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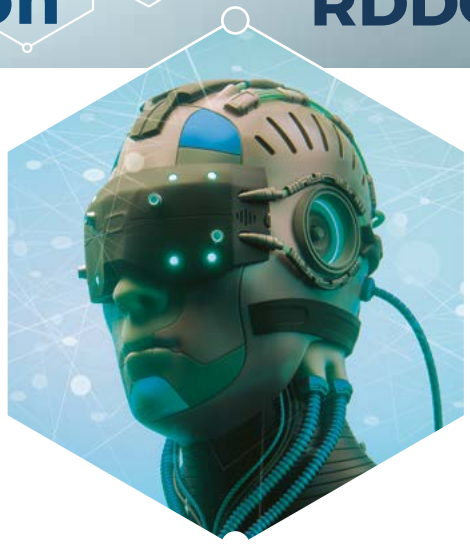
Emerging technology snapshot

Mild traumatic brain injury (mTBI) prevention



Mild TBIs (mTBIs) often occur due to an injury to the head as a result of contact and/or acceleration/deceleration of forces acting on the brain. While typically benign, mTBI has a complex etiology, various symptoms, and a risk of short- and long-term sequelae. Most mTBI studies discuss diagnosis; with limited understanding of mechanisms and risk factors, the corpus of knowledge on prevention is much smaller, and is based mainly on sports/vehicular injuries and protective gear.

Enabling Science and Technology

Helmets and protective gear

Helmets, mouthguards, visors, and other gear may protect against mTBI, but there is no single design that is effective in all settings and against all injuries. Recent studies discuss the contribution of helmet liners (e.g., auxetic foam), fit, and the use of helmet-fitted sensors to prevention.

Impact tests and modelling

Quantitative assessments based on updated headforms (e.g., gender-specific), impact tests, and computational modelling contribute to our understanding of mTBI mechanics, help to assess the protective effects, and lead to better design of helmets and other protective gear.

Education and awareness programs

Awareness campaigns on the part of Brain Injury Canada, Ontario Neurotrauma Foundation, US Centers for Disease Control, military health-care and sports associations have led to more frequent diagnosis (better care and prevention of persistent, long-term damage) and wider adoption of preventive measures.

Proteomics

The role of proteins (e.g., apolipo-protein E, nrf2, growth factors) in preventing inflammation after neurological trauma is a new approach in understanding and treating mTBI. Stimulation of protein expression pathways may prevent progressive damage.

Other neuroprotectants

Pharmaceuticals and nutritional supplements that act on multiple genomic, proteomic and metabolic pathways may enhance outcomes after brain injury. Examples include alpha-linoleic acid (or other omega-3 fatty acids), curcumin, or quercetin.

"Because the most effective method of protection against concussion and TBI is prevention, reconsideration of helmet design and efficacy is crucial to reducing incidences of concussion, TBI, secondary neuronal damage, and chronic neurocognitive disability at clinical and epidemiological levels."

Sone, J.Y., et al. "Helmet efficacy against concussion and traumatic brain injury: A review". *Journal of Neurosurgery*. 126, 3 (2017): 768-781.

Canada

Signals

Academic

Canadian universities (Ottawa, Toronto, Calgary) contribute to research on prevention, especially in the area of sports and protective gear. Other important players are the University of North Carolina, the University of California, Virginia Tech, and the University of Pittsburgh, as well as several Chinese institutions (Zhejiang, Fudan).

Government

Organizations such as the US Centers for Disease Control lead initiatives such as HEADS UP, an educational campaign on concussion in sport. The National Institute of Standards and Technology is working with other US government agencies to standardize test methods related to protective gear.

Collaboration

In Canada, research networks exist between major universities (Toronto, Calgary) and hospitals. In the US, the University of California and US Veterans Affairs serve as hubs, connecting with multiple US-based universities, health centres, and defence agencies.

Defence

The US Department of Veterans Affairs has published guidelines on clinical management of mTBI and maintains a Defense and Veterans Brain Injury Center. In Canada, Defence Research and Development Canada (DRDC) ranks 15th among organizations with published research.

Corporate

Regulations for (consumer) helmets in Canada require that manufacturers meet ratings developed by the Snell Memorial Foundation, the CSA, or other organizations. Military helmets are subject to national/NATO specifications. In the US, VICIS is adapting its football helmet to meet ballistic and blunt force protective requirements set by the US Army medical staff.

"Mild TBI is one of the most common neurological conditions, with an estimated annual incidence of 500/100,000 in the United States."

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.

IMPACT

Social

mTBI can lead to significant sequelae that last a lifetime, especially if undiagnosed. mTBI can affect physical functioning, cognition, sensory processing, communication and behaviour which can have a significant impact on a person's life and social interactions (family and workspace).

Policy

TBI is a public health issue of utmost importance, especially for sports, military populations, and youth. Preventive measures are currently dependent on standards (e.g., for protective gear), clinical guidelines and definitions, and coaching/return to work manuals.

Economic

Better prevention of mTBIs, especially of repeated injury, will reduce the number of events and their severity as well as their morbidity, thus reducing long-term healthcare and disability costs.

Defence

mTBI has been labelled the signature injury of the 1990-91 Gulf War and has become a major concern for the military healthcare community. Military-specific preventative methods are necessary to address the special needs of this sector, e.g., protection against blasts, training, cumulative effects of jolts as well as blunt trauma.

"[mTBI] represents one of the highest research priorities in military medicine because both clinical experience and experimental results suggest specific blast–body–brain interactions cause complex, interconnected physiological and molecular alterations that can lead to long-term neurological deficits."

Cernak, I. "Military-Relevant Traumatic Brain Injuries: A Pressing Research Challenge." *Johns Hopkins Technical Digest*, 31, 4 (2013).

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Please provide feedback

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