American Red Cross

Scientific Advisory Council

ARC SAC Advisory
Mild Traumatic Brain Injury (Concussion)

Overall Recommendation:

Standards:

1. Any person who a provider of first aid believes has sustained trauma [forceful bump, blow, or jolt to the head or body that results in rapid movement of the head and brain], along with any of the signals listed in table 6 [may be delayed] must be presumed to have sustained a mild traumatic brain injury or concussion.
2. Any person having sustained a mild traumatic brain injury or concussion must be removed from activity (ie., sport or other recreational activities) and must be referred to a qualified health care professional, experienced in evaluating and managing concussion.

Guidelines:

Options:

Questions to be addressed:

How can a first aid provider identify a person with a *mild traumatic brain injury* (ie., concussion) after sustaining trauma to the head and what are recommendations for managing this situation?

Introduction/Overview:

According to the Centers for Disease Control and Prevention[1] a traumatic brain injury (TBI) is "caused by a bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain." The common mechanism of injury (MOI) include a: 1) coup, 2) contra-coup, 3) rotational acceleration-deceleration and 4) repetitive impact. A forceful blow (eg., projectile [ball, fist, unrestricted objects in a vehicle]) to the resting, movable head produces a coup injury, producing maximal brain injury beneath the point of impact. When the head strikes an unyielding object (ie., falling to the ground and striking the head on surface) a contra-

coup injury occurs producing localized trauma opposite the site of cranial impact. Rotational acceleration-deceleration occurs when the brain is “torqued” or twisted, while repetitive impact occur when the brain sustain low-impact trauma over the course of a period of time (eg., boxing, soccer heading). Depending on the type of trauma sustained, age of the person and other factors, a variety of signs and symptoms may be recognized in adults and pediatric patients.[2-11]

In the military, a TBI is often the result of blast related injuries. Common mechanism of injury include but are not limited to:[11-14] 1) direct exposure to over the pressurization wave produced by a blast, 2) being stuck with flying debris (coup) from a blast injury, 3) being thrown across the environment from a blast injury or 4) jumping[15] from a plane (paratroopers). And while not all blows sustained by the head result in a TBI[16], the severity[1,7,8,17] of injury can range from “mild,” diffuse injury (ie., a brief change in mental status or consciousness) to “moderate” or “severe,” (ie., an extended period of unconsciousness or amnesia sustained after the trauma) depending on variety of factors at the time of injury. Important factors in determining the severity of injury include: 1) the velocity of the head before impact, 2) time over which the force is applied, 3) magnitude of the force applied to the head[9,18] or body[9,18] 4) amount of linear and/or rotational accleration-deceleration[19], 5) criteria and tools used to determine the presence or absence of mTBI[20-23] and level of familiarity with the signs and symptoms of a concussion.[24]

The majority of TBIs occurring each year are concussions or other forms of mild TBI (mTBI).[25,26] A cerebral concussion is best classified as a mild diffuse injury with the term mTBI typically used interchangeably with the term concussion (as will be in the case of this document).[7,8,25,27] However it should be noted that according to a review of literature by Mosenthal[28], concussions can and do occur even when a person sustains other types of traumatic brain injuries. Currently, there is universally accepted agreement on a standard definition for both adults and children[2] and diagnosis or nature of concussion. This is likely due to the variations in the mechanism of injury and presentations of TBI, as well as the more severe, but less common head injuries that can cause damage to the brain stem and other vital centers of the brain.[8,29-31] Agreement does exist however on several features that incorporate clinical, pathologic, and biomechanical injury constructs associated with head injury.[8,9]

Summary of Scientific Foundation:

Providers of first aid must first recognize that no two mTBI (ie., concussions) are identical in both the cause and presentation. The degree of the resulting signs and symptoms from the physical trauma can be very different and difficult to visualize[11,13,32] by a first aid provider depending upon a variety of factors. The diagnosis of a mTBI should involve the assessment of a range of domains including, but not limited to the person's: 1) symptoms, 2) signs, 3) behavior, 4) balance and coordination, 5) sleeping patterns 6) cognition and analytical abilities and 7) response to physical exertion.[3,8,9,11,20,23-25,33-35] with each assessment tool adding additional information regarding the status of the injured person by independently evaluating differing aspects of cerebral functioning.[22] However, while assessment tools such as neuropsychological and neurocognitive and balance and coordination testing are commonly used and provide the greatest amount of objective measures regarding a person's of cognitive function and recovery after a concussive injury[8,9,20,22,23,36-38]; individual variations in test scores and the necessity of baseline assessment makes it difficult for providers of first aid to administer these tools and interpret the results.

To help recognize a concussion, providers of first aid should observe for two items. First, the person sustaining a mTBI should experience a forceful bump, blow, or jolt to the head or body that results in rapid movement of the head and brain. Second, providers of first aid should observe for any change in the person's physical, cognitive, emotional or sleeping patterns. These signs and symptoms can be located in Table 6. Note that these signals may or may not appear immediately and that some people do not recognize or admit (athletes) that they are having problems.

Any person who a provider of first aid believes is experiencing any of the signs and symptoms listed in table 1 and who has sustained trauma to the head should be removed from activity [ie,. sport] and referred to a qualified health care professional, experienced in evaluating and managing concussion.

Table 1. Signs and Symptoms of a Concussion.

Physical	Cognitive	Affective	Sleep
Headache	Difficulty thinking clearly	Irritability	Drowsiness
Nausea or vomiting	Feeling mentally "foggy"	Sadness/depression	Sleeping more or less than usual
Balance or coordination problems	Difficulty concentrating	Anxiety	Difficulty falling asleep
Dizziness	Decreased processing speed	Heighted emotions	
Double or blurry vision	Difficulty remembering new information	Nervousness	
Sensitivity to light	Difficulty remembering events *prior* to the trauma		
Sensitivity to noise	Difficulty recalling events *after* to the trauma		
Tinnitus	Feeling "sluggish" or slowed down		
Fatigue			
Does not "feel right" or is "feeling down"			
Feeling "sluggish", having no energy			
Numbness/tingling			
Loss of consciousness			

References

References

1. Centers for Disease Control and Prevention. Traumatic brain injury. 2011; http://www.cdc.gov/traumaticbraininjury/. Accessed December 17, 2011.

2. DeMatteo CA, Hanna SE, Mahoney WJ, et al. "My child doesn't have a brain injury, he only has a concussion". *Pediatrics.* 2010;125(2):327-334.

3. Grubenhoff JA, Kirkwood M, Dexiang G, Deakyne S, Wathen J. Evaluation of the Standardized Assessment of Concussion in a Pediatric Emergency Department. *Pediatrics.* 2010;126(4):688-695.

4. Rathlev NK, Medzon R, Lowery D, et al. Intracranial pathology in elders with blunt head trauma. *Acad Emerg Med.* 2006;13(3):302-307.

5. Ropper AH, Gorson KC. Clinical practice. Concussion. *N Engl J Med.* 2007;356(2):166-172.

6. Sheedy J, Harvey E, Faux S, Geffen G, Shores EA. Emergency department assessment of mild traumatic brain injury and the prediction of postconcussive symptoms: a 3-month prospective study. *Journal of Head Trauma Rehabilitation.* 2009;24(5):333-343.

7. Kennedy JE, Jaffee MS, Leskin GA, Stokes JW, Leal FO, Fitzpatrick PJ. Posttraumatic stress disorder and posttraumatic stress disorder-like symptoms and mild traumatic brain injury. *Journal of Rehabilitation Research & Development.* 2007;44(7):895-919.

8. Guskiewicz KM, Bruce SL, Cantu RC, et al. National Athletic Trainers' Association position statement: management of sport-related concussion. *J Athl Train.* 2004;39(3):280-297. http://www.nata.org/sites/default/files/MgmtOfSportRelatedConcussion.pdf.

9. McCrory P, Meeuwisse W, Johnston K, et al. Consensus statement on concussion in sport: the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *J Athl Train.* 2009;44(4):434-448.

10. Bell KR, Hoffman JM, Temkin NR, et al. The effect of telephone counselling on reducing post-traumatic symptoms after mild traumatic brain injury: a randomised trial. *J Neurol Neurosurg Psychiatry.* 2008;79(11):1275-1281.

11. Department of Veterans Affairs and Department of Defense. VA/ DOD clinical practice guideline for management of concussion/mild traumatic brain injury. 2009; http://www.healthquality.va.gov/mtbi/concussion_mtbi_full_1_0.pdf. Accessed December 18, 2011.

12. Snell FI, Halter MJ. A signature wound of war: mild traumatic brain injury. *J Psychosoc Nurs Ment Health Serv.* 2010;48(2):22-28.

13. Belanger HG, Uomoto JM, Vanderploeg RD. The Veterans Health Administration's (VHA's) Polytrauma System of Care for mild traumatic brain injury: costs, benefits, and controversies. *J Head Trauma Rehabil.* 2009;24(1):4-13.

14. Thompson JM, Scott KC, Dubinsky L. Battlefield brain: unexplained symptoms and blast-related mild traumatic brain injury. *Can Fam Physician.* 2008;54(11):1549-1551.

15. Ivins BJ, Crowley JS, Johnson J, Warden DL, Schwab KA. Traumatic brain injury risk while parachuting: comparison of the personnel armor system for ground troops helmet and the advanced combat helmet. *Military Medicine.* 2008;173(12):1168-1172.

16. Polito MZ, Thompson JW, DeFina PA. A review of the International Brain Research Foundation novel approach to mild traumatic brain injury presented at the International Conference on Behavioral Health and Traumatic Brain Injury. *J Am Acad Nurse Pract.* 2010;22(9):504-509.

17. Maruta J, Lee SW, Jacobs EF, Ghajar J. A unified science of concussion. *Ann N Y Acad Sci.* 2010;1208:58-66.

18. Gennarelli T. Mechanisms of brain injury. *J Emerg Med.* 1993;11(suppl 1):5-11.

19. Beckwith JG, Chu JJ, Greenwald RM. Validation of a noninvasive system for measuring head acceleration for use during boxing competition. *J Appl Biomech.* 2007;23(3):238-244.
20. Lau B, Lovell MR, Collins MW, Pardini J. Neurocognitive and symptom predictors of recovery in high school athletes. *Clin J Sport Med.* 2009;19(3):216-221.
21. Petchprapai N, Winkelman C. Mild traumatic brain injury: determinants and subsequent quality of life. A review of the literature. *J Neurosci Nurs.* Oct 2007;39(5):260-272.
22. Broglio SP, Puetz TW. The effect of sport concussion on neurocognitive function, self-report symptoms and postural control: a meta-analysis. *Sports Medicine.* 2008;38(1):53-67.
23. Valovich McLeod TC, Barr WB, McCrea M, Guskiewicz KM. Psychometric and measurement properties of concussion assessment tools in youth sports. *J Athl Train.* 2006;41(4):399-408.
24. Coghlin CJ, Myles BD, Howitt SD. The ability of parents to accurately report concussion occurrence in their Bantam-aged minor hockey league children. *J Can Chiropr Assoc.* 2009;53(4):233-250.
25. Centers for Disease Control and Prevention. *Heads Up: Brain Injury in Your Practice.* Atlanta, GA: U.S. Department of Health and Human Services; 2007.
26. Coronado VG, Xu L, Basavaraju SV, et al. Surveillance for traumatic brain injury-related deaths--United States, 1997-2007. *MMWR.* 2011;60(5):1-32.
27. Ptito A, Chen JK, Johnston KM. Contributions of functional magnetic resonance imaging (fMRI) to sport concussion evaluation. *Neuro Rehab.* 2007;22(3):217-227.
28. Mosenthal AC, Livingston DH, Lavery RF, et al. The effect of age on functional outcome in mild traumatic brain injury: 6-month report of a prospective multicenter trial. *J Trauma.* May 2004;56(5):1042-1048.
29. Levin HS, Hanten G, Roberson G, et al. Prediction of cognitive sequelae based on abnormal computed tomography findings in children following mild traumatic brain injury. *J Neurosurg Pediatr.* 2008;1(6):461-470.
30. Ruff RM, Jurica P. In search of a unified definition for mild traumatic brain injury. *Brain Inj.* Dec 1999;13(12):943-952.
31. Hettich T, Whitfield E, Kratz K, Frament C. Case report: use of the Immediate Post Concussion Assessment and Cognitive Testing (ImPACT) to assist with return to duty determination of special operations soldiers who sustained mild traumatic brain injury. *J Spec Oper Med.* Fall 2010;10(4):48-55.
32. American Congress on Rehabilitation Medicine. Definition of mild traumatic brain injury. *J Head Trauma Rehabil.* 1993;1993(8):3.
33. Holm L, Cassidy JD, Carroll LJ, Borg J. Summary of the WHO Collaborating Centre for Neurotrauma Task Force on Mild Traumatic Brain Injury. *J Rehabil Med.* 2005;37(3):137-141.
34. Leddy JJ, Baker JG, Kozlowski K, Bisson L, Willer B. Reliability of a Graded Exercise Test for Assessing Recovery From Concussion. *Clin J Sport Med.* 2011;21(2):89-94.
35. Broglio SP, Ferrara MS, Sopiarz K, Kelly MS. Reliable change of the Sensory Organization Test. *Clin J Sport Med.* 2008;18(2):148-154.
36. Brown CN, Guskiewicz KM, Bleiberg J. Athlete characteristics and outcome scores for computerized neuropsychological assessment: a preliminary analysis. *J Athl Train.* 2007;42(4):515-523.

37. Makdissi M, Collie A, Maruff P, et al. Computerised cognitive assessment of concussed Australian Rules footballers. *Br J Sports Med.* 2001;35(5):354-360.

38. Makdissi M, McCrory P, Ugoni A, Darby D, Brukner P. A prospective study of postconcussive outcomes after return to play in Australian football. *Am J Sports Med.* 2009;37(5):877-883.