
INTERNATIONAL CONCUSSION CONSENSUS

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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.

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*).

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.

• **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).

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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 (PLoSM)*, 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 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

Dr. Schatz is a neuropsychologist and Professor of Psychology at Saint Joseph's University. He has extensive experience in clinical, research, and education work, and has collaborated on projects funded by the National Academy of Neuropsychology, the Department of Defense, the Sports Concussion Center of NJ, and Pennsylvania Head Injury Program. Dr. Schatz has been a recipient numerous teaching, research, and service awards throughout his career, and he currently maintains an active research program on validation of computer-based neuropsychological assess-

ment, and outcomes following mTBI in youth, high school, and college athletes.

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 of 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.