
SOLVING THE CONCUSSION CRISIS: PRACTICAL SOLUTIONS

(Consensus - 2015)



Chair: Neilank K Jha MD

Senior Advisors: Robert Cantu MD, Thomas Gennarelli MD, Charles Tator CM MD PhD

Sports Advisors: Julian E Bailes MD, Christopher Giza MD, Vernon Williams MD, Elizabeth Pieroth PsyD, Lisa Fischer MD, Samuel Gandy MD PhD

Multi-Disciplinary Advisory Team: Steve Devick OD, Vincenzo S Basile MD

MSc, Michael J Ellis MD FRCS, Rosemarie Scolaro Moser PhD ABN ABPP-RP, Gary W Small MD, Adam Raikes MS LAT ATC, Stefan Bulfon DC BSc CSCS, Sylvia Boddener OT CHT GDM MBA, Jason P Mihalik PhD CATC ATC, Lesley Ritchie PhD C.Psych

Scientific Advisory Team: Anthony Kontos PhD, Eric Massicotte MD MSc FRCS, Kevin Hrusovsky BS MBA ScD, Patrick Neary BEd MA PhD, Alain Ptito PhD,

Philip Schatz PhD, Christopher M Butt PhD, Dara L Dickstein PhD

Policy Advisors: Gillian Hotz PhD, Pierre Frémont MD PhD, Louise Logan BA (Hons) JD, John Mandarino

Legal Advisory: Al Pace LLB, Paul Mazza LLB, Alexander Voudouris LLB

Stakeholders: Tanya Morton, Stephanie Mester, Candace Atherton

This white paper is an international collaborative effort to address concussion management, science, policy and future directions. This article is driven by data and rooted in science. There has been no sponsorship or financial interest influencing the development of this statement of agreement. This consensus statement will be constantly updated based on advances in science.

These efforts aim to provide much needed direction for concussion management rendered by school boards, workers' compensation boards, amateur and professional sporting associations, as well as insurance providers and government.

The aforementioned groups are encouraged to strive towards the best medical practices outlined in this white paper. Concussed individuals may reference this policy paper when advocating for care.

TENETS OF A CONCUSSION:

- Concussion is a Traumatic Brain Injury (1-3).
- CT scans are normal (3-7).
- No loss of consciousness in up to 90% of cases (8-10).
- Do not need to hit your head (3, 5, 6).

Up to 90% recover in 1-2 weeks (11-16).

~ 10% > 2 weeks.

- Pediatric populations may take longer to recover.

May present with cognitive, emotional, physical symptoms and sleep disturbances (17-27).

There may be symptoms corresponding to injury to the frontal, temporal, parietal and occipital lobes, cerebellum, brain stem and cranial nerves resulting in a constellation of symptoms that differ from individual to individual (16, 26, 28-31).

Concussion is a clinical diagnosis with the aid of the following:

- History (mechanism of injury and previous injury history).
- Symptom checklist (13, 32-37).
- Focused exam (neurological, cervical, balance testing, vestibular, visual, exertion) (29, 38-41).
- Neurocognitive testing (10, 21, 31-33, 36, 40, 42-54).

Education and early guidance following a concussion may reduce the duration of symptoms (11, 17, 23, 39, 55-59).

Protecting the concussed individual from repeat injury is of paramount importance (14, 21, 57, 60-62).



History of prior concussion may be associated with a higher rate of a subsequent concussion and prolonged duration of symptoms (14, 60-69).

Levels of physical and cognitive activity that exacerbate concussion symptoms may be associated with prolonged recovery (27, 32, 57, 70-74).

Chronic neurocognitive impairment is reported in some professional athletes with repetitive head injuries (14, 19, 20, 25, 75-78).

For the purposes of this white paper, a concussion specialist is defined as a licensed health care professional with training and experience in concussion management who adheres to the aforementioned tenets of a concussion and sees a sufficiently high volume of cases.

A concussion specialist is a key member of the multi-disciplinary care (MDC) team on complex cases and communicates with certified athletic trainers, athletic associations, school boards, workers' compensation boards, insurance adjusters and other licensed health care professionals as required in advocating for the concussed individual.

Medical reports, workers' compensation board, school board and insurance assessments that are inconsistent with the tenets of a concussion outlined in this paper should be reassessed.

PROFESSIONAL SPORTS LEAGUES:

CTE (Chronic Traumatic Encephalopathy):

In the absence of prospective trials with proper design and methodology, we are currently unable to make a determination on the risk and incidence of CTE in professional athletes (61, 62, 69, 79-82).

However, despite the lack of data, the professional sports leagues should be encouraged to continue with their efforts to advance concussion education, management and research.

It is incumbent upon the medical and scientific community to work with the leagues to protect past, current and future players while maintaining the value of athletic participation. The following 5-point plan is a first step in solving the concussion crisis in sports:

- 1) Education and prevention surrounding concussions at the grassroots level amongst children as a joint project between the medical community, league and the players association as a measure to prevent declining enrolment at all levels of sport.
- 2) MDC for all athletes suffering from Post-Concussive Syndrome (persistent symptoms of traumatic brain injury) (31, 83-86).
- 3) Ensure athletes are managed with the most up-to-date concussion protocols.
- 4) Include the current known risks of concussion in the existing education process for athletes, parents, coaches, and other stakeholders.
- 5) Continue to invest in concussion research and development beneficial to athletes in all sports, specifically in the areas of education, prevention, diagnostics, management and treatments.

WORKERS' COMPENSATION BOARDS:

- Recognize the tenets of a concussion.
- Develop and implement policies on education, prevention and awareness surrounding concussions.
- Facilitate prompt access to care via concussion specialist.
- Provide MDC for workers with prolonged symptoms.
- Return-to-work program with the guidance of a MDC team that includes a concussion specialist.



- Return-to-learn/play program and academic accommodations/modifications with the guidance of a MDC team that includes a concussion specialist (17, 55-58, 63, 70, 93).

GOVERNMENT:

- Recognize concussion as a public health issue.
- Recognize the tenets of a concussion.
- Develop and implement policies on education, prevention and awareness surrounding concussions.
- Facilitate prompt access to care via concussion specialist.
- Advocate for MDC for patients with prolonged symptoms.
- Expand funding in concussion research.

INSURANCE PROVIDERS:

- Recognize the tenets of a concussion.
- Develop and implement policies on education, prevention and awareness surrounding concussions.
- Fund access to care via concussion specialist.
- Provide MDC for patients with prolonged symptoms.

FUTURE OF CONCUSSION MANAGEMENT AND RESEARCH:

Private donors, foundations, corporations, granting agencies, governments, professional and amateur sports leagues, workers’ compensation boards, school boards and insurance providers are encouraged to participate in the following areas of clinical research:

• **PREVENTION:**

Invest in education, awareness, and prevention to reduce the incidence of concussions.

AMATEUR SPORTING ASSOCIATIONS:

- Recognize the tenets of a concussion.
- Develop and implement policies on education, prevention and awareness surrounding concussions (31, 84, 87, 88).
- Facilitate prompt access to care via concussion specialist.
- Advocate for MDC for athletes with prolonged symptoms.
- Return-to-play program with the guidance of a MDC team that includes a concussion specialist (18, 31, 84-86, 89-91).

SCHOOL BOARDS:

- Recognize the tenets of a concussion.
- Develop and implement policies on education, prevention and awareness surrounding concussions.
- Facilitate prompt access to care via concussion specialist.
- Advocate for MDC for students with prolonged symptoms (92).

- **DIAGNOSTICS:**

Improved validation of current diagnostic tools and further research in biomarkers, brain imaging and other diagnostic techniques in their clinical application in the management of concussion (94-96).

- **MANAGEMENT / TREATMENTS:**

Facilitate multi-centred prospective clinical trials evaluating the efficacy of existing and new potential management/treatments for concussion (59, 74, 97, 98).

ACKNOWLEDGEMENTS:

Megan MacQuarrie, Katherine Sung, Guillaume Cheung, Bianca DeBenedictis, Twayne Pereira, Cassandra Hogan, Juliana Iannuzziello, Rima Thapar, and Susur Lee.

References:

1. Carman AJ, Ferguson R, Cantu R, Comstock RD, Dacks PA, DeKosky ST, et al. Expert consensus document: Mind the gaps-advancing research into short-term and long-term neuropsychological outcomes of youth sports-related concussions. *Nature reviews Neurology*. 2015;11(4):230-44. doi: 10.1038/nrneurol.2015.30. PubMed PMID: 25776822.
2. Bazarian JJ, McClung J, Shah MN, Cheng YT, Flesher W, Kraus J. Mild traumatic brain injury in the United States, 1998--2000. *Brain injury*. 2005;19(2):85-91. PubMed PMID: 15841752.
3. McCrory P, Meeuwisse W, Aubry M, Cantu B, Dvorak J, Echemendia RJ, et al. Consensus statement on concussion in sport--the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*. 2013;23(2):89-117. doi: 10.1097/JSM.0b013e31828b67cf. PubMed PMID: 23478784.
4. McCrory P, Meeuwisse W, Johnston K, Dvorak J, Aubry M, Molloy M, et al. Consensus Statement on Concussion in Sport: the 3rd International Conference on Concussion in Sport held in Zurich, November 2008. *British journal of sports medicine*. 2009;43 Suppl 1:i76-90. doi: 10.1136/bjism.2009.058248. PubMed PMID: 19433429.
5. McCrory P, Johnston K, Meeuwisse W, Aubry M, Cantu R, Dvorak J, et al. Summary and agreement statement of the 2nd International Conference on Concussion in Sport, Prague 2004. *British journal of sports medicine*. 2005;39(4):196-204. doi: 10.1136/bjism.2005.018614. PubMed PMID: 15793085; PubMed Central PMCID: PMC1725173.
6. Aubry M, Cantu R, Dvorak J, Graf-Baumann T, Johnston K, Kelly J, et al. Summary and agreement statement of the First International Conference on Concussion in Sport, Vienna 2001. Recommendations for the improvement of safety and health of athletes who may suffer concussive injuries. *British journal of sports medicine*. 2002;36(1):6-10. PubMed PMID: 11867482; PubMed Central PMCID: PMC1724447.
7. Halstead ME, Walter KD, Council on Sports M, Fitness. American Academy of Pediatrics. Clinical report--sport-related concussion in children and adolescents. *Pediatrics*. 2010;126(3):597-615. doi: 10.1542/peds.2010-2005. PubMed PMID: 20805152.
8. Meehan WP, 3rd, d'Hemecourt P, Comstock RD. High school concussions in the 2008-2009 academic year: mechanism, symptoms, and management. *The American journal of sports medicine*. 2010;38(12):2405-9. doi: 10.1177/0363546510376737. PubMed PMID: 20716683; PubMed Central PMCID: PMC3120225.
9. Guskiewicz KM, Weaver NL, Padua DA, Garrett WE, Jr. Epidemiology of concussion in collegiate and high school football players. *The American journal of sports medicine*. 2000;28(5):643-50. PubMed PMID: 11032218.
10. McCrea M, Kelly JP, Randolph C, Cisler R, Berger L. Immediate neurocognitive effects of concussion. *Neurosurgery*. 2002;50(5):1032-40; discussion 40-2. PubMed PMID: 11950406.
11. Grubenhoff JA, Deakynne SJ, Brou L, Bajaj L, Comstock RD, Kirkwood MW. Acute concussion symptom severity and delayed symptom resolution. *Pediatrics*. 2014;134(1):54-62. doi: 10.1542/peds.2013-2988. PubMed PMID: 24958583.
12. Preiss-Farzanegan SJ, Chapman B, Wong TM, Wu J, Bazarian JJ. The relationship between gender and postconcussion symptoms after sport-related mild traumatic brain injury. *PM & R : the journal of injury, function, and rehabilitation*. 2009;1(3):245-53. doi: 10.1016/j.pmrj.2009.01.011. PubMed PMID: 19627902.
13. Meehan WP, 3rd, Mannix RC, Stracciolini A, Elbin RJ, Collins MW. Symptom severity predicts prolonged recovery after sport-related concussion, but age and amnesia do not. *The Journal of pediatrics*. 2013;163(3):721-5. doi: 10.1016/j.jpeds.2013.03.012. PubMed PMID: 23628374; PubMed Central PMCID: PMC3732501.
14. Guskiewicz KM, McCrea M, Marshall SW, Cantu RC, Randolph C, Barr W, et al. Cumulative effects associated with recurrent concussion in collegiate football players: the NCAA Concussion Study. *Jama*. 2003;290(19):2549-55. doi: 10.1001/jama.290.19.2549. PubMed PMID: 14625331.
15. Pellman EJ, Viano DC, Casson IR, Arfken C, Powell J. Con-

- cussion in professional football: injuries involving 7 or more days out--Part 5. *Neurosurgery*. 2004;55(5):1100-19. PubMed PMID: 15509317.
16. Ellis MJ, Leddy JJ, Willer B. Physiological, vestibulo-ocular and cervicogenic post-concussion disorders: an evidence-based classification system with directions for treatment. *Brain injury*. 2015;29(2):238-48. doi: 10.3109/02699052.2014.965207. PubMed PMID: 25314613.
 17. Ransom DM, Vaughan CG, Pratson L, Sady MD, McGill CA, Gioia GA. Academic effects of concussion in children and adolescents. *Pediatrics*. 2015;135(6):1043-50. doi: 10.1542/peds.2014-3434. PubMed PMID: 25963014.
 18. Cantu RC. Posttraumatic Retrograde and Anterograde Amnesia: Pathophysiology and Implications in Grading and Safe Return to Play. *Journal of athletic training*. 2001;36(3):244-8. PubMed PMID: 12937491; PubMed Central PMCID: PMC155413.
 19. Guskiewicz KM, Marshall SW, Bailes J, McCrea M, Cantu RC, Randolph C, et al. Association between recurrent concussion and late-life cognitive impairment in retired professional football players. *Neurosurgery*. 2005;57(4):719-26; discussion -26. PubMed PMID: 16239884.
 20. Guskiewicz KM, Marshall SW, Bailes J, McCrea M, Harding HP, Jr., Matthews A, et al. Recurrent concussion and risk of depression in retired professional football players. *Medicine and science in sports and exercise*. 2007;39(6):903-9. doi: 10.1249/mss.0b013e3180383da5. PubMed PMID: 17545878.
 21. Yeates KO, Luria J, Bartkowski H, Rusin J, Martin L, Bigler ED. Postconcussive symptoms in children with mild closed head injuries. *The Journal of head trauma rehabilitation*. 1999;14(4):337-50. PubMed PMID: 10407207.
 22. Mihalik JP, Stump JE, Collins MW, Lovell MR, Field M, Maroon JC. Posttraumatic migraine characteristics in athletes following sports-related concussion. *Journal of neurosurgery*. 2005;102(5):850-5. doi: 10.3171/jns.2005.102.5.0850. PubMed PMID: 15926709.
 23. 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 pediatrics*. 2013;167(2):156-61. doi: 10.1001/jamapediatrics.2013.434. PubMed PMID: 23247384; PubMed Central PMCID: PMC4461429.
 24. Kuehl MD, Snyder AR, Erickson SE, McLeod TC. Impact of prior concussions on health-related quality of life in collegiate athletes. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*. 2010;20(2):86-91. doi: 10.1097/JSM.0b013e3181cf4534. PubMed PMID: 20215889.
 25. Kutner KC, Erlanger DM, Tsai J, Jordan B, Relkin NR. Lower cognitive performance of older football players possessing apolipoprotein E epsilon4. *Neurosurgery*. 2000;47(3):651-7; discussion 7-8. PubMed PMID: 10981753.
 26. Collins MW, Kontos AP, Reynolds E, Murawski CD, Fu FH. A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA*. 2014;22(2):235-46. doi: 10.1007/s00167-013-2791-6. PubMed PMID: 24337463.
 27. Majerske CW, Mihalik JP, Ren D, Collins MW, Reddy CC, Lovell MR, et al. Concussion in sports: postconcussive activity levels, symptoms, and neurocognitive performance. *Journal of athletic training*. 2008;43(3):265-74. doi: 10.4085/1062-6050-43.3.265. PubMed PMID: 18523563; PubMed Central PMCID: PMC2386420.
 28. Shuttleworth-Rdwards AB, Radloff SE. Compromised visuomotor processing speed in players of Rugby Union from school through to the national adult level. *Archives of clinical neuropsychology : the official journal of the National Academy of Neuropsychologists*. 2008;23(5):511-20. doi: 10.1016/j.acn.2008.05.002. PubMed PMID: 18585890.
 29. Guskiewicz KM, Ross SE, Marshall SW. Postural Stability and Neuropsychological Deficits After Concussion in Collegiate Athletes. *Journal of athletic training*. 2001;36(3):263-73. PubMed PMID: 12937495; PubMed Central PMCID: PMC155417.
 30. Prins ML, Alexander D, Giza CC, Hovda DA. Repeated mild traumatic brain injury: mechanisms of cerebral vulnerability. *Journal of neurotrauma*. 2013;30(1):30-8. doi: 10.1089/neu.2012.2399. PubMed PMID: 23025820; PubMed Central PMCID: PMC4047842.
 31. Guskiewicz KM, Bruce SL, Cantu RC, Ferrara MS, Kelly JP, McCrea M, et al. National Athletic Trainers' Association Position Statement: Management of Sport-Related Concussion. *Journal of athletic training*. 2004;39(3):280-97. PubMed PMID: 15514697; PubMed Central PMCID: PMC522153.
 32. Mrazik M, Naidu D, Lebrun C, Game A, Matthews-White J. Does an individual's fitness level affect baseline concussion symptoms? *Journal of athletic training*. 2013;48(5):654-8. doi: 10.4085/1062-6050-48.3.19. PubMed PMID: 23725489; PubMed Central PMCID: PMC3784367.
 33. Schatz P, Pardini JE, Lovell MR, Collins MW, Podell K. Sensitivity and specificity of the ImpACT Test Battery for concussion in athletes. *Archives of clinical neuropsychology : the official journal of the National Academy of Neuropsychologists*. 2006;21(1):91-9. doi: 10.1016/j.acn.2005.08.001. PubMed PMID: 16239884.

- PMID: 16143492.
34. Maddocks DL, Dicker GD, Saling MM. The assessment of orientation following concussion in athletes. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*. 1995;5(1):32-5. PubMed PMID: 7614078.
 35. Putukian M, Echemendia R, Dettwiler-Danspeckgruber A, Duliba T, Bruce J, Furtado JL, et al. Prospective clinical assessment using Sideline Concussion Assessment Tool-2 testing in the evaluation of sport-related concussion in college athletes. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*. 2015;25(1):36-42. doi: 10.1097/JSM.000000000000102. PubMed PMID: 24915173.
 36. McCrea M, Kelly JP, Randolph C, Kluge J, Bartolic E, Finn G, et al. Standardized assessment of concussion (SAC): on-site mental status evaluation of the athlete. *The Journal of head trauma rehabilitation*. 1998;13(2):27-35. PubMed PMID: 9575254.
 37. McLeod TC, Leach C. Psychometric properties of self-report concussion scales and checklists. *Journal of athletic training*. 2012;47(2):221-3. PubMed PMID: 22488289; PubMed Central PMCID: PMC3418135.
 38. Baker JG, Freitas MS, Leddy JJ, Kozlowski KF, Willer BS. Return to full functioning after graded exercise assessment and progressive exercise treatment of postconcussion syndrome. *Rehabilitation research and practice*. 2012;2012:705309. doi: 10.1155/2012/705309. PubMed PMID: 22292122; PubMed Central PMCID: PMC3265107.
 39. 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. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*. 2010;20(1):21-7. doi: 10.1097/JSM.ob013e3181c6c22c. PubMed PMID: 20051730.
 40. Jinguji TM, Bompadre V, Harmon KG, Satchell EK, Gilbert K, Wild J, et al. Sport Concussion Assessment Tool-2: baseline values for high school athletes. *British journal of sports medicine*. 2012;46(5):365-70. doi: 10.1136/bjsports-2011-090526. PubMed PMID: 22228554.
 41. Bell DR, Guskiewicz KM, Clark MA, Padua DA. Systematic review of the balance error scoring system. *Sports health*. 2011;3(3):287-95. doi: 10.1177/1941738111403122. PubMed PMID: 23016020; PubMed Central PMCID: PMC3445164.
 42. Glaviano NR, Benson S, Goodkin HP, Broshek DK, Saliba S. Baseline SCAT2 Assessment of Healthy Youth Student-Athletes: Preliminary Evidence for the Use of the Child-SCAT3 in Children Younger Than 13 Years. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*. 2015;25(4):373-9. doi: 10.1097/JSM.000000000000154. PubMed PMID: 25318531.
 43. Collins MW, Iverson GL, Lovell MR, McKeag DB, Norwig J, Maroon J. On-field predictors of neuropsychological and symptom deficit following sports-related concussion. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*. 2003;13(4):222-9. PubMed PMID: 12855924.
 44. Gysland SM, Mihalik JP, Register-Mihalik JK, Trulock SC, Shields EW, Guskiewicz KM. The relationship between sub-concussive impacts and concussion history on clinical measures of neurologic function in collegiate football players. *Annals of biomedical engineering*. 2012;40(1):14-22. doi: 10.1007/s10439-011-0421-3. PubMed PMID: 21994067.
 45. Leong DF, Balcer LJ, Galetta SL, Evans G, Gimre M, Watt D. The King-Devick test for sideline concussion screening in collegiate football. *Journal of optometry*. 2015;8(2):131-9. doi: 10.1016/j.optom.2014.12.005. PubMed PMID: 25649742; PubMed Central PMCID: PMC4401827.
 46. McCrea M, Barr WB, Guskiewicz K, Randolph C, Marshall SW, Cantu R, et al. Standard regression-based methods for measuring recovery after sport-related concussion. *Journal of the International Neuropsychological Society : JINS*. 2005;11(1):58-69. doi: 10.1017/S1355617705050083. PubMed PMID: 15686609.
 47. De Marco AP, Broshek DK. Computerized Cognitive Testing in the Management of Youth Sports-Related Concussion. *Journal of child neurology*. 2014. doi: 10.1177/0883073814559645. PubMed PMID: 25477270.
 48. Bruce J, Echemendia R, Meeuwisse W, Comper P, Sisco A. 1 year test-retest reliability of ImPACT in professional ice hockey players. *The Clinical neuropsychologist*. 2014;28(1):14-25. doi: 10.1080/13854046.2013.866272. PubMed PMID: 24345194.
 49. Iverson GL, Lovell MR, Collins MW. Interpreting change on ImPACT following sport concussion. *The Clinical neuropsychologist*. 2003;17(4):460-7. doi: 10.1076/clin.17.4.460.27934. PubMed PMID: 15168911.
 50. Lovell MR, Collins MW, Iverson GL, Johnston KM, Bradley JP. Grade 1 or "ding" concussions in high school athletes. *The American journal of sports medicine*. 2004;32(1):47-54. PubMed PMID: 14754723.
 51. Galetta KM, Barrett J, Allen M, Madda F, Delicata D, Tennant AT, et al. The King-Devick test as a determinant of head trauma and concussion in boxers and MMA fighters. *Neurology*. 2011;76(17):1456-62. doi: 10.1212/WNL.ob013e31821184c9. PubMed PMID: 21288984; PubMed Central PMCID: PMC3087467.

52. Lovell MR, Solomon GS. Psychometric data for the NFL neuropsychological test battery. *Applied neuropsychology*. 2011;18(3):197-209. doi: 10.1080/09084282.2011.595446. PubMed PMID: 21846219.
53. Guskiewicz KM, Register-Mihalik J, McCrory P, McCrea M, Johnston K, Makdissi M, et al. Evidence-based approach to revising the SCAT2: introducing the SCAT3. *British journal of sports medicine*. 2013;47(5):289-93. doi: 10.1136/bjsports-2013-092225. PubMed PMID: 23479486.
54. Echemendia RJ, Iverson GL, McCrea M, Macciocchi SN, Gioia GA, Putukian M, et al. Advances in neuropsychological assessment of sport-related concussion. *British journal of sports medicine*. 2013;47(5):294-8. doi: 10.1136/bjsports-2013-092186. PubMed PMID: 23479487.
55. Baker JG, Rieger BP, McAvoy K, Leddy JJ, Master CL, Lana SJ, et al. Principles for return to learn after concussion. *International journal of clinical practice*. 2014;68(11):1286-8. doi: 10.1111/ijcp.12517. PubMed PMID: 25348379.
56. Master CL, Gioia GA, Leddy JJ, Grady MF. Importance of 'return-to-learn' in pediatric and adolescent concussion. *Pediatric annals*. 2012;41(9):1-6. doi: 10.3928/00904481-20120827-09. PubMed PMID: 22953975.
57. Moser RS, Glatts C, Schatz P. Efficacy of immediate and delayed cognitive and physical rest for treatment of sports-related concussion. *The Journal of pediatrics*. 2012;161(5):922-6. doi: 10.1016/j.jpeds.2012.04.012. PubMed PMID: 22622050.
58. Lovell MR, Collins MW, Iverson GL, Field M, Maroon JC, Cantu R, et al. Recovery from mild concussion in high school athletes. *Journal of neurosurgery*. 2003;98(2):296-301. doi: 10.3171/jns.2003.98.2.0296. PubMed PMID: 12593614.
59. Schneider KJ, Meeuwisse WH, Nettel-Aguirre A, Barlow K, Boyd L, Kang J, et al. Cervicovestibular rehabilitation in sport-related concussion: a randomised controlled trial. *British journal of sports medicine*. 2014;48(17):1294-8. doi: 10.1136/bjsports-2013-093267. PubMed PMID: 24855132.
60. Iverson GL, Gaetz M, Lovell MR, Collins MW. Cumulative effects of concussion in amateur athletes. *Brain injury*. 2004;18(5):433-43. doi: 10.1080/02699050310001617352. PubMed PMID: 15195792.
61. McKee AC, Cantu RC, Nowinski CJ, Hedley-Whyte ET, Gavett BE, Budson AE, et al. Chronic traumatic encephalopathy in athletes: progressive tauopathy after repetitive head injury. *Journal of neuropathology and experimental neurology*. 2009;68(7):709-35. doi: 10.1097/NEN.0b013e3181a9d503. PubMed PMID: 19535999; PubMed Central PMCID: PMC2945234.
62. McKee AC, Stern RA, Nowinski CJ, Stein TD, Alvarez VE, Daneshvar DH, et al. The spectrum of disease in chronic traumatic encephalopathy. *Brain : a journal of neurology*. 2013;136(Pt 1):43-64. doi: 10.1093/brain/aws307. PubMed PMID: 23208308; PubMed Central PMCID: PMC3624697.
63. Carson JD, Lawrence DW, Kraft SA, Garel A, Snow CL, Chatterjee A, et al. Premature return to play and return to learn after a sport-related concussion: physician's chart review. *Canadian family physician Medecin de famille canadien*. 2014;60(6):e310, e2-5. PubMed PMID: 24925965; PubMed Central PMCID: PMC4055342.
64. 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):1562-7; discussion 7. doi: 10.1227/NEU.0b013e31820e382e. PubMed PMID: 21258259.
65. Collins MW, Grindel SH, Lovell MR, Dede DE, Moser DJ, Phalin BR, et al. Relationship between concussion and neuropsychological performance in college football players. *Jama*. 1999;282(10):964-70. PubMed PMID: 10485682.
66. Corwin DJ, Zonfrillo MR, Master CL, Arbogast KB, Grady MF, Robinson RL, et al. Characteristics of prolonged concussion recovery in a pediatric subspecialty referral population. *The Journal of pediatrics*. 2014;165(6):1207-15. doi: 10.1016/j.jpeds.2014.08.034. PubMed PMID: 25262302; PubMed Central PMCID: PMC4253594.
67. Giza CC, Hovda DA. The Neurometabolic Cascade of Concussion. *Journal of athletic training*. 2001;36(3):228-35. PubMed PMID: 12937489; PubMed Central PMCID: PMC155411.
68. Mansell JL, Tierney RT, Higgins M, McDevitt J, Toone N, Glutting J. Concussive signs and symptoms following head impacts in collegiate athletes. *Brain injury*. 2010;24(9):1070-4. doi: 10.3109/02699052.2010.494589. PubMed PMID: 20597635.
69. Tator CH. Chronic traumatic encephalopathy: how serious a sports problem is it? *British journal of sports medicine*. 2014;48(2):81-3. doi: 10.1136/bjsports-2013-093040. PubMed PMID: 24273309.
70. 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. doi: 10.1542/peds.2013-2125. PubMed PMID: 24394679; PubMed Central PMCID: PMC3904277.
71. Griesbach GS, Hovda DA, Molteni R, Wu A, Gomez-Pinilla F. Voluntary exercise following traumatic brain injury: brain-derived neurotrophic factor upregulation and recovery of function. *Neuroscience*. 2004;125(1):129-39. doi: 10.1016/j.neuroscience.2004.01.030. PubMed PMID: 15051152.
72. Thomas DG, Apps JN, Hoffmann RG, McCrea M, Hammeke T. Benefits of strict rest after acute concussion: a randomized

- controlled trial. *Pediatrics*. 2015;135(2):213-23. doi: 10.1542/peds.2014-0966. PubMed PMID: 25560444.
73. Moser RS, Schatz P. A Case for Mental and Physical Rest in Youth Sports Concussion: It's Never too Late. *Frontiers in neurology*. 2012;3:171. doi: 10.3389/fneur.2012.00171. PubMed PMID: 23248612; PubMed Central PMCID: PMC3518809.
 74. Schneider KJ, Iverson GL, Emery CA, McCrory P, Herring SA, Meeuwisse WH. The effects of rest and treatment following sport-related concussion: a systematic review of the literature. *British journal of sports medicine*. 2013;47(5):304-7. doi: 10.1136/bjsports-2013-092190. PubMed PMID: 23479489.
 75. Covassin T, Elbin R, Kontos A, Larson E. Investigating baseline neurocognitive performance between male and female athletes with a history of multiple concussion. *Journal of neurology, neurosurgery, and psychiatry*. 2010;81(6):597-601. doi: 10.1136/jnnp.2009.193797. PubMed PMID: 20522868.
 76. Jordan BD, Relkin NR, Ravdin LD, Jacobs AR, Bennett A, Gandy S. Apolipoprotein E epsilon4 associated with chronic traumatic brain injury in boxing. *Jama*. 1997;278(2):136-40. PubMed PMID: 9214529.
 77. Matser JT, Kessels AG, Jordan BD, Lezak MD, Troost J. Chronic traumatic brain injury in professional soccer players. *Neurology*. 1998;51(3):791-6. PubMed PMID: 9748028.
 78. Wall SE, Williams WH, Cartwright-Hatton S, Kelly TP, Murray J, Murray M, et al. Neuropsychological dysfunction following repeat concussions in jockeys. *Journal of neurology, neurosurgery, and psychiatry*. 2006;77(4):518-20. doi: 10.1136/jnnp.2004.061044. PubMed PMID: 16543534; PubMed Central PMCID: PMC2077488.
 79. Omalu BI, Hamilton RL, Kamboh MI, DeKosky ST, Bailes J. Chronic traumatic encephalopathy (CTE) in a National Football League Player: Case report and emerging medicolegal practice questions. *Journal of forensic nursing*. 2010;6(1):40-6. doi: 10.1111/j.1939-3938.2009.01064.x. PubMed PMID: 20201914.
 80. Gardner A, Iverson GL, McCrory P. Chronic traumatic encephalopathy in sport: a systematic review. *British journal of sports medicine*. 2014;48(2):84-90. doi: 10.1136/bjsports-2013-092646. PubMed PMID: 23803602.
 81. Solomon GS, Zuckerman SL. Chronic traumatic encephalopathy in professional sports: retrospective and prospective views. *Brain injury*. 2015;29(2):164-70. doi: 10.3109/02699052.2014.965205. PubMed PMID: 25314314.
 82. Maroon JC, Winkelman R, Bost J, Amos A, Mathyssek C, Miele V. Chronic traumatic encephalopathy in contact sports: a systematic review of all reported pathological cases. *PloS one*. 2015;10(2):e0117338. doi: 10.1371/journal.pone.0117338. PubMed PMID: 25671598; PubMed Central PMCID: PMC4324991.
 83. Echemendia RJ, Iverson GL, McCrea M, Broshek DK, Gioia GA, Sautter SW, et al. Role of neuropsychologists in the evaluation and management of sport-related concussion: an inter-organization position statement. *Archives of clinical neuropsychology : the official journal of the National Academy of Neuropsychologists*. 2012;27(1):119-22. doi: 10.1093/arclin/acr077. PubMed PMID: 22180540.
 84. Harmon KG, Drezner JA, Gammons M, Guskiewicz KM, Halstead M, Herring SA, et al. American Medical Society for Sports Medicine position statement: concussion in sport. *British journal of sports medicine*. 2013;47(1):15-26. doi: 10.1136/bjsports-2012-091941. PubMed PMID: 23243113.
 85. Moreau WJ, Nabhan DC. Development of the 2012 American Chiropractic Board of Sports Physicians position statement on concussion in athletics. *Journal of chiropractic medicine*. 2013;12(4):269-73. doi: 10.1016/j.jcm.2013.07.002. PubMed PMID: 24396329; PubMed Central PMCID: PMC3838726.
 86. Makdissi M, Cantu RC, Johnston KM, McCrory P, Meeuwisse WH. The difficult concussion patient: what is the best approach to investigation and management of persistent (>10 days) postconcussive symptoms? *British journal of sports medicine*. 2013;47(5):308-13. doi: 10.1136/bjsports-2013-092255. PubMed PMID: 23479490.
 87. McCrory P, Meeuwisse WH, Aubry M, Cantu B, Dvorak J, Echemendia RJ, et al. Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012. *British journal of sports medicine*. 2013;47(5):250-8. doi: 10.1136/bjsports-2013-092313. PubMed PMID: 23479479.
 88. Benson BW, Hamilton GM, Meeuwisse WH, McCrory P, Dvorak J. Is protective equipment useful in preventing concussion? A systematic review of the literature. *British journal of sports medicine*. 2009;43 Suppl 1:i56-67. doi: 10.1136/bjism.2009.058271. PubMed PMID: 19433427.
 89. Bleiberg J, Cernich AN, Cameron K, Sun W, Peck K, Ecklund PJ, et al. Duration of cognitive impairment after sports concussion. *Neurosurgery*. 2004;54(5):1073-78; discussion 8-80. PubMed PMID: 15113460.
 90. White PE, Shee AW, Finch CF. Independent appraiser assessment of the quality, methodological rigour and transparency of the development of the 2008 international consensus statement on concussion in sport. *British journal of sports medicine*. 2014;48(2):130-4. doi: 10.1136/bjsports-2013-092720. PubMed PMID: 24128756.
 91. Giza CC, Kutcher JS, Ashwal S, Barth J, Getchius TS, Gioia GA, et al. Summary of evidence-based guideline update: evaluation and management of concussion in sports: report

of the Guideline Development Subcommittee of the American Academy of Neurology. *Neurology*. 2013;80(24):2250-7. doi: 10.1212/WNL.0b013e31828d57dd. PubMed PMID: 23508730; PubMed Central PMCID: PMC3721093.

92. Moser RS, Schatz P, Jordan BD. Prolonged effects of concussion in high school athletes. *Neurosurgery*. 2005;57(2):300-6; discussion -6. PubMed PMID: 16094159.
93. Gibson S, Nigrovic LE, O'Brien M, Meehan WP, 3rd. The effect of recommending cognitive rest on recovery from sport-related concussion. *Brain injury*. 2013;27(7-8):839-42. doi: 10.3109/02699052.2013.775494. PubMed PMID: 23758286.
94. Kulbe JR, Geddes JW. Current status of fluid biomarkers in mild traumatic brain injury. *Experimental neurology*. 2015. doi: 10.1016/j.expneurol.2015.05.004. PubMed PMID: 25981889.
95. Siman R, Shahim P, Tegner Y, Blennow K, Zetterberg H, Smith DH. Serum SNTF Increases in Concussed Professional Ice Hockey Players and Relates to the Severity of Postconcussion Symptoms. *Journal of neurotrauma*. 2015. doi: 10.1089/neu.2014.3698. PubMed PMID: 25419578.
96. Yuh EL, Hawryluk GW, Manley GT. Imaging concussion: a review. *Neurosurgery*. 2014;75 Suppl 4:S50-63. doi: 10.1227/NEU.0000000000000491. PubMed PMID: 25232884.
97. McCrea M, Guskiewicz KM, Marshall SW, Barr W, Randolph C, Cantu RC, et al. Acute effects and recovery time following concussion in collegiate football players: the NCAA Concussion Study. *Jama*. 2003;290(19):2556-63. doi: 10.1001/jama.290.19.2556. PubMed PMID: 14625332.
98. Burke MJ, Fralick M, Nejatbakhsh N, Tartaglia MC, Tator CH. In search of evidence-based treatment for concussion: characteristics of current clinical trials. *Brain injury*. 2015;29(3):300-5. doi: 10.3109/02699052.2014.974673. PubMed PMID: 25383510.

Bios:

Neilank K Jha, MD, FRCSC

Dr. Jha is the Founder of KONKUSSION. His vision is to revolutionize and redefine the management of concussions. Within KONKUSSION he has assembled what he describes as “one of the best teams in sports” to tackle this challenging issue from both a clinical and research perspective. He pursued his undergraduate studies at the University of Toronto, completed his medical school training at McMaster, completed a 6 year residency in neurosurgery at McMaster University and subsequently completed a two year fellowship from the University of Toronto in complex spinal disorders. He is a board certified Neurosurgeon FRCS(C) and a

fellowship trained Spine Surgeon. He is the Editor-in-Chief of *Current Research: Concussion*, the first International peer reviewed journal with a focus on mTBI research.

Robert Cantu, MD

Dr. Cantu is a clinical professor of neurosurgery at Boston University, the Chairman of the Department of Surgery at Emerson Hospital, the medical director of the National Center for Catastrophic Sports Injury Research, and a founding member and chairman of the Medical Advisory Board for Sports Legacy Institute. Not only does he advise numerous National Football League, National Hockey League, and National Basketball Association teams, Dr. Cantu also acts as a consultant to many scholastic and professional athletes for various health topics such as post-head-injury return-to-play, high school sports safety issues, and special health and exercise concerns for seniors.

Thomas Gennarelli, MD

A recipient of NINDS's 1991 Brain Injury Research Award, Dr. Gennarelli is the founder of The Froedtert Hospital & The Medical College of Wisconsin CIREN Center, the tenth center of the Crash Injury Research and Engineering Network (CIREN) of the National Highway Traffic Safety Administration, a member of the national medical honor society, a founding member of the International Neurotrauma Society, the International Society for Neuroemergencies and the Eastern Association for the Surgery of Trauma (EAST).

Charles Tator, CM, PhD, MD

Dr. Tator is a professor of neurosurgery at University of Toronto, a board member of Parachute Canada, and the Project Director for the Canadian Sports Concussion Project at the Krembil Neuroscience Centre at Toronto Western Hospital. For his efforts in injury prevention, Dr. Tator was rewarded the USA Hockey Excellence in Safety Award and the Lifetime Achievement Award from the American Spinal Injury Association.

Julian E. Bailes, MD

Dr. Bailes is the neurological consultant for the National Football League Players' Association, advisor to the National Collegiate Athletics Association, chairman of Pop Warner Football, and medical director for the Center for Study of Retired Athletes at the University of North Carolina. A leader in the research of neurovascular diseases, his laboratory researches the mechanisms of and treatments for cerebral concussions.

Christopher Giza, MD

A specialist in paediatric neurology, Dr. Giza acts not only as a civilian advisor to the US Department of Defense, he also serves the National Collegiate Athletic Association Concussion Task Force and Major League Soccer Concussion Program Committee. As co-chair of the American Academy of Neurology Academy committee, Dr. Giza is responsible for the development of an evidence-based Practice Guideline for Management of Sports Concussions.

Vernon Williams, MD

Dr. Williams is a physician at Kerlan-Jobe Orthopaedic Clinic with a focus on Sports Neurology and pain management and the founder and director of the exclusive Kerlan-Jobe Sports Neurology Fellowship Program. He currently serves as Neurological Medical Consultant for local college and high school sports teams and several professional sports organizations, which include the Los Angeles Dodgers, the Los Angeles Lakers, and the Los Angeles Kings.

Elizabeth Pieroth, PsyD

An expert in concussions and traumatic brain injuries, Dr. Pieroth is a clinical neuropsychologist for the Northshore University Health System and a member of Heads Up Football Advisory Committee. Her neurological consulting services are highly sought after, with patrons including the Chicago Bears, the Chicago Blackhawks, the Chicago White Sox, and the US Soccer teams.

Lisa Fischer, MD

Dr. Fischer is the Chair of the SIFP Program of Sport and Exercise Medicine in the College of Family Physicians of Canada, Dr. Fischer also holds the roles of Assistant Professor at the Departments of Family Medicine and Faculty of Health Sciences, along with Primary Care Sport Medicine Director at the Fowler Kennedy Sport Medicine Clinic. With extensive experience in post-concussive rehabilitation, Dr. Fischer reviews guidelines for post-concussion syndrome and persistent symptoms for the Ontario Neurotrauma Foundation, provides related educational workshops, and continues to lead clinical care of concussive athletes with Canadian Concussion Collaborative.

Samuel Gandy, MD, PhD

Part of the team that first founded amyloid-reducing drugs, Dr. Gandy is a professor of neurology and psychiatry, Associate Director of the Mount Sinai Alzheimer's Disease Research Center, and Chair of the National Medical and Scien-

tific Advisory Council of the Alzheimer's Association. He has made significant impact in scientific literature, serving in the capacity of an editor for several prominent journals including *The Journal of Clinical Investigation*, the *Public Library of Science-Medicine (PLoS M)*, and *Current Alzheimer Research* and continues to train new scientists and lectures at the Mount Sinai School of Medicine.

Steve Devick, OD

Dr. Devick is founder and CEO of King-Devick Test, Inc. Since its conception in 1976, the King-Devick test has been implemented in a wide range of healthcare practices for various ailments, most notably as an objective sideline screening test for concussion. Dr. Devick is the recipient for the 2011 Ernst Jokl Sports Medicine Award from the United States Sports Academy for exceptional sports-related medical research, and has been a keen speaker at multiple conferences, his most recent advocacy for concussion awareness at the 2014 White House Healthy Kids & Safe Sports Concussion Summit.

Vincenzo S Basile, MD, MSc, FRCSC

Dr. Basile is a neurologist licensed to practice in the Province of Ontario and holds certification in Adult Neurology from the Royal College of Physicians and Surgeons of Canada. He also has Canadian certification in Electrophysiology and is licensed to perform electromyography and nerve conduction studies (EMG/NCS) from the Canadian Society of Clinical Neurophysiologists (CSCN). In addition to seeing patients and teaching at Sunnybrook Hospital, Dr. Basile is also the Medical Director of Stroke and Neurology at both Mackenzie Health Hospital and William Osler Hospital.

Michael J Ellis, MD, FRCSC

On top of holding clinical appointments at the Department of Surgery and Pediatrics, Section of Neurosurgery at the University of Manitoba, Dr. Ellis is Medical Director of the Pan Am Concussion Program and Co-Director for Canada North Concussion Network. He is also researches at the Manitoba Institute of Child Health on clinical epidemiology and management of pediatric sports-related concussion and investigates the advancement of neuro-imaging and exercise science assessment tools in concussion.

Rosemarie Scolaro Moser, PhD, ABN, ABPP-RP

Dr. Moser is a neuropsychologist and rehabilitation specialist who serves as the Director of the Sports Concussion Center of New Jersey. She is the author of *Ahead of the Game: The Parent's Guide to Youth Sports Concussion*, and is a subject

matter expert for the U.S. Centers for Disease Control and Prevention national guidelines on pediatric mild traumatic brain injury. She has authored landmark research publications in the area of youth concussion, provides concussion services to youth, amateur and professional athletes and teams, and is an Adjunct Professor of Clinical Psychology at the Widener University. A long time advocate for concussion legislation, Dr. Moser was a key facilitator of the International Conference on Psychological Health and Traumatic Brain Injury which addressed the U S Congress. She has served as a past president of the New Jersey Psychological Association and the New Jersey Neuropsychological Society.

Gary W. Small, MD

Dr. Small is the director for Geriatric Psychiatry, Memory and Aging Research Center, a professor in Psychiatry and Biobehavioral Sciences at UCLA, the founder of the UCLA Memory Clinic and director of the UCLA Center on Aging. Named one of the world's top 50 innovators in science and technology by the Scientific American magazine, he continues to research on Alzheimer's and other neurological diseases with the support of the National Institute of Health.

Adam Raikes, MS, LAT, ATC

Adam Raikes is currently a Doctoral student in Pathokinesiology at Utah State University.

Stefan Bulfon, DC, BSc, CSCS

Dr. Bulfon holds a four year doctorate degree in chiropractic medicine from the Canadian Memorial Chiropractic College. Prior to these studies he completed a four year Honours Bachelor of Science Degree in Kinesiology at the University of Western Ontario and also holds a certification as a Strength and Conditioning Specialist (CSCS) with the National Strength and Conditioning Association (NSCA). Understanding that new information regarding health care is being discovered daily, Dr. Bulfon strongly believes that continuously improving one's education is the key to providing the most effective care for his patients. Be it by reading the latest scientific journal articles, attending different conferences or simply taking additional courses he understands that staying current is a necessity for proper patient care.

Sylvia Boddener, OT, CHT, GDM, MBA

Ms. Boddener is an Occupational Therapist as well as the Senior Director of Clinical Programs and Outcomes at Altum Health, a division of the University Health Network in Toronto, Canada.

Jason P Mihalik , PhD, CAT(C), ATC

Jason Mihalik is an Assistant Professor in the Department of Exercise and Sport Science at the University of North Carolina in Chapel Hill. Dr. Mihalik completed his undergraduate degree in Exercise Science with a specialization in Athletic Therapy at Concordia University (Montreal, Quebec, Canada) in 2001. He completed his graduate work in Sports Medicine at the University of Pittsburgh (Pittsburgh, PA), earning his Master's Degree in December 2004. He was a recipient of the Dr. Thomas S. and Mrs. Caroline H. Royster, Jr. 5-year fellowship, allowing him to complete his doctoral work at The University of North Carolina at Chapel Hill in the summer of 2009.

Lesley Ritchie, PhD, C. Psych

Dr. Ritchie is an assistant professor in Neuropsychology Service at the Department of Clinical Health Psychology, University of Manitoba, and a research Affiliate at their Centre On Aging where she investigates aging and neuropsychology, mild cognitive impairment, neuropsychological rehabilitation, and sport neuropsychology. She is also a Sport Neuropsychology Consultant to the NHL (Winnipeg Jets) for whom she conducts baseline and post-injury neuropsychological assessment services and she is the Continuing Ed Board Member for the Manitoba Psychological Society that promotes the advancement of psychology for the purpose of servicing human health, welfare, and quality of life.

Anthony Kontos, PhD

Dr. Kontos is the University of Pittsburgh Medical Center's Assistant Director of Research, Associate Professor in the Department of Orthopaedic Surgery, and a member of the Association of Applied Sport Psychology and American College of Sports Medicine. His publications and presentations have surpassed the 150 mark and reports on assorted subjects, from concussive psychological issues of underrepresented groups to TBI neuromotor effects in youth.

Eric Massicotte, MD, MSc, FRCSC

A graduate of the University of Ottawa School of Medicine in 1995, Dr. Massicotte entered the Neurosurgical Training Program at the University of Manitoba in 1995 until 1999 at which time he transferred to the University of Toronto to complete his neurosurgical training. He became a Fellow of the Royal College of Physicians and Surgeons of Canada in 2001. During his time in Manitoba Dr. Massicotte completed a Master in Science with the department of surgery. His research focused on white matter changes in the rat model. In order to further his interest in spine he undertook a

fellowship year at the Toronto Western Hospital under the direction of Dr. Michael Fehlings and Dr. Charles Tator. He is now Assistant Professor in the Department of Surgery, and member of the Division of Neurosurgery at the Toronto Western Hospital. His clinical practice focuses on spine with research interests in outcome measures and guidelines, and medical education.

Kevin Hrusovsky, BS, MBA

Mr. Kevin Hrusovsky has been the Chief Executive Officer of Quanterix Corporation since March 4, 2015. He holds a B.S. in Mechanical Engineering from the Ohio State University and an MBA from Ohio University. He was awarded the 2013 Entrepreneur of the Year from Ohio State University and holds an Honorary Doctorate degree from Framingham State University for contributions to life sciences and personalized medicine.

Patrick Neary, BEd, MA, PhD

Dr. Patrick Neary, BEd, MA, PhD is a Co-Founder of Neurochaos Solutions, Inc. and serves as its Consultant. Dr. Neary is an exercise physiologist and tenured faculty member in the Faculty of Kinesiology and Health Studies at the University of Regina, Regina, Saskatchewan, Canada, as a Full Professor. He has worked with Professional Ice Hockey Teams and the Canadian Men's Ice Hockey Team. He has published extensively, including his research on the pathophysiology of sport-induced concussion (funded by the Saskatchewan Health Research Foundation and the Canadian Institutes of Health Research).

Alain Ptito, PhD

Dr. Ptito is a neuropsychologist, specializing in research on mechanisms of cerebral reorganization and plasticity who currently acts as the Director of the Psychology Department at McGill University Health Centre. His studies aim to help not only victims of motor vehicle accidents, but also soldiers injured in combat and athletes, and his findings have helped improve the lives of various patient populations.

Philip Schatz, PhD

Along with his affinity for technology, Dr. Schatz is a neuropsychologist and webmaster at the Psychology Department at Saint Joseph's University. He has extensive experience in clinical, research, and education work, having held a vast range of positions, from psychology consultant of Professional Psychological Group and Neurobehavioral Specialist at the Moss Rehabilitation Hospital, to board member of the Philadelphia Neuropsychology Society and Director of

the National Academy of Neuropsychology distance Program. Besides having been the principle investigator of the Disorders of Consciousness (DOC) Advanced Care Protocol (ACP) funded by the Department of Defense, Dr. Schatz's involvement in concussion research is associated with the International Brain Research Foundation, Sports Concussion Center of NJ, and Pennsylvania Head Injury Program. Currently Chair of Information Technology at the National Academy of Neuropsychology, Dr. Schatz carries on his research on TBI outcomes, youth TBI, and computer-based neuropsychological assessment.

Christopher M Butt, PhD

Dr. Butt is currently a Principal Scientist and Site Manager at DSM Nutritional Products and conducts research on the effects of dietary omega-3 fatty acids on the brain.

Dara L Dickstein, PhD

Dr. Dickstein is currently an Assistant Professor in the Department of Neuroscience at the Icahn school of Medicine at Mount Sinai and a member of the Friedman Brain Institute, Department of Neuroscience. Her educational background is in molecular genetics and immunology. Dr. Dickstein is a co-PL in the Alzheimer's Disease Research Center at Mount Sinai and a member of the Computational Neurobiology and Imaging Center (CNIC) at Mount Sinai.

Gillian Hotz, PhD

A nationally recognized behavioral neuroscientist, Dr. Hotz is a research professor at University of Miami, director to KiDZ Neuroscience Center, WalkSafe and BikeSafe Concussion Programs, and a founding member for numerous head injury care programs, such as the Pediatric Brain & SCI Program. She has developed a county-wide concussion protocol and surveillance system, a model that can be adopted.

Pierre Frémont, MD, PhD

A leading researcher with Laval University's Le Centre de recherche de CHU de Québec, Dr. Frémont is Chair of Canadian Concussion Collaborative Interest and a member of the Institut Technologies de l'Information et Sociétés at Laval University. He primarily studies population health and how to optimize health practices and investigates concussion management in sport and school settings through structured protocols.

Louise Logan, BA (Hons), JD

Graduate of the executive program at the Ivey School of Business at University of Western Ontario, Ms. Logan is President and CEO of Parachute, a national charity for injury prevention. Involved in provincial, national, and international workplace health and safety for more than 15 years, Ms. Logan held myriad positions at other public safety organizations such as President and CEO of the Public Services Health & Safety Association, and Director General of Policy and Regulation at WorkSafeBC.

John Mandarino

John Mandarino is the Director of the LiUNA Canadian Tri-Fund.

Al Pace, LLB

Al Pace has practiced law for more than 30 years and has earned a stellar reputation for skill and outstanding client service. After completing his studies at the University of Toronto and the University of Windsor where he received his LL.B., Al was called to the Bar for the province of Ontario in 1980. Initially, Al developed his law practice in the areas of personal injury and civil litigation.

Paul Mazza, LLB

Paul Mazza is a member of the Executive Committee of the Canadian Bar Association. He received his undergraduate education at McMaster University in Hamilton, and graduated from The University of Windsor Law School.

Alexander Voudouris, LLB

Alexander was called to the bar in 1991 and since then has practiced exclusively in the Personal Injury field.

Tanya Morton

Tanya Morton is a former school principal who was instrumental in implementing the Early Learning Programs. Unfortunately she suffered a concussion and continues to experience lingering effects. However, she is highly involved in changing the landscape of concussion management.

Stephanie Mester

Stephanie Mester is a Waterloo undergraduate where her interest lies in public health studies. She is driven to educate athletes, students, and the general public on concussions and post-concussive syndrome.

Candace Atherton

Candace is an I.T project manager. She had a fall in 2013 and continues to battle her post concussive syndrome. However she is motivated to return to work symptom free and has seen improvement with her symptoms on a post-concussion protocol.