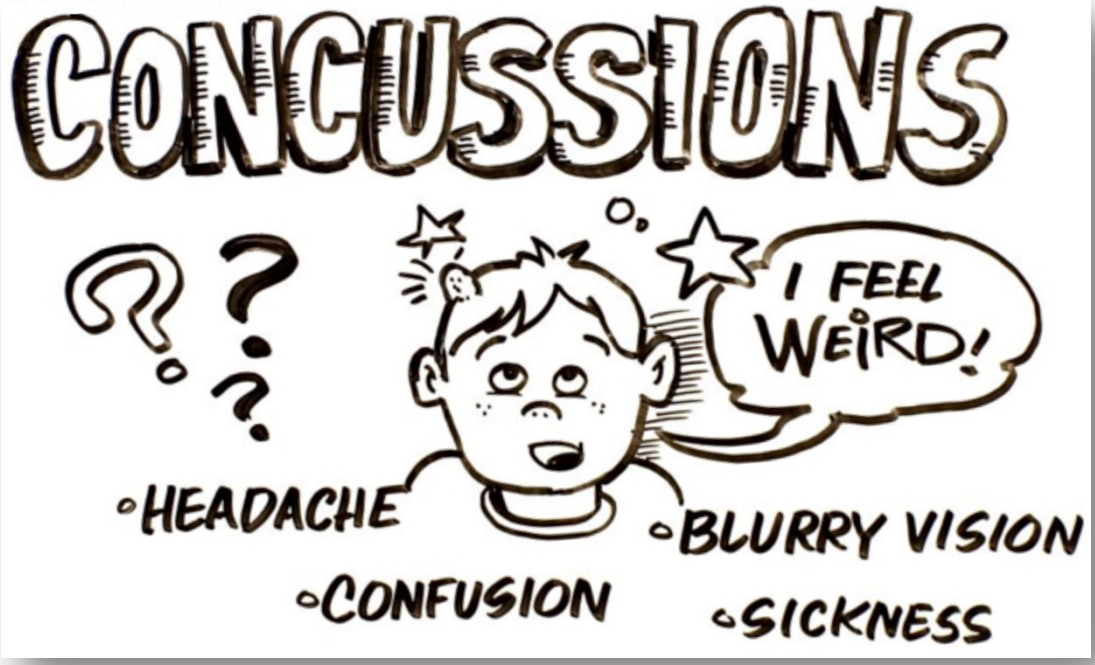
Guidelines for Diagnosing and Managing Pediatric Concussion

First edition, June 2014

REFERENCEs and LEVELS OF EVIDENCE



Ontario Neurotrauma Foundation
Fondation ontarienne de neurotraumatologie

This is the companion document to the *Guidelines for Diagnosing and Managing Pediatric Concussion, First Edition*.

Levels of Evidence

Levels of evidence are used to guide the reader as to the strength of the individual recommendation. There are many ways to grade levels of evidence. Some emphasize the quality of randomized clinical trials. However, because so few randomized clinical trials have studied pediatric concussion, we used a broader system to rank evidence that also emphasizes the strength of systematic reviews or large studies that may not involve interventions. In our system, A is the strongest level of evidence. The levels are defined as follows:

- **A** =Consistent, good-quality, patient-oriented evidence (example, at least one large randomized control trial, meta-analysis or systematic review with homogeneity, or large, high-quality, multi-centre cohort study);
- **B** = Inconsistent or limited-quality patient-oriented evidence (example: smaller cohort studies, case studies or control trials with limitations);
- **C** = Consensus, usual practice, opinion or weaker-level evidence.[1,2]

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Cover image courtesy of Dr. Mike Evans

[1] http://www.essentialevidenceplus.com/product/ebm_loe.cfm?show=sort. Accessed May 8, 2014.
[2] Ebell MH1, Siwek J, Weiss BD, Woolf SH, Susman J, Ewigman B, Bowman M. Strength of recommendation taxonomy (SORT): a patient-centered approach to grading evidence in the medical literature. Am Fam Physician. 2004 Feb 1;69(3):548-56.

Table of Contents

3.1i	Advise on general monitoring, regular follow up with primary care or a sport medicine physician until symptoms disappear, and referral to specialized care after one month if symptoms persist.	B/C
3.1j	Follow the written and verbal information your health care professional gives you.	B/C
4.1	Recommend that the child/adolescent follow a stepwise return-to-learn plan.	B/C
4.2	Develop a return-to-learn program after acute symptoms have improved.	B/C
4.3	Recommend additional assessment and accommodations if symptoms worsen or fail to improve.	B/C
4.4	Develop a return-to-play program only after the child/adolescent has started his/her return-to-learn program.	B
4.5	Refer any child/adolescent who has sustained multiple concussions to an expert in sport concussion to help with return-to-play decisions and/or retirement from contact sports.	B
5.1	Assess any modifiers that may delay recovery.	B
5.2	Make sure the child/adolescent is not taking any medication that might mask or modify the symptoms.	B
5.3	Assess, document and manage significant, prolonged complaints based on specific symptoms, etiology and the time since injury.	B
5.4a(i)	Place every child/adolescent on a program of sleep hygiene.	C
5.4a(ii)	Screen for factors that may influence the child/adolescent's sleep/wake cycle.	B
5.4a(iii)	Consider non-pharmacological treatments to improve sleep.	C
5.4a(iv)	Consider prescribing medication on a short-term basis if sleep has not improved.	C
5.4a(v)	Refer the child/adolescent to a pediatric sleep if sleep has not improved.	C
5.4b(i)	Take a history of any headaches.	B
5.4b(ii)	Establish the degree and duration of the disability that the headaches cause.	B
5.4b(iii)	Perform a neurological exam and a head/neck exam.	C
5.4b(iv)	Consider non-pharmacological, complementary and/or alternative medicine therapies for headache.	C
5.4b(v)	Consider treating migraine headaches with prescription medication.	B
5.4c(i)	Assess for persistent cognitive difficulties.	B
5.4c(ii)	Manage any cognitive impairments.	B
5.4d(i)	Assess for balance and vestibular impairments.	B
5.4d(ii)	Assess for benign positional vertigo.	B

5.4d(iii)	Refer for further assessment and treatment if balance and/or vestibular system are dysfunctional.	B
5.4e(i)	Assess ongoing vision dysfunctions.	B
5.4e(ii)	Refer children/adolescents who have changes in functional vision to a specialist.	B
5.4f(i)	Assess and manage persistent fatigue if it is a significant symptom.	B
5.4g(i)	Assess for existing and new mental health symptoms and disorders.	B
5.4g(ii)	Ask the child/adolescent and parents and/or caregivers to report on mood and feelings.	B
5.4g(iii)	Treat any mental health symptoms.	B
5.4g(iv)	Consider referring to a specialist with experience in pediatric mental health.	B
5.5	Recommend rehabilitation therapy to improve symptoms and mobility, as needed.	B
5.6	Consider a broad differential diagnosis.	C
5.7	Consider the need for specialized therapy if symptoms persist.	B
5.8	Work with the child/adolescent's primary care professional, school and/or employer regarding accommodations needed to tasks or schedules.	B
5.9	Assess and treat any physical, cognitive and neurological deficits.	A/B
Appendix 1	Search Strategy for Systematic Review	

O.1: Learn to recognize the symptoms of concussion.

Level B

Glang A, Koester MC, Beaver S, Clay J, McLaughlin K. Online training in sports concussion for youth sports coaches. *Int J Sports Sci Coach*. 2010;5(1):1–11.

Gioia GA, Collins M, Isquith PK. Improving identification and diagnosis of mild traumatic brain injury with evidence: psychometric support for the acute concussion evaluation. *J Head Trauma Rehabil*. 2008;23(4):230–242.

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McCrea M, Kelly JP, Randolph C, Cisler R, Berger L. Immediate neurocognitive effects of concussion. *Neurosurgery*. 2002;50(5):1032–1040.

O2: Adopt a formal policy that prevents a child/adolescent who may have sustained a concussion from returning to play on the same day as the injury.

Level B

Purcell L. What are the most appropriate return-to-play guidelines for concussed child athletes? *Br J Sports Med*. 2009;43 Suppl 1:i51–i55.

Schatz P, Moser RS, Covassin T, Karpf R. Early indicators of enduring symptoms in high school athletes with multiple previous concussions. *Neurosurgery*. 2011;68(6):1562–1567.

Wiebe DJ, Collins MW, Nance ML. Identification and validation of prognostic criteria for persistence of mild traumatic brain injury-related impairment in the pediatric patient. *Pediatr Emerg Care*. 2012;28(6):498–502.

Yard EE, Comstock RD. Compliance with return to play guidelines following concussion in US high school athletes, 2005-2008. *Brain Inj*. 2009;23(11):888–898.

O.3: Ensure policies are in place to accommodate a child/adolescent who has sustained a concussion.

Level B

Bassett SS, Slater EJ. Neuropsychological function in adolescents sustaining mild closed head injury. *J Pediatr Psychol*. 1990;15(2):225–236.

Master CL, Gioia GA, Leddy JJ, Grady MF. Importance of “Return-to-Learn” in Pediatric and Adolescent Concussion. *Pediatr Ann*. 2012;41(9):1–6.

Schatz P, Moser RS, Covassin T, Karpf R. Early indicators of enduring symptoms in high school athletes with multiple previous concussions. *Neurosurgery*. 2011;68(6):1562–1567.

Wiebe DJ, Collins MW, Nance ML. Identification and validation of prognostic criteria for persistence of mild traumatic brain injury-related impairment in the pediatric patient. *Pediatr Emerg Care*. 2012;28(6):498–502.

0.4: Consider baseline neuro-cognitive testing if the child/adolescent plays high-risk sports—not as a general rule.

Level B

Mihalik JP, Stump JE, Collins MW, Lovell MR, Field M, Maroon JC. Posttraumatic migraine characteristics in athletes following sports-related concussion. *J Neurosurg*. 2005;102(5):850–855.

Lau BC, Collins MW, Lovell MR. Sensitivity and specificity of subacute computerized neurocognitive testing and symptom evaluation in predicting outcomes after sports-related concussion. *Am J Sports Med*. 2011;39(6):1209–1216.

1.1: Remove the child/adolescent from play immediately if you suspect a concussion.

Level B

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

McCrory P1, Meeuwisse WH, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Br J Sports Med.* 2013;47(5):250-8.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

Yard EE, Comstock RD. Compliance with return to play guidelines following concussion in US high school athletes, 2005-2008. *Brain Inj*. 2009;23(11):888–898.

1.2: Assess the child/adolescent for symptoms related to concussion.

Level B

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

McCrea M, Kelly JP, Randolph C, et al. Standardized assessment of concussion (SAC): on-site mental status evaluation of the athlete. *J Head Trauma Rehabil*. 1998;13(2):27–35.

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Piland SG, Motl RW, Guskiewicz KM, McCrea M, Ferrara MS. Structural validity of a self-report concussion-related symptom scale. *Med Sci Sport Exerc*. 2006;38(1):27–32.

Randolph C, Millis S, Barr WB, et al. Concussion Symptom Inventory: An empirically derived scale for monitoring resolution of symptoms following sport-related concussion. *Arch Clin Neuropsychol*. 2009;24(3):219–229.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Phys Sportsmed.* 2010;38(1):139-46.

1.3: Watch for possible symptoms of concussion to evolve.

Level B

Collins MW, Iverson GL, Lovell MR, McKeag DB, Norwig J, Maroon J. On-field predictors of neuropsychological and symptom deficit following sports-related concussion. *Clin J Sport Med*. 2003;13(4):222–229.

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Piland SG, Motl RW, Guskiewicz KM, McCrea M, Ferrara MS. Structural validity of a self-report concussion-related symptom scale. *Med Sci Sport Exerc*. 2006;38(1):27–32.

Randolph C, Millis S, Barr WB, et al. Concussion Symptom Inventory: An empirically derived scale for monitoring resolution of symptoms following sport-related concussion. *Arch Clin Neuropsychol*. 2009;24(3):219–229.

1.4: Take a child/adolescent who shows symptoms of concussion to a health care professional.

Level B

Collins MW, Iverson GL, Lovell MR, McKeag DB, Norwig J, Maroon J. On-field predictors of neuropsychological and symptom deficit following sports-related concussion. *Clin J Sport Med*. 2003;13(4):222–229.

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Vos P. Mild traumatic brain injury. *Eur J Neurol*. 2012;19(2):191–198.

2.1: Assess and treat any physical, cognitive and neurological deficits.

Level A

Gioia GA, Schneider JC, Vaughan CG, Isquith PK. Which symptom assessments and approaches are uniquely appropriate for paediatric concussion? *Br J Sports Med*. 2009;43 Suppl 1:i13–i22.

Level B

Bassett SS, Slater EJ. Neuropsychological function in adolescents sustaining mild closed head injury. *J Pediatr Psychol*. 1990;15(2):225–236.

Blinman TA, Houseknecht E, Snyder C, Wiebe DJ, Nance ML. Postconcussive symptoms in hospitalized pediatric patients after mild traumatic brain injury. *J Pediatr Surg*. 2009;44(6):1223–1228.

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Broglio SP, Eckner JT, Surma T, Kutcher JS. Post-concussion cognitive declines and symptomatology are not related to concussion biomechanics in high school football players. *J Neurotrauma*. 2011;28(10):2061–2068.

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Falk AC, Von WL, Soderkvist BK. The specificity of post-concussive symptoms in the pediatric population. *J Child Heal Care*. 2009;13(3):227–238.

Furman GR, Lin CC, Bellanca JL, Marchetti GF, Collins MW, Whitney SL. Comparison of the balance accelerometer measure and balance error scoring system in adolescent concussions in sports. *Am J Sports Med*. 2013;41(6):1404–1410.

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Grubenhoff JA, Kirkwood MW, Deakyne S, Wathen J. Detailed concussion symptom analysis in a paediatric ED population. *Brain Inj*. 2011;25(10):943–949.

Grubenhoff JA, Kirkwood M, Gao D, Deakyne S, Wathen J. Evaluation of the standardized assessment of concussion in a pediatric emergency department. *Pediatrics*. 2010;126(4):688–695.

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Kontos AP, Covassin T, Elbin RJ, Parker T. Depression and neurocognitive performance after concussion among male and female high school and collegiate athletes. *Arch Phys Med Rehabil*. 2012;93(10):1751–1756.

Lau BC, Kontos AP, Collins MW, Mucha A, Lovell MR. Which on-field signs/symptoms predict protracted recovery from sport-related concussion among high school football players? *Am J Sports Med*. 2011;39(11):2311–2318.

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Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

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

Thomas DG, Collins MW, Saladino RA, Frank V, Raab J, Zuckerbraun NS. Identifying neurocognitive deficits in adolescents following concussion. *Acad Emerg Med*. 2011;18(3):246–254.

Valovich TC, Perrin DH, Gansneder BM. Repeat administration elicits a practice effect with the Balance Error Scoring System but not with the Standardized Assessment of Concussion in high school athletes. *J Athl Train*. 2003;38(1):51–56.

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Yeates KO, Kaizar E, Rusin J, et al. Reliable change in postconcussive symptoms and its functional consequences among children with mild traumatic brain injury. *Arch Pediatr Adolesc Med*. 2012;166(7):615–622.

2.2: Determine the need for CT imaging.

Level A

Borg J, Holm L, Cassidy JD, et al. Diagnostic procedures in mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med*. 2004;(43 Suppl):61–75.

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Kuppermann N, Holmes JF, Davan PS, et al. Identification of children at very low risk of clinically-important brain injuries after head trauma: a prospective cohort study. *Lancet*. 2009;374(9696):1160-70.

Pickering A, Harnan S, Fitzgerald P, Pandor A, Goodacre S. Clinical decision rules for children with minor head injury: a systematic review. *Arch Dis Child*. 2011;96(5):414-21.

Vos P. Mild traumatic brain injury. *Eur J Neurol*. 2012;19(2):191–198.

Level B

Easter JS, Bakes K, Dhaliwal J, Miller M, Caruso E, Haukoos JS. Comparison of PECARN, CATCH, and CHALICE Rules for Children With Minor Head Injury: A Prospective Cohort Study. *Ann Emerg Med.* 2014 pii: S0196-0644(14)00092-4.

Lyttle MD, Crowe L, Oakley E, Dunning J, Babi FE. Comparing CATCH, CHALICE and PECARN clinical decision rules for paediatric head injuries. *Emerg Med J.* 2012;29(10):785-94.

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Thomas DG, Collins MW, Saladino RA, Frank V, Raab J, Zuckerbraun NS. Identifying neurocognitive deficits in adolescents following concussion. *Acad Emerg Med*. 2011;18(3):246–254.

2.3: Consider admission or prolonged observation if the child/adolescent shows "red flag" symptoms.

Level B

Babcock L, Byczkowski T, Wade SL, Ho M, Mookerjee S, Bazarian JJ. Predicting postconcussion syndrome after mild traumatic brain injury in children and adolescents who present to the emergency department. *JAMA Pediatr*. 2013;167(2):156–161.

Bassett SS, Slater EJ. Neuropsychological function in adolescents sustaining mild closed head injury. *J Pediatr Psychol*. 1990;15(2):225–236.

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Vos P. Mild traumatic brain injury. *Eur J Neurol*. 2012;19(2):191–198.

2.4: Treat acute headaches.

Level C

2.5: Prescribe physical and cognitive rest.

Level B/C

Brown NJ, Mannix RC, O'Brien MJ, Gostine D, Collins MW, Meehan WP 3rd. Effect of cognitive activity level on duration of post-concussion symptoms. *Pediatrics.* 2014;133(2):e299-304.

Kontos AP, Elbin RJ, Schatz P, et al. A revised factor structure for the post-concussion symptom scale: baseline and postconcussion factors. *Am J Sports Med*. 2012;40(10):2375–2384.

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Yard EE, Comstock RD. Compliance with return to play guidelines following concussion in US high school athletes, 2005-2008. *Brain Inj.* 2009;23(11):888-98.

2.6: Discharge the child/adolescent for observation at home under certain conditions.

Level B

Adams J, Frumiento C, Shatney-Leach L, Vane DW. Mandatory admission after isolated mild closed head injury in children: is it necessary? *J Pediatr Surg*. 2001;36(1):119–121.

Borg J, Holm L, Cassidy JD, et al. Diagnostic procedures in mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med*. 2004;(43 Suppl):61–75.

Davis RL, Hughes M, Gubler KD, Waller PL, Rivara FP. The use of cranial CT scans in the triage of pediatric patients with mild head injury. *Pediatrics*. 1995;95(3):345–349.

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Vos P. Mild traumatic brain injury. *Eur J Neurol*. 2012;19(2):191–198.

3.1: Provide verbal information and written handouts to the child/adolescent and the parents and/or caregivers.

Level A

Ponsford J, Willmott C, Rothwell A, et al. Impact of early intervention on outcome after mild traumatic brain injury in children. *Pediatrics*. 2001;108(6):1297–1303.

Level B

Gagnon I, Swaine B, Friedman D, Forget R. Exploring children's self-efficacy related to physical activity performance after a mild traumatic brain injury. *J Head Trauma Rehabil*. 2005;20(5):436–449.

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Swaine BR, Gagnon I, Champagne F, et al. Identifying the specific needs of adolescents after a mild traumatic brain injury: a service provider perspective. *Brain Inj*. 2008;22(7-8):581–588.

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Waisman Y, Siegal N, Siegal G, Amir L, Cohen H, Mimouni M. Role of diagnosis-specific information sheets in parents' understanding of emergency department discharge instructions. *Eur J Emerg Med.* 2005;12(4):159-62.

Yard EE, Comstock RD. Compliance with return to play guidelines following concussion in US high school athletes, 2005-2008. *Brain Inj.* 2009;23(11):888-98.

3.1a: Inform on the expected course of recovery and return-to-school/play.

Level B

Bonfield CM, Lam S, Lin Y, Greene S. The impact of attention deficit hyperactivity disorder on recovery from mild traumatic brain injury. *J Neurosurg*. 2013;Pediatrics(2):97–102.

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Zemek RL, Farion KJ, Sampson M, McGahern C. Prognosticators of persistent symptoms following pediatric concussion: a systematic review. *JAMA Pediatr*. 2013;167(3):259–65.

Zemper ED. A Two-Year Prospective Study of Cerebral Concussion in American Football. Am J Sports Medicine 2003l 11: 157-172.

3.1b: Advise on the risks and complications of re-injury, especially of persistent symptoms.

Level B

Bey T and Ostick B. Second Impact Syndrome. West J Emerg Med. Feb 2009; 10(1):6–10.

Eisenberg MA, Andrea J, Meehan W, Mannix R. Time interval between concussions and symptom duration. *Pediatrics*. 2013;132(1):8–17.

Gagnon I, Forget R, Sullivan SJ, Friedman D. Motor performance following a mild traumatic brain injury in children: an exploratory study. *Brain Inj*. 1998;12(10):843–853.

Gagnon I, Swaine B, Friedman D, Forget R. Visuomotor response time in children with a mild traumatic brain injury. *J Head Trauma Rehabil*. 2004;19(5):391–404.

Guideline Summary: Care of the patient with mild traumatic brain injury. [American Association of Neuroscience Nurses] 42. *info@guideline.gov (NGC)*. 2011.

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):876–882.

McCrory PR, Berkovic SF. Second impact syndrome. *Neurology*. 1998;50(3):677–683.

Ponsford J, Willmott C, Rothwell A, et al. Impact of early intervention on outcome after mild traumatic brain injury in children. *Pediatrics*. 2001;108(6):1297–1303.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

Saunders RL, Harbaugh RE. The Second Impact in Catastrophic Contact-Sports Head Trauma. *JAMA.* 1984;252(4):538-539.

Swaine BR, Gagnon I, Champagne F, et al. Identifying the specific needs of adolescents after a mild traumatic brain injury: a service provider perspective. *Brain Inj*. 2008;22(7-8):581–588.

Yard EE, Comstock RD. Compliance with return to play guidelines following concussion in US high school athletes, 2005-2008. *Brain Inj.* 2009;23(11):888-98.

Zemper ED. Two-year prospective study of relative risk of a second cerebral concussion. *Am J Phys Med Rehabil*. 2003;82(9):653–659.

3.1c: Advise on managing sleep proactively.

Level C

3.1d: Advise on managing headaches.

Level B

Meehan WP 3rd. Medical therapies for concussion. *Clin Sports Med.* 2011;30(1):115-24.

Ponsford J, Willmott C, Rothwell A, et al. Impact of early intervention on outcome after mild traumatic brain injury in children. *Pediatrics*. 2001;108(6):1297–1303.

3.1e: Advise on coping with fatigue.

Level B

Harvey AG, Bryant RA. Acute stress disorder after mild traumatic brain injury. *J Nerv Ment Dis*. 1998;186(6):333–337.

Ponsford J, Willmott C, Rothwell A, et al. Impact of early intervention on outcome after mild traumatic brain injury in children. *Pediatrics*. 2001;108(6):1297–1303.

3.1f: Advise on maintaining social networks and interactions.

Level B

Gagnon I, Swaine B, Champagne F, Lefebvre H. Perspectives of adolescents and their parents regarding service needs following a mild traumatic brain injury. *Brain Inj*. 2008;22(2):161–173.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Harvey AG, Bryant RA. Acute stress disorder after mild traumatic brain injury. *J Nerv Ment Dis*. 1998;186(6):333–337.

Ilie G, Mann RE, Boak A, Adlaf EM, Hamilton H, et al. Suicidality, Bullying and Other Conduct and Mental Health Correlates of Traumatic Brain Injury in Adolescents. *PLoS ONE.* 2014;9(4):e94936.

Jonsson C, Andersson EE. Mild traumatic brain injury: A description of how children and youths between 16 and 18 years of age perform leisure activities after 1 year. *Dev Neurorehabil.* 2013;16(1):1-8.

Kaldoja ML, Kolk A. Social-emotional behaviour in infants and toddlers with mild traumatic brain injury. *Brain Inj*. 2012;26(7-8):1005–1013.

Ponsford J, Willmott C, Rothwell A, et al. Impact of early intervention on outcome after mild traumatic brain injury in children. *Pediatrics*. 2001;108(6):1297–1303.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

3.1g: Advise on avoiding alcohol and other recreational drugs.

Level B

Swaine BR, Gagnon I, Champagne F, et al. Identifying the specific needs of adolescents after a mild traumatic brain injury: a service provider perspective. *Brain Inj*. 2008;22(7-8):581–588.

3.1h: Advise on avoiding driving during recovery.

Level B

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Preece MH, Horswill MS, Geffen GM. Driving after concussion: the acute effect of mild traumatic brain injury on drivers' hazard perception. *Neuropsychology*. 2010;24(4):493–503.

Preece MH, Geffen GM, Horswill MS. Return-to-driving expectations following mild traumatic brain injury. *Brain Inj*. 2013;27(1):83–91.

3.1i: Advise on general monitoring, regular follow up with primary care or a sport medicine physician until symptoms disappear, and referral to specialized care after one month if symptoms persist.

Level B

Babcock L, Byczkowski T, Wade SL, Ho M, Mookerjee S, Bazarian JJ. Predicting postconcussion syndrome after mild traumatic brain injury in children and adolescents who present to the emergency department. *JAMA Pediatr*. 2013;167(2):156–161.

Eisenberg MA, Andrea J, Meehan W, Mannix R. Time interval between concussions and symptom duration. *Pediatrics*. 2013;132(1):8–17.

Guideline Summary: Care of the patient with mild traumatic brain injury. [American Association of Neuroscience Nurses] 42. *info@guideline.gov (NGC)*. 2011.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Harvey AG, Bryant RA. Acute stress disorder after mild traumatic brain injury. *J Nerv Ment Dis*. 1998;186(6):333–337.

Piland SG, Motl RW, Guskiewicz KM, McCrea M, Ferrara MS. Structural validity of a self-report concussion-related symptom scale. *Med Sci Sport Exerc*. 2006;38(1):27–32.

Ponsford J, Willmott C, Rothwell A, et al. Impact of early intervention on outcome after mild traumatic brain injury in children. *Pediatrics*. 2001;108(6):1297–1303.

Randolph C, Millis S, Barr WB, et al. Concussion Symptom Inventory: An empirically derived scale for monitoring resolution of symptoms following sport-related concussion. *Arch Clin Neuropsychol*. 2009;24(3):219–229.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

Swaine BR, Gagnon I, Champagne F, et al. Identifying the specific needs of adolescents after a mild traumatic brain injury: a service provider perspective. *Brain Inj*. 2008;22(7-8):581–588.

Thomas DG, Collins MW, Saladino RA, Frank V, Raab J, Zuckerbraun NS. Identifying neurocognitive deficits in adolescents following concussion. *Acad Emerg Med*. 2011;18(3):246–254.

Vos P. Mild traumatic brain injury. *Eur J Neurol*. 2012;19(2):191–198.

3.1j: Follow the written and verbal information your health care professional gives you.

Level B

Isaacman DJ, Purvis K, Gyuro J, Anderson Y, Smith D Standardized instructions: do they improve communication of discharge information from the emergency department? *Pediatric*s. 1992;89(6 Pt 2):1204-8.

Waisman Y, Siegal N, Siegal G, Amir L, Cohen H, Mimouni M. Role of diagnosis-specific information sheets in parents' understanding of emergency department discharge instructions. *Eur J Emerg Med.* 2005;12(4):159-62.

4.1: Recommend that the child/adolescent follow a stepwise return-to-learn plan.

Level B/C

Brown NJ, Mannix RC, O'Brien MJ, Gostine D, Collins MW, Meehan WP 3rd. Effect of cognitive activity level on duration of post-concussion symptoms. *Pediatrics.* 2014;133(2):e299-304.

Gagnon I, Swaine B, Champagne F, Lefebvre H. Perspectives of adolescents and their parents regarding service needs following a mild traumatic brain injury. *Brain Inj*. 2008;22(2):161–173.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Majerske CW, Mihalik JP, Ren D, Collins MW, Reddy CC, Lovell MR, Wagner AK. Concussion in sports: postconcussive activity levels, symptoms, and neurocognitive performance. *J Athl Train.* 2008;43(3):265-74.

Makdissi M, Davis G, Jordan B, Patricios J, Purcell L, Putukian M. Revisiting the modifiers: how should the evaluation and management of acute concussions differ in specific groups? *Br J Sports Med*. 2013;47(5):314–320.

Purcell L. What are the most appropriate return-to-play guidelines for concussed child athletes? *Br J Sports Med*. 2009;43 Suppl 1:i51–i55.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

4.2: Develop a return-to-learn program after acute symptoms have improved.

Level B/C

Bassett SS, Slater EJ. Neuropsychological function in adolescents sustaining mild closed head injury. *J Pediatr Psychol*. 1990;15(2):225–236.

Brown NJ, Mannix RC, O'Brien MJ, Gostine D, Collins MW, Meehan WP 3rd. Effect of cognitive activity level on duration of post-concussion symptoms. *Pediatrics.* 2014;133(2):e299-304.

Furman GR, Lin CC, Bellanca JL, Marchetti GF, Collins MW, Whitney SL. Comparison of the balance accelerometer measure and balance error scoring system in adolescent concussions in sports. *Am J Sports Med*. 2013;41(6):1404–1410.

Gagnon I, Swaine B, Friedman D, Forget R. Children show decreased dynamic balance after mild traumatic brain injury. *Arch Phys Med Rehabil*. 2004;85(3):444–452.

Gagnon I, Swaine B, Champagne F, Lefebvre H. Perspectives of adolescents and their parents regarding service needs following a mild traumatic brain injury. *Brain Inj*. 2008;22(2):161–173.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Majerske CW, Mihalik JP, Ren D, Collins MW, Reddy CC, Lovell MR, Wagner AK. Concussion in sports: postconcussive activity levels, symptoms, and neurocognitive performance. *J Athl Train.* 2008;43(3):265-74.

Makdissi M, Davis G, Jordan B, Patricios J, Purcell L, Putukian M. Revisiting the modifiers: how should the evaluation and management of acute concussions differ in specific groups? *Br J Sports Med*. 2013;47(5):314–320.

Master CL, Gioia GA, Leddy JJ, Grady MF. Importance of "Return-to-Learn" in Pediatric and Adolescent Concussion. *Pediatr Ann*. 2012;41(9):1–6.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

Sandel NK, Lovell MR, Kegel NE, Collins MW, Kontos AP. The relationship of symptoms and neurocognitive performance to perceived recovery from sports-related concussion among adolescent athletes. *Appl Neuropsychol*. 2013;Child. 2(1):64–69.

4.3: Recommend additional assessment and accommodations if symptoms worsen or fail to improve.

Level B/C

Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

4.4: Develop a return-to-play program only after the child/adolescent has started his/her return-to-learn program.

Level B

Asplund CA, McKeag DB, Olsen CH. Sport-related concussion: factors associated with prolonged return to play. *Clin J Sport Med*. 2004;14(6):339–343.

Gagnon I, Swaine B, Friedman D, Forget R. Exploring children's self-efficacy related to physical activity performance after a mild traumatic brain injury. *J Head Trauma Rehabil*. 2005;20(5):436–449.

Gagnon I, Swaine B, Champagne F, Lefebvre H. Perspectives of adolescents and their parents regarding service needs following a mild traumatic brain injury. *Brain Inj*. 2008;22(2):161–173.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Lovell MR, Collins MW, Iverson GL, et al. Recovery from mild concussion in high school athletes. *J Neurosurg*. 2003;98(2):296–301.

Majerske CW, Mihalik JP, Ren D, Collins MW, Reddy CC, Lovell MR, Wagner AK. Concussion in sports: postconcussive activity levels, symptoms, and neurocognitive performance. *J Athl Train.* 2008;43(3):265-74.

Makdissi M, Davis G, Jordan B, Patricios J, Purcell L, Putukian M. Revisiting the modifiers: how should the evaluation and management of acute concussions differ in specific groups? *Br J Sports Med*. 2013;47(5):314–320.

Master CL, Gioia GA, Leddy JJ, Grady MF. Importance of "Return-to-Learn" in Pediatric and Adolescent Concussion. *Pediatr Ann*. 2012;41(9):1–6.

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):876–882.

McCrory P1, Meeuwisse WH, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Br J Sports Med.* 2013;47(5):250-8.

Purcell L. What are the most appropriate return-to-play guidelines for concussed child athletes? *Br J Sports Med*. 2009;43 Suppl 1:i51–i55.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

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

Swaine BR, Gagnon I, Champagne F, et al. Identifying the specific needs of adolescents after a mild traumatic brain injury: a service provider perspective. *Brain Inj*. 2008;22(7-8):581–588.

Yard EE, Comstock RD. Compliance with return to play guidelines following concussion in US high school athletes, 2005-2008. *Brain Inj.* 2009;23(11):888-98.

4.5: Refer any child/adolescent who has sustained multiple concussions to an expert in sport concussion to help with return-to-play decisions and/or retirement from contact sports.

Level B

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Moser RS, Schatz P. Enduring effects of concussion in youth athletes. *Arch Clin Neuropsychol*. 2002;17(1):91–100.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

Schatz P, Moser RS, Covassin T, Karpf R. Early indicators of enduring symptoms in high school athletes with multiple previous concussions. *Neurosurgery*. 2011;68(6):1562–1567.

5.1: Assess any modifiers that may delay recovery.

Level B

Asplund CA, McKeag DB, Olsen CH. Sport-related concussion: factors associated with prolonged return to play. *Clin J Sport Med*. 2004;14(6):339–343.

Babcock L, Byczkowski T, Wade SL, Ho M, Mookerjee S, Bazarian JJ. Predicting postconcussion syndrome after mild traumatic brain injury in children and adolescents who present to the emergency department. *JAMA Pediatr*. 2013;167(2):156–161.

Babikian T, McArthur D, Asarnow RF. Predictors of 1-month and 1-year neurocognitive functioning from the UCLA longitudinal mild, uncomplicated, pediatric traumatic brain injury study. *J Int Neuropsychol Soc*. 2013;19(2):145–154.

Berz K, Divine J, Foss KB, Heyl R, Ford KR, Myer GD. Sex-specific differences in the severity of symptoms and recovery rate following sports-related concussion in young athletes. *Physician Sportsmed*. 2013;41(2):58–63.

Bonfield CM, Lam S, Lin Y, Greene S. The impact of attention deficit hyperactivity disorder on recovery from mild traumatic brain injury. *J Neurosurg*. 2013;Pediatrics(2):97–102.

Brooks BL, McKay CD, Mrazik M, Barlow KM, Meeuwisse WH, Emery CA. Subjective, but not Objective, Lingering Effects of Multiple Past Concussions in Adolescents. *J Neurotrauma*. 2013;30(17):1469–1475.

Castile L, Collins CL, McIlvain NM, Comstock RD. The epidemiology of new versus recurrent sports concussions among high school athletes, 2005-2010. *Br J Sports Med*. 2012;46(8):603–610.

Colvin AC, Mullen J, Lovell MR, West R V, Collins MW, Groh M. The role of concussion history and gender in recovery from soccer-related concussion. *Am J Sports Med*. 2009;37(9):1699–1704.

de Kruijk J. Prediction of post-traumatic complaints after mild traumatic brain injury: Early symptoms and biochemical markers. *J Neurol Neurosurg Psychiatry*. 2002;73(6):727–732.

Eisenberg MA, Andrea J, Meehan W, Mannix R. Time interval between concussions and symptom duration. *Pediatrics*. 2013;132(1):8–17.

Fay TB, Yeates KO, Taylor HG, et al. Cognitive reserve as a moderator of postconcussive symptoms in children with complicated and uncomplicated mild traumatic brain injury. *J Int Neuropsychol Soc*. 2010;16(1):94–105.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Ilie G, Mann RE, Boak A, Adlaf EM, Hamilton H, et al. Suicidality, Bullying and Other Conduct and Mental Health Correlates of Traumatic Brain Injury in Adolescents. *PLoS ONE.* 2014;9(4):e94936.

Iverson GL, Gaetz M, Lovell MR, Collins MW. Relation between subjective fogginess and neuropsychological testing following concussion. *J Int Neuropsychol Soc*. 2004;10(6):904–906.

Kirkwood MW, Yeates KO, Randolph C, Kirk JW. The implications of symptom validity test failure for ability-based test performance in a pediatric sample. *Psychol Assess*. 2012;24(1):36–45.

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.

Lau BC, Kontos AP, Collins MW, Mucha A, Lovell MR. Which on-field signs/symptoms predict protracted recovery from sport-related concussion among high school football players? *Am J Sports Med*. 2011;39(11):2311–2318.

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*. 2008;Pediatrics(6):461–470.

Makdissi M, Davis G, Jordan B, Patricios J, Purcell L, Putukian M. Revisiting the modifiers: how should the evaluation and management of acute concussions differ in specific groups? *Br J Sports Med*. 2013;47(5):314–320.

Massagli TL, Fann JR, Burington BE, Jaffe KM, Katon WJ, Thompson RS. Psychiatric illness after mild traumatic brain injury in children. *Arch Phys Med Rehabil*. 2004;85(9):1428–1434.

McClincy MP, Lovell MR, Pardini J, Collins MW, Spore MK. Recovery from sports concussion in high school and collegiate athletes. *Brain Inj*. 2006;20(1):33–39.

McCrea M, Kelly JP, Randolph C, Cisler R, Berger L. Immediate neurocognitive effects of concussion. *Neurosurgery*. 2002;50(5):1032–1040.

McCrea M, Guskiewicz K, Randolph C, Barr WB, Hammeke TA, Marshall SW, Powell MR, Woo Ahn K, Wang Y, Kelly JP. Incidence, clinical course, and predictors of prolonged recovery time following sport-related concussion in high school and college athletes. *J Int Neuropsychol Soc.* 2013;19(1):22-33.

McKinlay A, Grace R, Horwood J, Fergusson D, MacFarlane M. Adolescent psychiatric symptoms following preschool childhood mild traumatic brain injury: evidence from a birth cohort. *J Head Trauma Rehabil*. 2009;24(3):221–227.

McKinlay A, Grace RC, Horwood LJ, Fergusson DM, MacFarlane MR. Long-term behavioural outcomes of pre-school mild traumatic brain injury. *Child Care, Heal Dev*. 2010;36(1):22–30.

McNally KA, Bangert B, Dietrich A, et al. Injury versus noninjury factors as predictors of postconcussive symptoms following mild traumatic brain injury in children. *Neuropsychology*. 2013;27(1):1–12.

Olsson KA, Lloyd OT, Lebrocque RM, McKinlay L, Anderson VA, Kenardy JA. Predictors of child post-concussion symptoms at 6 and 18 months following mild traumatic brain injury. *Brain Inj*. 2013;27(2):145–157.

Pellman EJ, Lovell MR, Viano DC, Casson IR. Concussion in professional football: Recovery of NFL and high school athletes assessed by computerized neuropsychological testing - Part 12. *Neurosurgery*. 2006;58(2):263–272.

Piland SG, Motl RW, Guskiewicz KM, McCrea M, Ferrara MS. Structural validity of a self-report concussion-related symptom scale. *Med Sci Sport Exerc*. 2006;38(1):27–32.

Ponsford J, Willmott C, Rothwell A, et al. Cognitive and behavioral outcome following mild traumatic head injury in children. *J Head Trauma Rehabil*. 1999;14(4):360–372.

Randolph C, Millis S, Barr WB, et al. Concussion Symptom Inventory: An empirically derived scale for monitoring resolution of symptoms following sport-related concussion. *Arch Clin Neuropsychol*. 2009;24(3):219–229.

Sandel NK, Lovell MR, Kegel NE, Collins MW, Kontos AP. The relationship of symptoms and neurocognitive performance to perceived recovery from sports-related concussion among adolescent athletes. *Appl Neuropsychol*. 2013;Child. 2(1):64–69.

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

Taylor HG, Dietrich A, Nuss K, et al. Post-concussive symptoms in children with mild traumatic brain injury. *Neuropsychology*. 2010;24(2):148–159.

Yeates KO, Taylor HG, Rusin J, et al. Longitudinal trajectories of postconcussive symptoms in children with mild traumatic brain injuries and their relationship to acute clinical status. *Pediatrics*. 2009;123(3):735–743.

Yeates KO, Taylor HG, Rusin J, et al. Premorbid child and family functioning as predictors of post-concussive symptoms in children with mild traumatic brain injuries. *Int J Dev Neurosci*. 2012;30(3):231–237.

Zemek RL, Farion KJ, Sampson M, McGahern C. Prognosticators of persistent symptoms following pediatric concussion: a systematic review. *JAMA Pediatr*. 2013;167(3):259–65.

Zuckerman SL, Lee YM, Odom MJ, Solomon GS, Forbes JA, Sills AK. Recovery from sports-related concussion: Days to return to neurocognitive baseline in adolescents versus young adults. *Surg Neurol Int*. 2012;3:130. doi:10.4103/2152-7806.102945.

5.2: Make sure the child/adolescent is not taking any medication that might mask or modify the symptoms.

Level B

McCrory P1, Meeuwisse WH, Aubry M, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Br J Sports Med.* 2013;47(5):250-8.

5.3: Assess, document and manage significant, prolonged complaints based on specific symptoms, etiology and the time since injury.

Level B

Barlow KM, Crawford S, Stevenson A, Sandhu SS, Belanger F, Dewey D. Epidemiology of Postconcussion Syndrome in Pediatric Mild Traumatic Brain Injury. *Pediatrics*. 2010;126(2):e374–e381.

Blinman TA, Houseknecht E, Snyder C, Wiebe DJ, Nance ML. Postconcussive symptoms in hospitalized pediatric patients after mild traumatic brain injury. *J Pediatr Surg*. 2009;44(6):1223–1228.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Ilie G, Mann RE, Boak A, Adlaf EM, Hamilton H, et al. Suicidality, Bullying and Other Conduct and Mental Health Correlates of Traumatic Brain Injury in Adolescents. *PLoS ONE.* 2014;9(4):e94936.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

Sady MD, Vaughan CG, Gioia GA. Psychometric Characteristics of the Postconcussion Symptom Inventory in Children and Adolescents. *Arch Clin Neuropsychol.* 2014 Apr15. [Epub ahead of print]

Taylor HG, Dietrich A, Nuss K, et al. Post-concussive symptoms in children with mild traumatic brain injury. *Neuropsychology*. 2010;24(2):148–159.

Yeates KO, Taylor HG, Rusin J, et al. Premorbid child and family functioning as predictors of post-concussive symptoms in children with mild traumatic brain injuries. *Int J Dev Neurosci*. 2012;30(3):231–237.

Zemek RL, Farion KJ, Sampson M, McGahern C. Prognosticators of persistent symptoms following pediatric concussion: a systematic review. *JAMA Pediatr*. 2013;167(3):259–65.

5.4a(i): Place every child/adolescent on a program of sleep hygiene.

Level C

5.4a(ii): Screen for factors that may influence the child/adolescent's sleep/wake cycle.

Level B

Blinman TA, Houseknecht E, Snyder C, Wiebe DJ, Nance ML. Postconcussive symptoms in hospitalized pediatric patients after mild traumatic brain injury. *J Pediatr Surg*. 2009;44(6):1223–1228.

Kaufman Y, Tzischinsky O, Epstein R, Etzioni A, Lavie P, Pillar G. Long-term sleep disturbances in adolescents after minor head injury. *Pediatr Neurol*. 2001;24(2):129–134.

5.4a(iii): Consider non-pharmacological treatments to improve sleep.

Level C

5.4a(iv): Consider prescribing medication on a short-term basis if sleep has not improved.

Level C

5.4a(v): Refer the child/adolescent to a pediatric sleep specialist if sleep has not improved.

Level C

5.4b(i): Take a history of any headaches.

Level B

Babikian T, Satz P, Zaucha K, Light R, Lewis RS, Asarnow RF. The UCLA longitudinal study of neurocognitive outcomes following mild pediatric traumatic brain injury. *J Int Neuropsychol Soc*. 2011;17(5):886–895.

Bonfield CM, Lam S, Lin Y, Greene S. The impact of attention deficit hyperactivity disorder on recovery from mild traumatic brain injury. *J Neurosurg*. 2013;Pediatrics(2):97–102.

Broglio SP, Eckner JT, Surma T, Kutcher JS. Post-concussion cognitive declines and symptomatology are not related to concussion biomechanics in high school football players. *J Neurotrauma*. 2011;28(10):2061–2068.

Kuczynski A, Crawford S, Bodell L, Dewey D, Barlow KM. Characteristics of post-traumatic headaches in children following mild traumatic brain injury and their response to treatment: a prospective cohort. *Dev Med Child Neurol*. 2013;55(7):636–641.

Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

5.4b(ii): Establish the degree and duration of the disability that the headaches cause.

Level B

Bonfield CM, Lam S, Lin Y, Greene S. The impact of attention deficit hyperactivity disorder on recovery from mild traumatic brain injury. *J Neurosurg*. 2013;Pediatrics(2):97–102.

Kuczynski A, Crawford S, Bodell L, Dewey D, Barlow KM. Characteristics of post-traumatic headaches in children following mild traumatic brain injury and their response to treatment: a prospective cohort. *Dev Med Child Neurol*. 2013;55(7):636–641.

Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

5.4b(iii): Perform a neurological exam and a head/neck exam.

Level C

5.4b(iv): Consider non-pharmacological, complementary and/or alternative medicine therapies for headache.

Level C

5.4b(v): Consider treating migraine headaches with prescription medication.

Level B

Kuczynski A, Crawford S, Bodell L, Dewey D, Barlow KM. Characteristics of post-traumatic headaches in children following mild traumatic brain injury and their response to treatment: a prospective cohort. *Dev Med Child Neurol*. 2013;55(7):636–641.

5.4c(i): Assess for persistent cognitive difficulties.

Level B

Anderson V, Catroppa C, Morse S, Haritou F, Rosenfeld J. Outcome from mild head injury in young children: A prospective study. *J Clin Exp Neuropsychol*. 2001;23(6):705–717.

Babikian T, McArthur D, Asarnow RF. Predictors of 1-month and 1-year neurocognitive functioning from the UCLA longitudinal mild, uncomplicated, pediatric traumatic brain injury study. *J Int Neuropsychol Soc*. 2013;19(2):145–154.

Bonfield CM, Lam S, Lin Y, Greene S. The impact of attention deficit hyperactivity disorder on recovery from mild traumatic brain injury. *J Neurosurg*. 2013;Pediatrics(2):97–102.

Gagnon I, Swaine B, Friedman D, Forget R. Children show decreased dynamic balance after mild traumatic brain injury. *Arch Phys Med Rehabil*. 2004;85(3):444–452.

Moser RS, Schatz P, Jordan BD. Prolonged effects of concussion in high school athletes. *Neurosurgery*. 2005;57(2):300–306.

Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

Sandel NK, Lovell MR, Kegel NE, Collins MW, Kontos AP. The relationship of symptoms and neurocognitive performance to perceived recovery from sports-related concussion among adolescent athletes. *Appl Neuropsychol*. 2013;Child. 2(1):64–69.

Sroufe NS, Fuller DS, West BT, Singal BM, Warschausky SA, Maio RF. Postconcussive symptoms and neurocognitive function after mild traumatic brain injury in children. *Pediatrics*. 2010;125(6):e1331–e1339.

Yeates KO, Luria J, Bartkowski H, Rusin J, Martin L, Bigler ED. Postconcussive symptoms in children with mild closed head injuries. *J Head Trauma Rehabil*. 1999;14(4):337–350.

5.4c(ii): Manage any cognitive impairments.

Level B

Bonfield CM, Lam S, Lin Y, Greene S. The impact of attention deficit hyperactivity disorder on recovery from mild traumatic brain injury. *J Neurosurg*. 2013;Pediatrics(2):97–102.

Moser RS, Schatz P, Jordan BD. Prolonged effects of concussion in high school athletes. *Neurosurgery*. 2005;57(2):300–306.

5.4d(i): Assess for balance and vestibular impairments.

Level B

Aligene K1, Lin E. Vestibular and balance treatment of the concussed athlete. *NeuroRehabilitation*. 2013;32(3):543-53.

Gagnon I, Forget R, Sullivan SJ, Friedman D. Motor performance following a mild traumatic brain injury in children: an exploratory study. *Brain Inj*. 1998;12(10):843–853.

Gagnon I, Swaine B, Friedman D, Forget R. Visuomotor response time in children with a mild traumatic brain injury. *J Head Trauma Rehabil*. 2004;19(5):391–404.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

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

5.4d(ii): Assess for benign positional vertigo.

Level B

Aligene K1, Lin E. Vestibular and balance treatment of the concussed athlete. *NeuroRehabilitation*. 2013;32(3):543-53.

Gagnon I, Forget R, Sullivan SJ, Friedman D. Motor performance following a mild traumatic brain injury in children: an exploratory study. *Brain Inj*. 1998;12(10):843–853.

Gagnon I, Swaine B, Friedman D, Forget R. Visuomotor response time in children with a mild traumatic brain injury. *J Head Trauma Rehabil*. 2004;19(5):391–404.

5.4d(iii): Refer for further assessment and treatment if balance and/or vestibular system are dysfunctional.

Level B

Aligene K1, Lin E. Vestibular and balance treatment of the concussed athlete. *NeuroRehabilitation*. 2013;32(3):543-53.

Gagnon I, Forget R, Sullivan SJ, Friedman D. Motor performance following a mild traumatic brain injury in children: an exploratory study. *Brain Inj*. 1998;12(10):843–853.

Gagnon I, Swaine B, Friedman D, Forget R. Visuomotor response time in children with a mild traumatic brain injury. *J Head Trauma Rehabil*. 2004;19(5):391–404.

5.4e(i): Assess ongoing vision dysfunctions.

Level B

Brosseau-Lachaine O, Gagnon I, Forget R, Faubert J. Mild traumatic brain injury induces prolonged visual processing deficits in children. *Brain Inj*. 2008;22(9):657–668.

Gagnon I, Swaine B, Friedman D, Forget R. Visuomotor response time in children with a mild traumatic brain injury. *J Head Trauma Rehabil*. 2004;19(5):391–404.

5.4e(ii): Refer children/adolescents who have changes in functional vision to a specialist.

Level B

Brosseau-Lachaine O, Gagnon I, Forget R, Faubert J. Mild traumatic brain injury induces prolonged visual processing deficits in children. *Brain Inj*. 2008;22(9):657–668.

Gagnon I, Swaine B, Friedman D, Forget R. Visuomotor response time in children with a mild traumatic brain injury. *J Head Trauma Rehabil*. 2004;19(5):391–404.

5.4f(i): Assess and manage persistent fatigue if it is a significant symptom.

Level B

Blinman TA, Houseknecht E, Snyder C, Wiebe DJ, Nance ML. Postconcussive symptoms in hospitalized pediatric patients after mild traumatic brain injury. *J Pediatr Surg*. 2009;44(6):1223–1228.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

5.4g(i): Assess for existing and new mental health symptoms and disorders.

Level B

Bonfield CM, Lam S, Lin Y, Greene S. The impact of attention deficit hyperactivity disorder on recovery from mild traumatic brain injury. *J Neurosurg*. 2013;Pediatrics(2):97–102.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Harvey AG, Bryant RA. Acute stress disorder after mild traumatic brain injury. *J Nerv Ment Dis*. 1998;186(6):333–337.

Ilie G, Mann RE, Boak A, Adlaf EM, Hamilton H, et al. Suicidality, Bullying and Other Conduct and Mental Health Correlates of Traumatic Brain Injury in Adolescents. *PLoS ONE.* 2014;9(4):e94936.

Kaldoja ML, Kolk A. Social-emotional behaviour in infants and toddlers with mild traumatic brain injury. *Brain Inj*. 2012;26(7-8):1005–1013.

Massagli TL, Fann JR, Burington BE, Jaffe KM, Katon WJ, Thompson RS. Psychiatric illness after mild traumatic brain injury in children. *Arch Phys Med Rehabil*. 2004;85(9):1428–1434.

Max JE, Schachar RJ, Landis J, Bigler ED, Wilde EA, Saunders AE, Ewing-Cobbs L, Chapman SB, Dennis M, Hanten G, Levin HS. Psychiatric disorders in children and adolescents in the first six months after mild traumatic brain injury. *J Neuropsychiatry Clin Neurosci.* 2013;25(3):187-97.

McKinlay A, Grace R, Horwood J, Fergusson D, MacFarlane M. Adolescent psychiatric symptoms following preschool childhood mild traumatic brain injury: evidence from a birth cohort. *J Head Trauma Rehabil*. 2009;24(3):221–227.

McKinlay A, Grace RC, Horwood LJ, Fergusson DM, MacFarlane MR. Long-term behavioural outcomes of pre-school mild traumatic brain injury. *Child Care, Heal Dev*. 2010;36(1):22–30.

Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

Sabini RC, Reddy CC. Concussion management and treatment considerations in the adolescent population. *Physician Sportsmed*. 2010;38(1):139–146.

Yeates KO, Luria J, Bartkowski H, Rusin J, Martin L, Bigler ED. Postconcussive symptoms in children with mild closed head injuries. *J Head Trauma Rehabil*. 1999;14(4):337–350.

5.4g(ii): Ask the child/adolescent and parents and/or caregivers to report on mood and feelings.

Level B

Barlow M, Schlabach D, Peiffer J, Cook C. Differences in change scores and the predictive validity of three commonly used measures following concussion in the middle school and high school aged population. *Int J Sports Phys Ther*. 2011;6(3):150–157.

Bonfield CM, Lam S, Lin Y, Greene S. The impact of attention deficit hyperactivity disorder on recovery from mild traumatic brain injury. *J Neurosurg*. 2013;Pediatrics(2):97–102.

Ganesalingam K, Yeates KO, Ginn MS, et al. Family burden and parental distress following mild traumatic brain injury in children and its relationship to post-concussive symptoms. *J Pediatr Psychol*. 2008;33(6):621–629.

Ilie G, Mann RE, Boak A, Adlaf EM, Hamilton H, et al. Suicidality, Bullying and Other Conduct and Mental Health Correlates of Traumatic Brain Injury in Adolescents. *PLoS ONE.* 2014;9(4):e94936.

Piland SG, Motl RW, Guskiewicz KM, McCrea M, Ferrara MS. Structural validity of a self-report concussion-related symptom scale. *Med Sci Sport Exerc*. 2006;38(1):27–32.

Randolph C, Millis S, Barr WB, et al. Concussion Symptom Inventory: An empirically derived scale for monitoring resolution of symptoms following sport-related concussion. *Arch Clin Neuropsychol*. 2009;24(3):219–229.

Sady MD, Vaughan CG, Gioia GA. Psychometric Characteristics of the Postconcussion Symptom Inventory in Children and Adolescents. *Arch Clin Neuropsychol.* 2014 Apr15. [Epub ahead of print]

5.4g(iii): Treat any mental health symptoms.

Level B

Bonfield CM, Lam S, Lin Y, Greene S. The impact of attention deficit hyperactivity disorder on recovery from mild traumatic brain injury. *J Neurosurg*. 2013;Pediatrics(2):97–102.

Chew E, Zafonte RD. Pharmacological management of neurobehavioral disorders following traumatic brain injury--a state-of-the-art review. *J Rehabil Res Dev.* 2009;46(6):851-79.

Ilie G, Mann RE, Boak A, Adlaf EM, Hamilton H, et al. Suicidality, Bullying and Other Conduct and Mental Health Correlates of Traumatic Brain Injury in Adolescents. *PLoS ONE.* 2014;9(4):e94936.

Silver JM, McAllister TW, Arciniegas DB. Depression and cognitive complaints following mild traumatic brain injury. *Am J Psychiatry.* 2009;166(6):653-61.

5.4g(iv): Consider referring to a specialist with experience in pediatric mental health.

Level B

Ilie G, Mann RE, Boak A, Adlaf EM, Hamilton H, et al. (2014) Suicidality, Bullying and Other Conduct and Mental Health Correlates of Traumatic Brain Injury in Adolescents. PLoS ONE 9(4): e94936. doi:10.1371/journal.pone.0094936

5.5: Recommend rehabilitation therapy to improve symptoms and mobility as needed.

Level B

Leddy JJ, Kozlowski K, Donnelly JP, Pendergast DR, Epstein LH, Willer B. A preliminary study of subsymptom threshold exercise training for refractory post-concussion syndrome. *Clin J Sport Med.* 2010;20(1):21-7.

Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

5.6: Consider a broad differential diagnosis.

Level C

5.7: Consider the need for specialized therapy if symptoms persist.

Level B

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Jonsson C, Andersson EE. Mild traumatic brain injury: a description of how children and youths between 16 and 18 years of age perform leisure activities after 1 year. *Dev Neurorehabil*. 2013;16(1):1–8.

Kuczynski A, Crawford S, Bodell L, Dewey D, Barlow KM. Characteristics of post-traumatic headaches in children following mild traumatic brain injury and their response to treatment: a prospective cohort. *Dev Med Child Neurol*. 2013;55(7):636–641.

Vidal PG, Goodman AM, Colin A, Leddy JJ, Grady MF. Rehabilitation strategies for prolonged recovery in pediatric and adolescent concussion. *Pediatr Ann*. 2012;41(9):1–7.

5.8: Work with the child/adolescent's primary care professional, school and/or employer regarding accommodations needed to tasks or schedules.

Level B

Harvey AG, Bryant RA. Acute stress disorder after mild traumatic brain injury. *J Nerv Ment Dis*. 1998;186(6):333–337.

Yard EE, Comstock RD. Compliance with return to play guidelines following concussion in US high school athletes, 2005-2008. *Brain Inj*. 2009;23(11):888–898.

5.9: Assess and treat any physical, cognitive and neurological deficits.

Level B

Bassett SS, Slater EJ. Neuropsychological function in adolescents sustaining mild closed head injury. *J Pediatr Psychol*. 1990;15(2):225–236.

Blinman TA, Houseknecht E, Snyder C, Wiebe DJ, Nance ML. Postconcussive symptoms in hospitalized pediatric patients after mild traumatic brain injury. *J Pediatr Surg*. 2009;44(6):1223–1228.

Borg J, Holm L, Cassidy JD, et al. Diagnostic procedures in mild traumatic brain injury: results of the WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury. *J Rehabil Med*. 2004;(43 Suppl):61–75.

Collins MW, Iverson GL, Lovell MR, McKeag DB, Norwig J, Maroon J. On-field predictors of neuropsychological and symptom deficit following sports-related concussion. *Clin J Sport Med*. 2003;13(4):222–229.

Furman GR, Lin CC, Bellanca JL, Marchetti GF, Collins MW, Whitney SL. Comparison of the balance accelerometer measure and balance error scoring system in adolescent concussions in sports. *Am J Sports Med*. 2013;41(6):1404–1410.

Gioia GA, Collins M, Isquith PK. Improving identification and diagnosis of mild traumatic brain injury with evidence: psychometric support for the acute concussion evaluation. *J Head Trauma Rehabil*. 2008;23(4):230–242.

Grubenhoff JA, Kirkwood M, Gao D, Deakyne S, Wathen J. Evaluation of the standardized assessment of concussion in a pediatric emergency department. *Pediatrics*. 2010;126(4):688–695.

Grubenhoff JA, Kirkwood MW, Deakyne S, Wathen J. Detailed concussion symptom analysis in a paediatric ED population. *Brain Inj*. 2011;25(10):943–949.

Guideline Summary: Care of the patient with mild traumatic brain injury. [American Association of Neuroscience Nurses] 42. *info@guideline.gov (NGC)*. 2011.

Guidelines for mild traumatic brain injury following closed head injury. Acute/Post-acute Assessment and Management. *Clin Pract Guidel Portal*. 2008.

Kontos AP, Covassin T, Elbin RJ, Parker T. Depression and neurocognitive performance after concussion among male and female high school and collegiate athletes. *Arch Phys Med Rehabil*. 2012;93(10):1751–1756.

Lau BC, Kontos AP, Collins MW, Mucha A, Lovell MR. Which on-field signs/symptoms predict protracted recovery from sport-related concussion among high school football players? *Am J Sports Med*. 2011;39(11):2311–2318.

McCrea M, Kelly JP, Randolph C, et al. Standardized assessment of concussion (SAC): on-site mental status evaluation of the athlete. *J Head Trauma Rehabil*. 1998;13(2):27–35.

McCrea M, Kelly JP, Randolph C, Cisler R, Berger L. Immediate neurocognitive effects of concussion. *Neurosurgery*. 2002;50(5):1032–1040.

Mihalik JP, Stump JE, Collins MW, Lovell MR, Field M, Maroon JC. Posttraumatic migraine characteristics in athletes following sports-related concussion. *J Neurosurg*. 2005;102(5):850–855.

Ponsford J, Willmott C, Rothwell A, et al. Cognitive and behavioral outcome following mild traumatic head injury in children. *J Head Trauma Rehabil*. 1999;14(4):360–372.

Rotarescu V, Ciurea AV. Quality of Life in Children after Mild Traumatic Brain Injury. *Journal of Medicine and Life* 2008, 1(3):307-22.

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

Thomas DG, Collins MW, Saladino RA, Frank V, Raab J, Zuckerbraun NS. Identifying neurocognitive deficits in adolescents following concussion. *Acad Emerg Med*. 2011;18(3):246–254.

Valovich TC, Perrin DH, Gansneder BM. Repeat administration elicits a practice effect with the Balance Error Scoring System but not with the Standardized Assessment of Concussion in high school athletes. *J Athl Train*. 2003;38(1):51–56.

Vos P. Mild traumatic brain injury. *Eur J Neurol*. 2012;19(2):191–198.

Yeates KO, Kaizar E, Rusin J, et al. Reliable change in postconcussive symptoms and its functional consequences among children with mild traumatic brain injury. *Arch Pediatr Adolesc Med*. 2012;166(7):615–622.

Appendix 1: Search Strategy for Systematic Review

Medline

- exp Brain Concussion/.
- Post-Concussion Syndrome/.
- (concuss$ or postconcuss$).tw.
- (commotio cerebri or post traumatic encephalopathy).tw.
- ((post commotion or post contusion or post head injury) adj2 syndrome*).tw.
- ((mild or minor or minimal) adj (traumatic brain or tbi)).tw.
- mtbi.tw.
- exp Brain Injuries/.
- ((post or persistent or unresolved or delayed) adj4 (brain or skull or head or injury)).mp.
- 8 and 9.
- or/1-7,10.
- (((severe or moderate) adj2 (head or brain or traumatic or tbi)) not (mild or minor)).ti.
- 11 not 12.
- 13 and (child* or adolescent or infan*).mp.
- 14 not (animal/ not human/).
- limit 15 to English.
- limit 27 to yr="1985 -Current".

Embase

- Brain Concussion/ or Concussion/.
- Post-Concussion Syndrome/.
- (concuss$ or postconcuss$).tw.
- (commotio cerebri or post traumatic encephalopathy).tw.
- ((Post commotion or post contusion or post head injury) adj2 syndrome$).tw.
- ((mild or minor or minimal) adj (traumatic brain or tbi)).tw.
- mtbi.tw.
- exp Brain Injury/.
- ((post or persistent or unresolved or delayed) adj4 (brain or skull or head or injury)).mp.
- (((severe or moderate) adj2 (head or brain or traumatic or tbi)) not (mild or minor)).ti.
- (8 and 9) not 10.
- or/1-7,11.
- 12 and (child* or adolescent or infan*).mp.
- exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/.
- 14 not exp human/.
- 13 not 15.
- limit 16 to English.
- limit 17 to yr="1985 -Current".

CINAHL

- (MH "Brain Concussion+" OR TX concuss* or postconcuss* OR TX commotio cerebri OR TX post traumatic encephalopathy OR post head injury N3 syndrome* or post contusion N3 syndrome* or post commotion N3 syndrome* OR TX Mild traumatic brain or TX minor traumatic brain or TX minimal traumatic brain or TX mild tbi or TX minor tbi or TX minimal tbi OR TX mtbi) AND (child* or adolescent or infan*).
- Limiters: Published Date from: 19850101-20141231;English Language.

PsycInfo

- brain concussion/.
- (concuss* or postconcuss*).tw.
- (commotio cerebri or post traumatic encephalopathy).tw.
- ((post commotion or post contusion or post head injury) adj2 syndrome*).tw.
- ((mild or minor or minimal) adj (traumatic brain or tbi)).tw.
- mtbi.tw.
- traumatic brain injury/.
- ((post or persistent or unresolved or delayed) adj4 (brain or skull or head or injury)).mp.
- 7 and 8.
- or/1-6,9.
- limit 10 to (childhood or adolescence <13 to 17 years>).
- (Infan* or newborn* or new-born* or perinat* or neonat* or baby or baby* or babies or toddler* or minors or minors* or boy or boys or boyfriend or boyhood or girl* or kid or kids or child or child* or children* or schoolchild* or schoolchild).mp. or school child.ti,ab. or school child*.ti,ab. or (adolescen* or juvenil* or youth* or teen* or under*age* or pubescen*).mp. or exp pediatrics/ or (pediatric* or paediatric* or peadiatric*).mp. or school.ti,ab. or school*.ti,ab. or (prematur* or preterm*).mp.
- 10 and 12.
- 11 or 13.
- limit 14 to English language.
- limit 15 to yr="1985 -Current".

SportDiscus

- (DE "BRAIN -- Concussion" OR DE "POSTCONCUSSION syndrome").
- Limiters: Published Date: 19850101-20141231; Language: English; Publication Type: Journal Article, Serial publication.

TRIP

- ("m* traumatic brain injury").
- (concussion).
- (pediatric* or paediatric* or child* or adolesc*) from:1985.
- Search in full document.
- Guidelines selected.

CENTRAL

- (concuss$ or postconcuss$).tw.
- (commotio cerebri or post traumatic encephalopathy).tw.
- ((post commotion or post contusion or post head injury) adj2 syndrome*).tw.
- mtbi.tw.
- or/1-4.
- (Infan* or newborn* or new-born* or perinat* or neonat* or baby or baby* or babies or toddler* or minors or minors* or boy or boys or boyfriend or boyhood or girl* or kid or kids or child or child* or children* or schoolchild* or schoolchild).mp. or school child.ti,ab. or school child*.ti,ab. or (adolescen* or juvenil* or youth* or teen* or under*age* or pubescen*).mp. or exp pediatrics/ or (pediatric* or paediatric* or peadiatric*).mp. or school.ti,ab. or school*.ti,ab. or (prematur* or preterm*).mp.
- 5 and 6.
- limit 7 to yr="1985 -Current".
- (three non-English records were removed in Reference Mananger).