

Brain vital signs capture undetected impairments in ice hockey players with concussions

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Neuroscientists show how Brain Vital Signs -- a breakthrough for analyzing complex brainwave data to provide a simple, practical and objective physiological evaluation of brain function -- is more sensitive in detecting brain function changes related to concussion than existing clinical tests for concussion. Credit: Health and Technology District's BrainNET

A team of Canadian and U.S. brain researchers have published results from a multi-year hockey concussion study, which tracked the brain function of young Junior A male ice hockey players using a new brainwave monitoring method called "brain vital signs."

The peer-reviewed study is published online, and will be featured as an "Editor's Choice" in the February issue of *Brain: A Journal of Neurology*, published by the Oxford University Press.

The study showed that "brain [vital signs](#)—a breakthrough for analyzing complex brainwave data to provide a simple, practical and objective physiological evaluation of brain function—is more sensitive in detecting brain function changes related to [concussion](#) than existing clinical tests for concussion. Brain vital signs translates complex

brain waves from portable electroencephalography (EEG) - measurable at the rink-side—into fast, user-friendly and intuitive results.

Study's findings:

The research team found that brain vital signs detected neurophysiological impairments, such as attention and cognitive processing deficits, in players who had been diagnosed with concussions and were cleared for return-to-play. Surprisingly, the team also found significant delays in cognitive processing for players whom were not diagnosed with concussions at any time during the season (sub-concussive effects).

This work emerged from an on-going Canada-U.S. collaboration between neuroscientists operating out of the Health and Technology District in Surrey, British Columbia, a science and innovation community, together with Mayo Clinic Sports Medicine Center in Rochester, Minnesota. Through a consortium of initiatives and technologies known as BrainNET, the Health and Technology District has designed a clinical-academic-innovation network dedicated to bringing advances in neuro-technologies to individual improvements in brain health.

Dr. Ryan D'Arcy, the Health and Technology District's co-founder, SFU professor and the study's senior author, describes the study as an important step forward in concussion evaluation and treatment management.

"Sports-related concussion is a major topic of discussion amongst scientists, clinicians, the medical community, the sports industry and various governmental agencies. There is growing concern that concussions may be associated with an increased risk of persistent cognitive and mental

health impairments later in life," says Dr. D'Arcy.

D'Arcy points out that despite dozens of clinical studies examining sports-related concussions, there remains a major gap in terms of objective, physiological measures of brain function that can be easily deployed and readily used at point-of-care.

According to Shaun Fickling, the study's lead author and a Ph.D. student at SFU, "What's even more surprising is that not only did we find undetected physiological impairments in players diagnosed with concussions who were cleared to play, we also found that players who were not diagnosed with concussions showed decreased cognitive processing speed post season—thought to be the result of repetitive 'sub-concussive impacts.'"

Dr. Aynsley Smith, Ph.D., sport and exercise psychologist and concussion investigator at Mayo Clinic Sports Medicine, adds: "Mayo Clinic has been on the forefront of research into the prevention, diagnosis and management of concussion in ice hockey. We recognized the need to move beyond subjective concussion diagnoses that relied on questions—that players could deny or exaggerate—to more objective measurements. This is why we were pleased to collaborate in this study."

Dr. Michael Stuart, M.D., professor of orthopedic surgery and the co-director of Mayo Clinic Sports Medicine, further explains, "Concussion in sports, especially in ice hockey, is a global public health issue with an estimated 1.6 million to 3.8 million sport-related concussions occurring per year in the United States alone. There is a growing urgency to develop practical approaches that use objective, physiological measures, which are also rapidly and easily deployable in sport and clinical settings so medical staff can better diagnose and treat concussions."

About the study:

The research team monitored and tracked 47 Tier III, Junior A, male ice hockey players over two seasons, and divided the players into two groups: players who were diagnosed with concussions and

players who were not. They used brain vital signs to conduct assessments at baseline, post-injury, return-to-play, and post-season time points.

In contrast to conventional, lengthy and cumbersome EEG methods that generate event-related potentials (ERPs), brain vital signs extracts these physiological measurements in less than 10 minutes and is easily and fully deployable within a variety of sporting and clinical settings.

The brain vital signs framework measured three core, well-established ERP brain responses: the N100 for auditory sensation; the P300 for basic attention; and the N400 for cognitive processing. The amplitudes and latencies for all three responses are converted to standardized scores through normative transformation to produce a total of six brain vital signs measurements.

Results:

- Concussion resulted in significantly increased amplitude and delayed latency scores for all six brain vital signs metrics (p < 0.05).
- A major finding was that players who had been cleared to return to play after their concussions (according to standard protocols) still showed impairments in the measure of basic attention. This shows that the current protocols are not sensitive enough to detect the subtle changes in [brain](#) function occurring after injury.
- The researchers also found changes occurring over the duration of the season in the group of players who were not diagnosed with concussions, raising further concerns around the emerging concept of "sub-concussive" impacts. Importantly, these "sub-concussive" impacts were associated with the players showing specific and significant delays in cognitive processing speed.

More information: Shaun D Fickling et al, Brain vital signs detect concussion-related neurophysiological impairments in ice hockey, *Brain* (2018). [DOI: 10.1093/brain/awy317](https://doi.org/10.1093/brain/awy317)

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