
<p>NP testing should be used only as part of a comprehensive concussion management strategy and should not be used in isolation. The ideal timing, frequency, and type of NP testing have not been determined. It is unknown whether use of NP testing in the management of sports concussion helps prevent recurrent concussion, catastrophic injury, or long-term complications.</p>	<p>Clinical LHCPs might use supplemental information, such as neurocognitive testing or other tools, to assist in determining concussion resolution. This may include but is not limited to resolution of symptoms as determined by standardized checklists and return to age-matched normative values or an individual's pre-injury baseline performance on validated neurocognitive testing. Graded physical activity. LHCPs might develop individualized graded plans for return to physical and cognitive activity, guided by a carefully monitored, clinically based approach to minimize exacerbation of early post-concussive impairments. Cognitive restructuring, a form of brief psychological counseling, can also be beneficial.</p>	<p>It is recognized, however, that abbreviated testing paradigms are designed for rapid concussion screening on the sidelines and are not meant to replace comprehensive NP testing, which should ideally be performed by trained neuropsychologists who are sensitive to subtle deficits that may exist beyond the acute episode; nor should they be used as a stand-alone tool for the ongoing management of sports concussions. Although formal NP testing may be beyond the resources of many sports or individuals, it is recommended that, in all organized high-risk sports, consideration be given to having this cognitive evaluation, regardless of the age or level of performance.</p>
<p>Management There is no same-day RTP for an athlete diagnosed with concussion. Athletes suspected of or with a diagnosis of concussion should be monitored for deteriorating physical or mental status. On-field, sideline, and post-sideline or office management includes multiple management recommendations. Key management recommendations include:</p>	<p>Clinical LHCPs might use supplemental information, such as neurocognitive testing or other tools, to assist in determining concussion resolution. This may include but is not limited to resolution of symptoms as determined by standardized checklists and return to age-matched normative values or an individual's pre-injury baseline performance on validated neurocognitive testing. Graded physical activity. LHCPs might develop individualized graded plans for return to physical and cognitive activity, guided by a carefully monitored, clinically based approach to minimize exacerbation of early post-concussive impairments. Cognitive restructuring, a form of brief psychological counseling, can also be beneficial.</p>	<p>Persistent symptoms (> 10 days) are generally reported in 10–15% of concussions. In general, symptoms are not specific to concussion, and it is important to consider other pathologies. Cases of concussion in sports where clinical recovery falls outside the expected window (i.e., 10 days) should be managed in a multidisciplinary manner by health care providers with experience in sports-related concussion. A determination of the clinical status of the patient, including whether there has been improvement or deterioration since the time of injury</p>
<p>On field: Acute stabilization, identification of cervical spine injury, and evaluation for severe brain injury and emergency transfer. Sideline: Physical examination to include symptoms, cognition, and balance assessment. Emphasis on removal from play when concerned. Post sideline/office: Detailed history of event mechanism, symptoms, and history of concussion. Focus on worsening symptoms, NP testing.</p>	<p>Cognitive restructuring, a form of brief psychological counseling, can also be beneficial.</p>	<p>This may involve seeking additional information from parents, coaches, teammates, and eyewitnesses to the injury. Physicians are also encouraged to evaluate the athlete with concussion for affective symptoms such as depression and anxiety, because these symptoms are common in all forms of TBI. Comorbid conditions such as mental health issues (i.e. depression), ADHD, learning disabilities, and sleep disorders have been reported as a consequence of all levels of TBI including sports-related concussion. Although mental health issues may be multifactorial in nature, it is recommended that the treating physician consider these issues in the treatment of patients with concussion. Important components of management after the initial period of physical and cognitive rest include associated therapies such as cognitive, vestibular, physical, and psychological therapy, consideration of assessment of other causes of prolonged symptoms, and consideration of commencement of a graded exercise program at a level that does not exacerbate symptoms. Low-level exercise for those who are slow to recover may be of benefit, although the optimal timing after injury for initiation of this treatment is currently unknown.</p>

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TABLE 1. (CONTINUED)

Source	American Medical Society for Sports Medicine position statement: Concussion in sport ¹	American Academy of Neurology summary of evidence-based guideline update: Evaluation and management of concussion in sports ²	Consensus statement on concussion in sport: The 4th International Conference on Concussion in Sport held in Zurich, November 2012 ³
Return to class	Students will need cognitive rest and may need academic accommodations such as reduced workload and extended time for tests while recovering.	There is some evidence that children should be treated more conservatively than adults.	Multi-modal physiotherapy treatment for persons with clinical evidence of cervical spine and/or vestibular dysfunction may be of benefit.
RTP	<p>Concussion symptoms should be resolved before returning to exercise. A RTP progression involves a gradual, stepwise increase in physical demands, sports-specific activities, and the risk for contact.</p> <p>If symptoms occur with activity, the progression should be halted and restarted at the preceding symptom-free step.</p> <p>RRP/practice after concussion should occur only with medical clearance from a licensed health care provider trained in the evaluation and management of concussion.</p> <p>The primary concern is decreased reaction time leading to an increased risk of a repeated concussion.</p>	<p>Athletes should not be permitted to RTP until they have been assessed by an experienced LHCP with training both in the diagnosis and management of concussion and in the recognition of more severe TBI.</p> <p>In addition, persons supervising athletes should prohibit an athlete with concussion from RTP/practice (contact-risk activity) until the athlete is asymptomatic off medication. Persons supervising athletes of high school age or younger with diagnosed concussion should treat them more conservatively regarding RTP than they treat older athletes.</p>	<p>A player with diagnosed concussion should not be allowed to RTP on the day of injury.</p> <p>Graded activity is recommended in a stepwise progression with 24-h between each step. The athlete should only continue to proceed to the next level if asymptomatic at the current level. It may take approximately 1 week to proceed through the full rehabilitation protocol once the athlete is asymptomatic at rest and with provocative exercise.</p> <p>If any post-concussion symptoms occur while in the stepwise program, then the patient should drop back to the previous asymptomatic level and try to progress again after a further 24-h period of rest has passed.</p> <p>An important consideration in RTP is that athletes with concussion should not only be symptom free, but also they should not be taking any pharmacological agents/medications that may mask or modify the symptoms of concussion.</p> <p>A more conservative RTP approach is recommended in children and adolescents.</p> <p>Sufficient time for assessment and adequate facilities should be provided for the appropriate medical assessment both on and off the field for all injured athletes.</p> <p>The final determination regarding concussion diagnosis and/or fitness to play is a medical decision based on clinical judgment.</p>
Long-term effects	<p>There is increasing concern that head impact exposure and recurrent concussions contribute to long-term neurologic sequelae such as chronic neurological impairment.</p> <p>Some studies have suggested an association between previous concussions and chronic cognitive dysfunction.</p> <p>Large-scale, epidemiological studies are needed to more clearly define risk factors and causation of any long-term neurological impairment.</p>	<p>Athletes with a history of multiple concussions and subjective persistent neurobehavioral impairment should be counseled about the risk factors for development of permanent or lasting neurobehavioral or cognitive impairments. The relationship remains inconclusive, however.</p> <p>Retirement from contact sports should be recommended in professional athletes who show objective evidence for chronic/persistent neurologic/cognitive deficits (such as seen on formal NP testing) to minimize risk for and severity of chronic neurobehavioral impairments.</p>	<p>Clinicians need to be mindful of the potential for long-term problems in the treatment of all athletes. It was agreed, however, that CTE represents a distinct taupathy with an unknown incidence in the athletic populations. A cause and effect relationship has not as yet been demonstrated between CTE and concussions or exposure to contact sports.</p> <p>At present, the interpretation of causation in the modern CTE case studies should proceed cautiously. It was also recognized that it is important to address the fears of parents/athletes from media pressure related to the possibility of CTE.</p>

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TABLE 1. (CONTINUED)

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	<p>There are no evidence-based guidelines for disqualifying/retiring an athlete from sport after a concussion. No clear delineation is made between professional and amateur athletes. Each case should be carefully deliberated and an individualized approach to determining disqualification taken.</p>		
Education for provider	<p>Physicians should be prepared to provide counseling regarding potential long-term consequences of a concussion and recurrent concussions.</p>	<p>Inexperienced LHCPs should be instructed in the proper administration of standardized validated sideline assessment tools. This instruction should emphasize that these tools are only an adjunct to the evaluation of the athlete with suspected concussion and cannot be used alone to diagnose concussion.</p>	
Education for patient	<p>Greater efforts are needed to educate involved parties including athletes, parents, coaches, officials, school administrators, and health care providers to improve concussion recognition management and prevention.</p>	<p>To foster informed decision-making, LHCPs should inform athletes (and where appropriate, the athletes' families) of evidence concerning the concussion risk factors. Accurate information regarding concussion risks also should be disseminated to school systems and sports authorities. Education and reassurance on symptoms may have benefit in decreasing the proportion of persons in whom chronic post-concussion syndrome develops.</p>	
Prevention	<p>Primary prevention of some injuries may be possible with modification and enforcement of the rules and fair play. Helmets are best suited to prevent impact injuries such as fractures, bleeding, and lacerations, but have not been shown to reduce the incidence and severity of concussions. There is no current evidence that mouth guards can reduce the severity of or prevent concussions. Secondary prevention may be possible by appropriate RTP management.</p>	<p>It is highly probable that headgear offers a protective effect on concussion in rugby. There is no compelling evidence that mouth guards protect from concussion. Data are insufficient to support or refute the efficacy of protective soccer headgear. Data are insufficient to support or refute the superiority of one type of football helmet in the prevention of concussions.</p>	<p>There is no good clinical evidence that currently available protective equipment will prevent concussion, although mouth guards have a definite role in preventing dental and orofacial injury. Biomechanical studies have shown a reduction in impact forces to the brain with the use of headgear and helmets, but these findings have not been translated to show a reduction in concussion incidence. For skiing and snowboarding, there are a number of studies to suggest that helmets provide protection against head and facial injury and hence should be recommended for participants in alpine sports. In specific sports such as cycling, motor and equestrian sports, protective helmets may prevent other forms of head injury (e.g., skull fracture) that are related to falling on hard surfaces and may be an important injury prevention issue for those sports. No evidence was provided to suggest an association between neck strength increases and concussion risk reduction.</p>

ADD, Attention deficit disorder; ADHD, attention deficit hyperactivity disorder; BESS, Balance Error Scoring System; CNAT, cognitive neurological assessment tools; CTE, chronic traumatic encephalopathy; LHCP, licensed health care providers; LOC, loss of consciousness; PTA, _____; SAC, Standardized Assessment of Concussions; RTP, return to play; mTBI, mild traumatic brain injury; NP, neuropsychological; SCAT, Standardized Concussion Assessment Tool; SORT, Strength-of-Recommendation Taxonomy; TBI, traumatic brain injury;

grading. To develop the recommendations, the group used the Strength-of-Recommendation Taxonomy (SORT) approach. The specific methodology used for their literature search and details about how the authors assigned the level of evidence were not provided, however. Moreover, the AMSSM group did not describe how disagreements in the level of evidence among reviewers of a specific article were adjudicated. The final guidelines were an amalgam of consensus, usual practice, expert opinion, and findings from case series. This position statement focused on risk factors, diagnosis, sideline evaluation and management, neuropsychological testing, return to class, return to play, short-term risks of premature return to play, long-term effects, disqualification from sport, education, and prevention. The full position statement is available at: http://www.amssm.org/Content/pdf%20files/2012_ConcussionPositionStmnt.pdf

The American Academy of Neurology (AAN) Summary of Evidence-Based Guideline Update: Evaluation and Management of Concussion in Sports⁴ provides an update of evidence for the evaluation and management of concussion in sports from the original AAN CPG published in 1997.⁶ The article is a summary of the full revised AAN guideline of 119 pages plus appendices that is available for download at www.neurology.org. The recommendations provided by the AAN Guideline subcommittee of experts were developed through a systematic review of all pertinent literature published from 1955 to June 2012 using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) evidence-based methodology. The evidence was graded, conclusions were derived from these studies, and a modified Delphi process was used to prevent any single author from exerting undue influence on the recommendations. The AAN group did include details about their parameters for the literature searches and numbers of articles reviewed. Each article was reviewed by two different reviewers, and if there was disagreement about the level of evidence for that article, a third reviewer was used to resolve the conflict. Unlike the AMSSM guidelines, the AAN guidelines did not base any of their final recommendations on consensus, usual practice, expert opinion, case-series, or meta-analyses. The AAN updated guideline focused on multiple factors surrounding concussion including those that increase or decrease concussion risk. Other areas of focus were:

- Diagnostic tools that are useful in identifying those with concussion
- Diagnostic tools that are useful in identifying those at increased risk for severe or prolonged early impairments, neurologic catastrophe, or chronic neurobehavioral impairment
- Clinical factors that are useful in identifying those at increased risk for severe or prolonged early post-concussion impairments, neurologic catastrophe, recurrent concussions, or chronic neurobehavioral impairment
- Interventions that enhance recovery, reduce the risk of recurrent concussion, or diminish long-term sequelae

The Consensus Statement on Concussion in Sport: The 4th International Conference on Concussion in Sport held in Zurich, November 2012⁵ is an update of the previous three recommendations that were originally developed in 2001 and last updated in 2008. The development of the recommendations involved a formal consensus process using the organizational guidelines published by the US National Institutes of Health.⁷ Specific details regarding how the literature was reviewed or weighted, or how consensus was achieved, are not provided. The goal of the conference was to

prepare recommendations for “the improvement of safety and health of athletes who suffer concussive injuries in ice hockey, rugby, football (soccer) as well as other sports.” Because this was a consensus-based guidelines effort, the goal was to provide recommendations for all aspects of concussion management even if there was little or no objective scientific evidence to support some of the recommendations. A multidisciplinary team of experts discussed the issues of epidemiology, basic and clinical science, and injury grading systems, cognitive assessment, new research methods, protective equipment, management, prevention, and long-term outcome. Members of this group also proposed sideline assessment of concussed athletes with the use of the Standardized Concussion Assessment Tool (SCAT). In the 2013 Consensus Statement, they recommended the SCAT3, which combines the Symptom Checklist, the Standardized Assessment of Concussions (SAC), and the Balance Error Scoring System (BESS), all of which are validated for assessment of concussion. It should be noted, however, that pediatric versions of the SCAT have not been validated.

Summary of Common Statements

The following topics were specifically addressed by the three guidelines groups, and the statements under each topic depict the common conclusions of all three groups.

Definition of concussion

Concussion is a traumatically, or biomechanically, induced alteration of brain function. Emphasis is placed on a pathophysiological process, or functional disruption, as opposed to anatomic, structural, or tissue injury. There remains some debate about the distinction between “mild TBI” and “concussion.” Many use these terms interchangeably, but there are some who still consider mTBI to reflect a more serious injury than a concussion.

Risk factors

A history of one or more concussions is a risk factor for a subsequent concussion. Sex as a risk factor for concussion is controversial, but for sports in which the playing rules are similar, such as soccer or basketball, females appear to have as much as a two-fold higher risk for concussion.

Symptoms

While there are many symptoms such as dizziness, lightheadedness, or confusion associated with concussion, headache was identified as the most common.

Diagnosis/initial evaluation

Concussion is a clinical diagnosis that is ideally made by a licensed health care provider familiar with the signs and symptoms of this injury. There is no single test that can be used to determine whether a concussion has occurred. Any athlete suspected of having a concussion should be immediately removed from play. Graded symptom and clinical sign checklists can be useful, particularly if completed pre-season and available for comparison with post-injury results. Monitoring of the injured athlete with serial assessments is important, because signs and symptoms may evolve or not appear for minutes or hours after the injury. Ideally, a multidisciplinary approach to assessment and management is used with inclusion of sports medicine specialists from various subspecialties as appropriate for the athlete’s symptoms and signs.

Imaging studies

Head CT scans are not routinely recommended but should be considered if there is clinical suspicion of intracranial hemorrhage or contusion.

Balance testing

Sideline testing of balance, or postural stability, is useful for objectively assessing balance after a concussion and has high specificity, but is not very sensitive. The Balance Error Scoring System (BESS) assessment tool is frequently used.

Neuropsychological testing

Brief neuropsychological evaluations, whether with computerized neuropsychological tests or with pencil/paper test batteries, are useful for detecting cognitive deficits after a concussion. Computerized neuropsychological tests, and extensive pencil/paper test batteries, require a neuropsychologist or psychologist for proper contextual interpretation. In addition, most concussions can be managed appropriately without the use of neuropsychological testing.

Return to play/school

There is no consensus or strong evidence for a single specific protocol to be followed for return to play or to school after a concussion. Return to exercise, practice, or play should not be permitted until the athlete has been evaluated by a licensed health care provider with experience in the evaluation and management of patients with a concussion. Before return to play, a gradual, stepwise increase in general physical activity, followed by sports-specific activities, is recommended. Progression to more strenuous steps is only recommended if the athlete is asymptomatic at the current level of activity. During this stepwise increase in activity, the athlete should not be taking any sedative or analgesic medications that might mask common post-concussive symptoms such as headaches or dizziness.

Long-term effects

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 association of single or multiple concussions with chronic degenerative neurological sequelae such as chronic traumatic encephalopathy (CTE), however, is not adequately defined by good quality epidemiological studies, and a cause and effect relationship has not been demonstrated.

Prevention

Currently available protective equipment, such as helmets or mouth guards, has not been shown to prevent or reduce the severity of concussions. In some cases, athletes' sports helmets have been found to reduce the incidence of skull fractures and scalp or facial lacerations.

Topics identified by each article for which recommendations remain uncertain and further research is needed:

- Identification of valid acute clinical signs or symptoms for those at risk for post-concussion syndrome or CTE, such as imaging or serum biomarkers
- Determination of the utility of serum biomarkers, or electrophysiological testing, for diagnosis and return to play decision making
- Identification of therapies, and especially specific pharmacotherapy, effective for treating post-concussive syndrome and long-term cognitive and physical sequelae of concussion
- Rules of play issues regulating the level of violence allowed in some sports such as ice hockey, or the concept of "risk compensation" (i.e., where athletes view head-protective gear as a license to hit harder, or use their head in more dangerous ways)
- More studies are needed before there can be recommendations for widespread use of baseline neuropsychological testing
- Additional research including specific delineation between amateur and professional sports or athletes is needed to determine clear recommendations concerning sports concussion and risk of chronic neurological impairment (CNI) and /or CTE.

Conclusion

The recently published guidelines produced by experts in the field of concussion in sport, working under the auspices of the American Medical Society for Sports Medicine, The American Academy of Neurology, and the International Conference on Concussion in Sport, provide the latest evidence and consensus-based guidance for the diagnosis and management of sports-related concussion. The comparison of guidelines from these three widely recognized and prominent groups provides the best available information regarding contemporary issues such as when it is safe to return to play after a concussion, what is known about long-term neurologic or cognitive deficits after multiple concussions, and how best to treat athletes who have sustained a concussion. Key recommendations of all three groups are that any athlete suspected of having a concussion should not be allowed to return to play on the day of the injury, athletes with concussion should not return to play until they have been evaluated by a licensed health care provider, and even then there should be a gradual, stepwise increase in physical activity. The three guidelines vary in their discussion and recommendations concerning CTE and CNI, reflecting that there remains insufficient clinical or scientific evidence to conclude that concussion in amateur or professional athletes is linked in some way to specific chronic neurological sequelae.

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