AAOS American Academy of Orthopaedic Surgeons
American Association of Orthopaedic Surgeons

Information Statement

Concussion (Mild Traumatic Brain Injury) and the Team Physician: A Consensus Statement

This Information Statement was developed as an educational tool based on the consensus opinion of the authors. It is not a product of a systematic review process. Readers are encouraged to consider the information presented and reach their own conclusions.

This document is a revision to the team physician consensus statement published in 2006 in Medicine and Science in Sports & Exercise and other publications. Key revisions appearing in this paper include:

- There is no same-day return-to-play (RTP).
- Neurological examination emphasizing cognitive function and balance.
- The role and limitations of neuropsychological testing.
- The utility of standardized baseline and post-injury assessments.
- The importance of pre-season planning.
- Acknowledged importance of cognitive rest.
- Acknowledged emerging technologies and their role in concussion research.
- Recognition of long-term complications of concussion.
- Legislation and governing body regulations for concussion.

DEFINITION
Concussion or mild traumatic brain injury (MTBI) is a pathophysiological process affecting the brain induced by direct or indirect biomechanical forces.
Common features include:

- Rapid onset of usually short-lived neurological impairment, which typically resolves spontaneously.
- Acute clinical symptoms that usually reflect a functional disturbance rather than structural injury.
- A range of clinical symptoms that may or may not involve loss of consciousness (LOC).
- Routine neuroimaging studies are typically normal.

GOAL

The goal is to assist the team physician in providing optimal medical care for the athlete with concussion.

To accomplish this goal, the team physician should have knowledge of and/or be involved with:

- Biomechanics and pathophysiology
- Epidemiology
- Pre-season planning and assessment
- Same-day evaluation and treatment
- Post-same-day evaluation and treatment
- Diagnostic testing
- Return-to-play
- Complications of concussion
- Prevention
- Legislative actions

SUMMARY

This document provides an overview of select medical issues that are important to team physicians who are responsible for athletes with concussion. It is not intended as a standard of care, and should not be interpreted as such. This document is only a guide, and as such, is of a general nature, consistent with the reasonable, objective practice of the healthcare professional. Individual treatment will turn on the specific facts and circumstances presented to the physician. Adequate insurance should be in place to help protect the physician, the athlete, and the sponsoring organization. This statement was developed by a collaboration of six major professional associations concerned about clinical sports medicine issues; they have committed to forming an ongoing project-based alliance to bring together sports medicine organizations to best serve active people and athletes. The organizations are: American Academy of Family Physicians, American Academy of Orthopaedic Surgeons, American College of Sports Medicine, American Medical Society for Sports Medicine, American Orthopaedic Society for Sports Medicine, and the American Osteopathic Academy of Sports Medicine.

Primary Authors

Stanley A. Herring, M.D., Chair, Seattle, Washington
Robert C. Cantu, M.D., Boston, Massachusetts
Kevin M. Guskiewicz, Ph.D., ATC, Chapel Hill, North Carolina
Margot Putukian, M.D., Princeton, New Jersey
W. Ben Kibler, M.D., Lexington, Kentucky

Expert Panel

John A. Bergfeld, M.D., Cleveland, Ohio
Lori A. Boyajian-O'Neill, D.O., Overland Park, Kansas
R. Robert Franks, D.O., Washington Township, New Jersey
Peter A. Indelicato, M.D., Gainesville, Florida
Walter Lowe, M.D., Houston, Texas
Francis G. O'Connor, M.D., Bethesda, Maryland
David C. Thorson, M.D., White Bear Lake, Minnesota

INTRODUCTION

It is *essential* the team physician understand:

- The recognition and evaluation of the athlete with concussion.
- After assessment by a health care provider, athletes suspected of or diagnosed with a concussion are removed from practice or competition at that time. There is no same-day return-to-play (RTP), even if the athlete's initial symptoms resolve as the athletic event evolves.
- In the absence of assessment by a health care provider, athletes suspected of concussion are removed from practice or competition and there is no same-day RTP. There is no subsequent RTP until the athlete is medically cleared by a health care provider.
- Management and treatment of the athlete with concussion be individualized.
    - Concussions are unique to each individual athlete.
    - Symptoms may vary with each concussion an athlete sustains.
- The factors involved in making RTP decisions after injury should be based on clinical judgment in conjunction with individual modifiers known to influence concussion recovery.
- A same-day medical plan specific to concussion injuries be developed.
- The need for documentation.
- While helmet materials and design are improving, there is no concussion-proof helmet.

It is *desirable* the team physician:

- Coordinate a systematic approach for the evaluation and treatment of the athlete with concussion.
- Implement a treatment program.
- Understand the potential sequelae of concussive injuries.
- Understand prevention strategies.
- Educate athletes, parents/guardians, coaches, caregivers and others.

EPIDEMIOLOGY

- Concussions occur commonly in helmeted and non-helmeted sports, and account for a significant number of time loss injuries.
- There are an excess of 3.8 million concussions occurring among participants in sports and recreational activities each year.
- Published reports indicate recognized concussion injuries occur frequently.
    - Football, ice hockey, soccer and lacrosse tend to have the highest concussion incidence rates when calculated by athlete exposure.
    - Competition concussion incidence rates are consistently higher than practice rates.
    - In sports with the same rules (basketball and soccer), recent research suggests the reported incidence rate of concussion is higher in female athletes.
    - The data demonstrating a difference between the reported incidence of concussion in adolescents and adult athletes is inconclusive.
- Self-report and trained observer data suggests significantly higher incidence of concussion.

BIOMECHANICS AND PATHOPHYSIOLOGY

- Concussions occur as a result of imparted linear and rotational accelerations to the brain.
- 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.
- Metabolic changes that occur in the animal model, and thought to occur in humans include:
    - Alterations in intracellular/extracellular glutamate, potassium and calcium
    - A relative decrease in cerebral blood flow in the setting of an increased requirement for glucose (i.e., increased glycolysis). This mismatch in the metabolic supply and demand may potentially result in cell dysfunction and increase the vulnerability of the cell to a second insult.

PRE-SEASON PLANNING AND ASSESSMENT

It is *essential* the team physician understand:

- The emergency medical action plan, including guidelines specific to concussion management.

It is *desirable* the team physician:

- Coordinate and be involved with a baseline assessment for high-risk sports and activities.
- Incorporate a standardized baseline assessment tool for concussion that includes prior concussion history, risk factors for prolonged or complicated recovery (see Table 1), symptom checklist and neurological examination emphasizing cognitive function and balance (See NFL document).
- Coordinate a team for concussion management (e.g., physicians, certified athletic trainers and other health care providers, neuropsychologists, school officials, emergency response personnel).

Table 1. Risk Factors that may prolong or complicate recovery from concussion

Factors	Modifier
Concussion History	Total number, proximity, severity (duration)
Symptoms	Total number, severity (intensity and especially duration)
Signs	Prolonged LOC (>1 min)
Susceptibility	Concussions occurring with lower impact magnitude and/or requiring longer recovery.
Age	Youth and adolescent athletes may recover more slowly.
Pre-existing conditions	Migraine, depression, anxiety/panic attacks, attention deficit hyperactivity disorder (ADHD), learning disabilities (LD)

SAME-DAY EVALUATION AND TREATMENT

It is *essential* the team physician:

- Implement the same-day medical action plan specific to concussion.
- Understand the indications for cervical spine immobilization and emergency transport.

On-Field

- Evaluate the injured athlete on-the-field in a systematic fashion:
  - Assess for adequate airway, breathing, and circulation (ABC's)
  - Perform a focused neurological assessment emphasizing mental status, neurological deficit, and cervical spine status
  - Determine initial disposition (emergency transport vs sideline evaluation)
- There is no return to play on the same day if a concussion is suspected or diagnosed.

Sideline

- Obtain a more detailed history and perform a more detailed physical examination.
  - Assess for cognitive, somatic, and affective signs and symptoms of acute concussion with particular attention paid to the number and severity of symptoms because of their prognostic significance (Table 2).
- The athlete should not be left unsupervised until a disposition decision is made.
- Perform and repeat neurological assessments, with particular emphasis on cognitive function, cranial nerve and balance testing ([32,] NFL document).
- Determine disposition for symptomatic and asymptomatic athletes, including post-injury follow-up (options include home with observation or transport to hospital).
- Provide post-event instructions to the athlete and others (e.g., regarding alcohol, medications, physical and cognitive exertion and medical follow-up).

Table 2: Selected acute and delayed signs and symptoms suggestive of concussion

Cognitive	Somatic	Affective	Sleep Disturbances
Confusion	Headache	Emotional lability	Trouble falling asleep
Anterograde amnesia	Dizziness	Irritability	Sleeping more than usual
Retrograde amnesia	Balance disruption	Fatigue	Sleeping less than usual
Loss of consciousness (LOC)	Nausea/vomiting	Anxiety	
Disorientation	Visual disturbances	Sadness	
Feeling "in a fog," "zoned out"	(photophobia, blurry/double vision)		
Vacant stare	Phonophobia		
Inability to focus			
Delayed verbal and motor responses			
Slurred/incoherent speech			
Excessive drowsiness			

It is *desirable* the team physician:

On-Field

- Have a plan to protect access to the injured athlete.
- Have emergency medical personnel on-site.
- Have medical supplies on-site for rescue, immobilization and transportation[1]

Sideline

- Delineate the mechanism of injury.
- Perform a more detailed assessment utilizing a standardized concussion assessment tool ([34], NFL documents)
- Coordinate the care and follow-up of the concussed athlete with certified athletic trainers and other health care providers.
- Discuss status of athlete with parents/guardians, caregivers, coaches and others within disclosure regulations.

POST-SAME-DAY EVALUATION AND TREATMENT

This is the period to monitor for improvement, as well as change in severity or the development of new signs or symptoms (Table 2).

It is *essential* the team physician:

- Obtain a comprehensive history of the current concussion.
    - Brief LOC (seconds, not minutes) is associated with specific early deficits, but does not predict the severity of injury; therefore classification systems or RTP guidelines based solely on brief LOC are not accurate.
    - The number and duration of additional signs and symptoms are more accurate in predicting severity and outcome. RTP guidelines which address these issues are more useful.
    - Duration of symptoms is a major factor in determining severity, therefore severity of injury should not be determined until all signs and symptoms have cleared.
- Understand risk factors may affect recovery (Table 1).
- Perform a neurological examination with particular emphasis on cognitive function, cranial nerve and balance testing.
- Determine the need for further evaluation and consultation.
- Understand the role and limitations of neuropsychological testing.
- Determine RTP status. The treatment of and the RTP decision for the athlete with concussion must be individualized.

It is *desirable* the team physician:

- Coordinate the care and follow-up of the athlete.
- Compare findings to standardized baseline assessment.
- Educate the athlete, parents/guardians, caregivers and others about concussion.
- Coordinate the care and follow-up of the concussed athlete with certified athletic trainers and other health care providers.
- Discuss status of athlete with parents/guardians, caregivers, coaches and others within disclosure regulations.
- Work in collaboration with the neuropsychologist to interpret neuropsychological testing.

DIAGNOSTIC TESTING

Imaging

It is *essential* the team physician understand:

- The limited value of plain skull radiographs, head CT or MRI for concussion.
- Indications for head CT or MRI (e.g., decreasing level of consciousness, increasing severity of signs and symptoms, persistent focal neurologic deficit), to assess associated injuries including intracranial bleed, cerebral edema, diffuse axonal injury, and/or skull fracture.
- Indications for the use of cervical imaging when cervical spine injury is suspected.

It is *desirable* the team physician:

- Review the results of the imaging studies.
- Recognize that advanced testing, such as functional MRI, diffusion tensor imaging and magnetic resonance spectroscopy, represent research tools that may one day be clinically applicable.

Neuropsychological (NP) Testing

It is *essential* the team physician understand:

- NP testing is recommended as an aid to clinical decision-making but not a requirement for concussion management.
- NP testing is one component of the evaluation process and should not be used as a stand-alone tool to diagnose, manage or make RTP decisions in concussion.
-

It is *desirable* the team physician understand:

- The indications and limitations of neuropsychological testing.
    - Post-injury neuropsychological test data are more useful if compared to the athlete's pre-injury baseline.
    - It is unclear what type and content of test data are most valid and valuable.
- Value of NP testing is enhanced when used as part of a multi-faceted assessment and treatment program.

Additional Tests

Biomarkers

- Investigation in the area of biomarkers (e.g., S-100 proteins, neuron specific enolase, Tau protein) is inconclusive for identifying individuals with concussion and represents research that may one day be clinically applicable.
-

Event-and-Evoked Related Potentials

- Electrophysiologic research using Event-and-Evoked Related Potentials is inconclusive for the clinical management of concussion at this time and represents research that may one day be clinically applicable.

RETURN-TO-PLAY (RTP) DECISION

The RTP decision should be individualized, and not based on a rigid timeline. The team physician is ultimately responsible for the RTP decision.[1]

Same-Day RTP

It is *essential* the team physician understand:

- There is no same-day RTP for the concussed athlete.

Post-Same-Day RTP

It is *essential* the team physician understand:

- Before resuming exercise, the athlete must be asymptomatic or returned to baseline symptoms at rest and has no symptoms with cognitive effort.
- Amnesia surrounding the event may be permanent.
- An athlete should no longer be taking medications that may mask or modify concussion symptoms.
- The athlete's clinical neurological examination (cognitive, cranial nerve and balance testing) have returned to baseline before resuming exercise.
- If performed, neuropsychological testing returns to at-least baseline before resuming contact/collision activities.
- Progressive aerobic and resistance exercise challenge tests should be utilized before full RTP.[34, 27]
- This process may take days, weeks or months.
- Recurrence of symptoms and/or signs warrants additional rest and monitoring.
- Certain risk factors may affect RTP decision-making (Table 1).
- Additional factors may affect RTP decision-making:
    - Risk-taking behaviors
    - Type of sport

It is *desirable* the team physician:

- Coordinate a team to implement sport-specific progressive aerobic and resistance exercise challenge tests before full RTP.
- Facilitate academic accommodations for symptomatic student athletes.
- Discuss status of athlete with parents/guardians, caregivers, certified athletic trainers, coaches, school officials and others within disclosure regulations.

COMPLICATIONS OF CONCUSSION

Concussion may cause a wide range of short- or long-term complications, affecting thinking, sensation, language or emotions. These changes may lead to problems with memory, communication, personality changes, as well as depression and the early onset of dementia. Other complications of concussion are also addressed in this section.

- Prior concussions may increase risk for subsequent concussions.
- Post-concussion syndrome
    - Persistent post-concussion symptoms lasting three months or longer
    - Indicator of concussion severity
    - Precludes RTP while present
    - Increased risk of depression

- Convulsive motor phenomena
    - Tonic posturing or convulsive movements within seconds of the concussion
    - Dramatic, but usually benign
    - Require no management beyond on-field ABCs
    - No anticonvulsant therapy required
- Post-traumatic seizures
    - Seizures occur days to months after concussion
    - Does require seizure management and precautions
    - Usually requires anticonvulsant therapy
- Second-impact syndrome
    - Occurs within minutes of concussion in athlete still symptomatic from prior brain injury, which can be earlier in same event.
    - Vascular engorgement leads to massive increase in intracranial pressure and brain herniation resulting in severe brain damage or death.
    - May occur with associated small subdural hematoma.
    - Except for boxing, most cases in literature in adolescents.
- Chronic Traumatic Encephalopathy (CTE)
    - A progressive neurodegenerative disease (tauopathy) caused by total brain trauma, and is not limited to athletes who have reported concussions.
    - The incidence and prevalence is unknown.
    - Diagnosed only after death by distinctive immunoreactive stains of the brain for Tau protein, and is not the same disease as Alzheimer's.
    - Typical signs and symptoms include a decline of recent memory and executive function, mood and behavioral disturbances (especially depression, impulsivity, aggressiveness, anger, irritability, suicidal behavior and eventual progression to dementia).
    - Initial signs and symptoms do not typically manifest until decades after trauma received (ages 40-50).
    - A small subset of individuals with CTE have developed Chronic Traumatic Encephalomyopathy (CTEM), a progressive motor neuron disease characterized by profound weakness, atrophy, spasticity and fasciculation similar to amyotrophic lateral sclerosis (ALS).
- Depression
    - Increased risk following a history of multiple concussions
    - May pre-date concussion and/or occur independent of concussion
    - Athletes with depression who later sustain concussion may experience worsening symptoms.
- Mild-Cognitive Impairment
    - Increased risk later in life following a history of multiple concussions.
    - May pre-date concussion and/or occur independent of concussion
    - Multiple concussions have been associated with an earlier onset of mild cognitive impairment

It is *essential* the team physician understand:

- Short- and long-term complications of concussion may be life-threatening or life-altering.
- Proper management may mitigate concussion complications such as second-impact syndrome and post-concussion syndrome

It is *desirable* the team physician:

- Counsel the athlete about the significance of the long-term consequences of concussion, especially recurrent concussion.
- Facilitate assessment and treatment of complications.
- Discuss status of athlete with parents/guardians, caregivers, certified athletic trainers and coaches and others within disclosure regulations.

PREVENTION

Concussions cannot be completely prevented.

It is *essential* the team physician understand:

- Helmets do not prevent concussion, though they decrease the incidence of skull fracture and major head trauma.
- There is currently no evidence to support the use of other personal protective equipment to prevent concussion and their use for this purpose may create a false sense of security.
    - Mouthguards decrease risk of dental or oral injury.
    - Head gear for soccer, rugby, wrestling, boxing may decrease risk of lacerations and soft-tissue trauma.
- Improper use of the head and improper fit of helmet or protective equipment may increase the risk of concussion.
- There are rules that prohibit hits to the head and other conduct which may decrease the incidence of concussion (e.g., spearing, head-to-head contact, leading with the head).

It is *desirable* the team physician:

- Educate athletes, parents/guardians and coaches regarding the significance of concussion, specifically to:
    - Understand short- and long-term health consequences
    - Recognize and report signs and symptoms of concussive injury
    - Understand earlier medical assessment and management promotes recovery
- Work with coaches and administrators to implement a concussion prevention program and policy, with emphasis on the importance of reporting concussion.
- Discuss the enforcement of rules to limit concussion with coaching staff, athletes, and officials before practice and competition.
- Discuss with athletes and coaches techniques which may increase the risk of concussion.
- Promote a safe playing environment which may lower the risk of head injury (e.g., field conditions, soccer goals, pole vault landing pits).
- Work with coaches, athletes and parents to change the culture of intentional acts of unsportsmanlike conduct that causes injury.
-

Legislation and Governance Issues

Many states have passed laws regarding concussion, and governing bodies have adopted rule changes and developed guidelines. The team physician is affected by legislation and governance issues both administratively and clinically.

It is *essential* the team physician understand:

- The laws of the state in which you are practicing regarding concussion.
- Rules and regulations from governing bodies regarding concussion.

It is *desirable* the team physician:

- Participate with state athletic associations in advocacy (interscholastic associations)
- Participate in the education of the athlete, parents/guardians, caregivers and others.

References:

1. American College of Sports Medicine website,www.acsm.org; Clinicians, Team Physician Consensus Statements
2. Barkhoudarian G, Hovda DA, Giza CC. *Clin Sports Med* 2011 Jan;30(1):33-48, vii-iii. The molecular pathophysiology of concussive brain injury.
3. Broglio SP, Ferrara MS, Macciocchi SN, Baumgartner TA, Elliott R: Test-retest reliability of computerized concussion assessment programs*. J Athl Train* 2007;42(4):509-514.
4. Cantu RC: Chronic traumatic encephalopathy in the National Football League. *Neurosurgery* 2007:61(2):223-225.
5. Cantu RC, Voy R: Second Impact Syndrome; a risk in any contact sport. *Phys Sportsmed* 1995;23:27-34.
6. Cubon VA, Putukian M, Boyer C, Dettwiler A: A Diffusion Tensor Imaging Study on the White Matter Skeleton in Individuals with Sports-Related Concussion. *J Neurotrauma* 2011; 28:189-201.
7. Davis GA, Iverson GL, Guskiewicz KM, Ptito A, Johnston KM. *Br J Sports Med* 2009 May;43 Suppl 1:i36-45.Contributions of neuroimaging, balance testing, electrophysiology and blood markers to the assessment of sport-related concussion.
8. Difiori J, Giza C. New techniques in concussion imaging. *Curr Sports Med Rep* 2010;9(1):35-39.
9. Echemendia RJ, Herring S, Bailes J: Who should conduct and interpret the neuropsychological assessment in sports-related concussion? *Br J Sports Med* 2009;43:i32-i35.
10. Echemendia, R., Putukian, M., Mackin, R.S., Julian, L., Shoss, N.: Neuropsychological Test Performance Prior to and Following Sports-Related Mild Traumatic Brain Injury. *Clin J Sports Med* 11:23-31, 2001.
11. Eckner J, Kutcher J. Concussion symptom scales and sideline assessment tools: a critical literature update. *Curr Sports Med Rep* 2010;9(1):8-15.
12. Ellemberg D. Advances in sport concussion assessment: from behavioral to brain imaging measures. - *J Neurotrauma* - 01-DEC-2009; 26(12): 2365-82
13. Guskiewicz K. Balance Assessment in the Management of Sports Related Concussion. *Clin Sports Med* 2011; 30: 89- 102.
14. Guskiewicz KM, Bruce SL, Cantu RC, Ferrara MS, Kelly JP, McCrea M, Putukian M, Valovich-McLeod TC: National Athletic Trainers' Association Position Statement: Management of Sport-Related Concussion. *J Athl Train* 2004 September; 39(3): 280-297.
15. Guskiewicz KM, Mihalik JP, Shankar V, Marshal SW, Crowell DH, Oliaro SM, Ciocca MF, Hooker DN: Measurement of head impacts in college football players: relationship between head impact biomechanics and acute clinical outcome after concussion. *Neurosurgery* 2007 Dec;61(6):1244-52; discussion 1252-3.
16. Gioia G, Isquith P, Schneider J, et al. New approaches to assessment and monitoring of concussion in children. *Top Lang Disorders* 2009;29(3):266-281.
17. Giza C, Hovda D. Ionic and metabolic consequences of concussion. In: Cantu RC, ed. Neurologic Athletic Head and Spine Injuries. Philadelphia, PA: WB Saunders; 2000:80-100.
18. Guskiewicz K, McCrea M, Marshall S, et al. Cumulative effects associated with recurrent concussion in collegiate football players: the NCAA concussion study. *JAMA* 2003;290(19):2549-2555.
19. Herring SA, Bergfeld J, Indelicato P, Jaffe R, Kibler WB, McKeag DB, Pallay R, Putukian M et al: Concussion (Mild Traumatic Brain Injury) and the Team Physician: A Consensus Statement *Medicine & Science in Sports & Exercise*. 37(11):2012-2016, November 2005.

20. Lovell M, Iverson G, Collins M, et al. Measurement of symptoms following sport-related concussion: reliability and normative data for the post-concussion scale. *Applied Neuropsychology* 2006;13:166-174.
21. Makdissi M, Darby D, Maruff P et al. Natural History of Concussion in Sports: Markers of Severity and Implications for Management. *Am J Sports Med* 2010; 38: 464- 470.
22. Meecham WP, Micheli LJ (eds) Concussion in Sports. *Clin Sports Med* 2011; 30:1
23. McCrory P. Sports concussion and the risk of chronic neurological impairment. *Clin J Sport Med* 2011;21(1):6-12.
24. McCrory P, Meeuwisse W, Johnston K, Dvorak J, Aubry M, Molloy M, Cantu R (authors), Broglio S, Davis G, Dick R, Echemendia R, Gioia G, Guskiewicz K, Herring S, Iverson G, Kelly J, Kissick J, Makdissi M, McCrea M, Ptito A, Purcell L, Putukian M (consensus panelists). Consensus Statement on Concussion in Sport: the 3rd International Conference on Concussion in Sort. Zurich, Switzerland, November 2008. *Br J Sports Med* 2009;43:i76-i84.
25. McCrea M, Guskiewicz KM, Marshall SW: Acute effects and recovery time following concussion in collegiate football players. the NCAA Concussion Study. *JAMA* 203;290:2556-2563.
26. McCrea M, Guskiewicz K, Randolph C, et al. Effects of a symptom-free waiting period on clinical outcome and risk of reinjury after sport-related concussion. *Neurosurgery* 2009; 65(5):876-82; discussion 882-3.
27. National Collegiate Athletic Association (NCAA) concussion information. http://www.ncaa.org/health-and-safety/medical-conditions/concussion
28. National Federation of High Schools. https://nfhslearn.com/courses/61037/concussion-in-sports
29. National Football League (NFL) Press Release. NFL outlines for players steps taken to address concussions.http://www.nfl.com/news/story/09000d5d8017cc67/article/nfl-outlines-for-players-steps-taken-to-address-concussions. Accessed May 12, 2010.
30. Pulsipher DT, Campbell RA, Thoma R, King JH. *Curr Sports Med Rep* 2011 Jan-Feb;10(1):14-20.A critical review of neuroimaging applications in sports concussion.
31. Putukian M: Repeat Mild Traumatic Brain Injury: How to Adjust Return to Play Guidelines. *Current Sports Med Reports* 5:15-22, 2006.
32. Putukian M, Aubry M, McCrory P: Return to play after sports concussion in elite and non-elite athletes. *Br J Sports Med* 2009 May;43 Suppl 1:i28-31.
33. Randolph C, McCrea M, Barr WB. Is neuropsychological testing useful in the management of sport-related concussion? *J. Athl. Train* 2005; 40(3):139-52.
34. SCAT2. BMJ Publishing Group Ltd and British Association of Sport and Exercise Medicine. *Br J Sports Med* 2009;43:i85-i88.
35. Van Kampen DA, Lovell MR, Pardini JE et al: The "value added" of neurocognitive testing after sports-related concussion. *Am J Sports Med* 2006;10(10):1-6.
36. Zack Lystedt Law

Information Statement 1029

For additional information, contact the Public Relations Department at 847-384-4036.