MindMirror Submission to The Senate Community Affairs References Committee Inquiry into Concussions and Repeated Head Trauma in Contact Sports

Introduction to MindMirror

MindMirror is headquartered in Seattle, Washington with operations in the US and Australia, with a team of senior emergency medicine doctors partnered with cutting-edge software engineers specialising in artificial intelligence and machine learning.

Our purpose is to be the most trusted and innovative provider of diagnostic support tools for healthcare providers, sports organisations, and the military.

MindMirror brings together the most advanced artificial intelligence models, delivered in a simple to use mobile phone application. Designed to work with professional athletes through to young amateurs, MindMirror can assist in the diagnosis of concussion and play a key role in knowing when the right time is to 'Return to Play'.

Importantly, MindMirror is a non-invasive solution that does not require any special equipment, is portable making it available for use in the field, and can be easily used by doctors, trainers, and coaching staff, through to parents and family members.

Backed by science and medical research, the MindMirror platform is the future of diagnostics, today.

Diagnosis and tracking of recovery from sports acquired minor traumatic brain injury (mTBI)

Concussion, or mTBI, in contact sport is an area of significant public concern, and recent high-profile cases have drawn public attention to the possible links between recurrent mTBI in sport and chronic traumatic encephalopathy (CTE). A coordinated approach is required to establish universal diagnostic criteria for concussion that will provide sports participants, and their parents, with the confidence to actively engage in contact sport in an era when inactivity is contributing to an obesity epidemic.

To ensure public confidence the diagnosis must be democratised. Current approaches to diagnosis and prognostication of mTBI in sport rely on guided subjective assessments by trained health or sports professionals. These assessments take time and are not available at all levels of competition. Biomarker tests that are in development provide the hope of an objective diagnostic modality and will certainly be excellent research tools. Unfortunately, the practicalities of blood sampling and pitch-side testing will not allow their roll-out to amateur or school-based sport, apart from in exceptional circumstances.

An ideal diagnostic tool would be available to all; be non-invasive, require minimal training and provide a reliable, objective and reproducible diagnosis. Such an objective tool could also be used to track the recovery from mTBI, providing an indication of when it would be safe for a participant with diagnosed concussion to return to play. Safe return to play has become a significant target for reduction of risk from repetitive mTBI, and a 2011 change in law in Texas established a legislative standard to govern the safe return to sport of children and adolescents.

"Today, House Bill 2038, a pro-student athlete safety legislation, authored by Representative Four Price and sponsored by Senator Bob Deuell, passed the Texas House of Representatives by a resounding vote of 129 to 5. The bill was named "Natasha's Law" for Natasha Helmick, a young Texas female star soccer player, who suffered repeated concussions on the field and ultimately gave up the game and her dream of playing on the USA Olympic Team due to her injuries. Representative Four Price introduced this legislation in the Texas House to address the growing problem of traumatic brain injuries among student athletes. The bill has the support of many student athletes, parents, athletic trainers, coaches, administrators, physicians, healthcare professionals, and the National Football League."

Washington State's Lystedt Law in Concussion. The Lystedt law requires high school athletes who have sustained a concussion to be removed from practice and play and not to be allowed to return until cleared by a medical professional.

Young athletes are particularly vulnerable to the long-term effects of mTBI, not only from a behavioural point of view, but because they are more likely to feel an obligation to return to play before they are symptom-free. The other group who are highly vulnerable to premature return to play are professional sport people, whose livelihood and identity are closely associated with their sports performance.

An objective measure of recovery would support return to play legislation that would otherwise be difficult to govern, and a record of this measure would give assessors assurance of the robust nature of governance of return to play protocols. A single scientific authority to oversee and coordinate research into mTBI, and to offer evidence-based guidance to government and governing bodies of sports codes, would allow for efficient and coordinated use of funds, as well as to collaborate in the establishment of widely acceptable definitions and guidelines. A co-funding model between sport code governing bodies, private sector stakeholders and the Commonwealth would maximise the available funding, and provide the best outcome for all stakeholders.

The CSIRO would be an ideally placed organisation, for example, and could develop the tools required for the use of peak sports bodies. This would mitigate any suggestion of conflicts of interest between bodies that require active participation in their codes, balancing participation levels against risk to participants. The system should be transparent and robust, with governing bodies responsible, in law, for the application of world-best-practice diagnosis and return to play practices.

Addressing terms of reference

The suggested model would address 4 points within the terms of reference of this committee:

e. The role of sports associations and clubs in the debate around concussion and repeated head trauma, including in financing research.

Sports associations would be responsible, in law, for developing and governing diagnosis and return to play protocols, in a model similar to that that has been enacted in Texas for the last 12 years. Diagnosis and recovery monitoring would be based on evidence developed by a scientific committee under the auspices of the CSIRO. That group may, or may not, include scientific representation from the codes, private sector stakeholders and commonwealth scientists with experience on mTBI assessment and management.

The codes would be responsible for the exact content of the protocols used and would base them on advice from the scientific committee. The committee, and its collaborating research groups, would be funded by the sports associations, private sector stakeholders and commonwealth-controlled grants. The quantum would have to be considered once the scale of the necessary research is identified.

f. The lack of a consistent definition of what constitutes 'concussion'.

Within the scope of the committee would be the development of a consensus diagnosis for significant mTBI. Longitudinal studies based on existing symptomatic diagnostic tools, such as the SCAT 5, would be combined with newer diagnostic modalities such as micro-RNA and neuro-ophthalmological tools, to identify the point at which a minor head injury becomes a clinically significant mTBI, with the possibility of concerning sequelae. The threshold for this may be different in different demographic groups. A single definition is unlikely to satisfy the complexity of such a multifaceted clinical condition, and a risk-based assessment which is tailored to the individual is more likely to be successful in protecting participants.

g. The prevalence, monitoring and reporting of concussion and long-term impacts of concussion and repeated head trauma, including in First Nations communities.

Within the terms of reference of a scientific committee would be the democratisation of concussion diagnosis and management of return to play. Technologies such as micro-RNA assays show promise as excellent research tools and diagnostic aids for elite sports participants, however the technology is unlikely to trickle down to the grassroots sporting level in the near future. Such biomarker tools could, however, be employed to assist in the training of a machine-learning algorithm which would use neuro-ophthalmological tools, such a Pupillary Light Reflex (PLR) or Vestibular Ocular Motor Screening (VOMS), which could be deployed on mobile phones. Mobile phones are now ubiquitous and a neuro-ophthalmological diagnostic application available for both Android and iOS could become universal at all sports events, from grassroots to elite levels. Such cloud-based technology could also populate a central national database of diagnostic data, potentially crowd-sourced with appropriate governance and regulations, which could be used to further finesse the application's accuracy. It could also allow audit and governance of the enforcement of robust return to play protocols, which would likely require legislative oversight due to medical confidentiality concerns. A central national database would allow monitoring and reporting of concussion, and long-term impacts of concussion and repeated head trauma, in all Australians due to the ubiquity of the technology and the ability to maintain a central store of vital focused information.

i. Alternative approaches to concussions and repeated head trauma in contact sport, and awareness raising about its risks.

Neuro-ophthalmological diagnosis and monitoring, in conjunction with current clinical tools, could be co-hosted on a single mobile phone application. Existing applications such as the RFU Head Injury Assessment application would be an example. The complexity of the application could be tailored to its audience; a simple Post-Concussion Symptom Scale (PCSS), partnered with an objective tool like pupillary light reflex (PLR), would be appropriate for the lay application. The PLR could be uploaded and interpreted by artificial intelligence (AI) in real time (current processes take 3-4 minutes depending on mobile telephone reception), and combined with the PCSS to give a likely risk and recommendation. A clinician-focused version of the application would permit greater inputs based on CSIRO recommendations, and may include components similar to the SCRUM application and additional PLR metrics. All data could be stored in the cloud, and available to clinicians for later assessment and treatment of the concussed player (once appropriate consent has been obtained). It could also be included in a personal medical record, potentially in the form of a standardised report with links to actual PLR files. This unified, multimodal, single point diagnostic and tracking strategy would simplify, and unify, both the diagnosis and management of mTBI whilst using existing and alternative methods. It would allow audit and monitoring, as well as ongoing research, to aid continuous improvement in the area. The ubiquitous presence of a mobile phone application in situations ranging from professional sport to community activity, which could be used to scientifically estimate risk and give guidance on return to sport, would raise awareness of the risks as well as mitigating them. It could also be used as a conduit for public health updates and education around head injury and other risks via regular updates to the application, and alerts using the mobile phone.

MindMirror technology

MindMirror is a health technology company.

MindMirror is committed to delivering ground-breaking innovation to reduce the burden of head injury and concussion in both professional and amateur sports, as well as in the broader community. To this end, Australian clinical academics Professor Paul Middleton and Dr Will Davies are advising on, and organising, a number of national and international clinical trials, making use of innovative study designs such as crowd-sourcing data using the MindMirror application on normal individuals, ranging from schoolchildren to university students, and also with amateur and professional sports people. Professor Middleton and Dr Davies are working with the University of New South Wales, and other Australian universities.

MindMirror plans to accumulate the largest, focused collection of data in the world on physiological and pathophysiological changes to the PLR, and the AI-powered recognition of patterns associated with brain injury. To this end, we have set up the Australasian PLR Registry (APLRR), with full ethical permission to collect diagnostic and risk-stratification data using MindMirror technology.

Baseline and exertional testing is taking place in partnership with sports medicine specialists in the UK, to assess the confounding effects of adrenergic drive and fatigue as possible confounders to pitch side testing. Once this baseline is complete, we will commence data collection on pitch side mTBI cases and subsequent recovery protocols. Concussion recovery data is already available from our research partners in the USA and is being used to train the AI model in detecting recovery from mTBI in high school American Football players. The PLR application is also being appraised against a clinical infrared pupillometers in an Australian hospital intensive care unit to ensure its performance is non-inferior in the clinical environment.

MindMirror is involved in multiple areas of neurodiagnostics, with an application also being clinically appraised for the assessment and diagnosis of vertigo through the use of an automated Head Impulse Test. This detects and quantifies saccades (the rapid, corrective eye movements identified in acute vertigo, used by neuro-otologists to differentiate posterior circulation stroke from peripheral vertigo). These same saccades are under investigation as a possible diagnostic modality in mTBI, as a vital component of the Vestibular Ocular Motor Screening test. Minor adjustments in the programming and use of MindMirror would allow the application to perform VOMS, testing systems that integrate balance, vision, and movement.

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Professor Middleton is a specialist in prehospital and emergency medicine. He has worked as part of prehospital trauma and helicopter critical care retrieval teams in both the UK and Australia.

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