

A New Safety Paradigm for Youth Football Pediatric Neurocognitive Testing, Impact Sensors and Telemedicine

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Introduction

Legislation mandating similar concussion prevention and management for youth football as provided at high school, college and professional levels is being proposed throughout the US. Ideally, this could include baseline neurocognitive testing, sensors for recording the location, number and magnitude of head hits and physician availability at all games and contact practices.

Methods

A recently validated pediatric neurocognitive test is now available for youth 5-12 years of age. A new football head sensor system is under trials to detect the number, location and magnitude of sports related head impacts and stores the information for ongoing dosimetry-like purposes. A new telemedicine system will soon be available in 11,000 Walgreen pharmacies and can provide virtual sideline physician assessment for youth football events anywhere in the country when needed for concussion evaluation and treatment recommendations.

Results

All three of these technological innovations have been assessed individually and recently as a part of a unified concussion management program. There applicability and utility, particularly for youth contact sports, will be presented and discussed. We believe this network can provide a new safety model for youth participating in contact sports and in particular, football.

Learning Objectives

1. Learn the latest technologies for concussion management in youth sports.
2. Understand concepts of neurocognitive testing and head hit velocity measurements for the management of concussion.
3. Learn about utility of remote sideline telemedicine access for acute concussion assessments in youth sports.

Conclusion

The utility of the new pediatric neurocognitive tests and the value of head sensors to measure and store biomechanical components of head hits offer unique opportunities for telemedicine in youth sports, along with potential cost savings that neurosurgeons are positioned to support.

References

1. Examination of the test-retest reliability of a computerized neurocognitive test battery. Nakayama Y, Covassin T, Schatz P, Nogle S, Kovan J. Am J Sports Med. 2014 Jun 6;42(8):2000-2005
2. www.impacttest.com
3. Kutcher JS, McCrory P, Davis G, Pfitz A, et al, What evidence exists for new strategies or technologies in the diagnosis of sports concussion and assessment of recovery? Br J Sports Med. 2013 Apr;47(5):299-303. doi: 10.1136/bjsports-2013-092257.
4. <http://www.mayoclinic.org/diseases-conditions/concussion/multimedia/vicid-20078289>

Neurocognitive Testing

- Pre-season Baseline neurocognitive (NC) testing provides personalized quantitative cognitive profile for each player
 - Post-injury (3 to 7 days after concussion) scores inform diagnosis and aid return-to-play and concussion management decisions
 - IMPACT[®] showed 81.9% sensitivity and 89.4% specificity in assessing concussions among high school athletes
- Immediate Sideline Assessments**
- Key components:
- Available history of concussion
 - Modified mobile neurocognitive evaluation
 - IMPACT[®] app or SCAT3[™] (1.3 and under version)
 - Balance evaluation
 - Vision examination



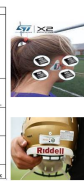
Schatz P, et al. Sensitivity and specificity of the IMPACT[®] test battery for concussion in athletes. CAN. 2005;08:001.

Impact Sensors

- Bring attention and impact analysis to severe hits that may go otherwise unnoticed
- Record number of hits accumulated, linear and rotational acceleration, and location of hit – data aids diagnosis of concussion



Sensor Name	Accelerometer design	Data Collected & Analyzed
Mercer "HeadTrack"	HeadTrack "Smart Fabric" using the inside of helmet	HeadTrack network player profile includes baseline reaction time, memory, cognitive ability, and other mental functions for post-concussion comparison. "Smart Fabric" contains accelerometer, gyroscope and digital thermometer detects location of impact and delivers wireless transmission.
Shockbox "Impact"	In-helmet sensor	Tracks number of hits, linear and rotational acceleration, wireless transmission to algorithm-analyzed mobile device profile. No hit location.
X2 Biosystems	"6-axis" behind ear patch	Records intensity of hit, linear and rotational acceleration, with prediction of location of hit. Wireless transmission.
Brain Sentry	Substituted helmet impact sensor	Tracks number of hits, alerts when hit exceeds 50g. Records impact intensity outside of helmet. No head location data recorded.
LINK IAS	Headband and small in-helmet sensor device	Stores impact severity, number of hits accumulated, and concussion risk



Telemedicine in Youth Football Concussion

Case Study
Telemedicine: An Innovative Approach to Screening, Diagnosis, and Management of Mild Traumatic Brain Injury



Results: "As the number of qualified healthcare providers with expertise in the diagnosis and management of concussions remains very small... [this] presents unique problems to rural communities without easy access to subspecialty care. **Telemedicine is a possible means by which to address the needs of the rural student-athlete.**"

Link: <https://www.youtube.com/watch?v=ZVLvTtUjpm>

Vogler RB, Chavez DD, Dooch DM, et al. Telemedicine: An Innovative Approach to Screening, Diagnosis, and Management of Mild Traumatic Brain Injury. *Neurology*. 2012;79(23):2008-2014.

Helmet Sensors and Accelerometers

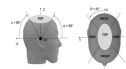
Quantitative threshold for injury prediction still remains unknown

NEUROSURGERY

HEAD IMPACT SEVERITY MEASURES FOR EVALUATING MILD TRAUMATIC BRAIN INJURY RISK EXPOSURE



CONCLUSION: A weighted combination of several biomechanical inputs, including impact location, is more predictive of concussion than a single biomechanical measure. This study is the first to the authors' knowledge to quantify improvements in the sensitivity of a biomechanical measure to incidence of concussion when impact location is considered.



Studies show head impact sensors providing **linear and rotational acceleration forces**, as well as **impact location** provide data that more strongly correlates with severity and prevalence of concussion. Quantitative threshold for injury prediction still remains unknown.

Donohue JM, Gorn J, Chu JJ, Cirico JJ. Head impact severity measures for evaluating mild traumatic brain injury risk exposure. *Neurosurgery*. 2008;64:758-77.

Conclusions

- Advanced neurocognitive testing, head impact sensors and telemedicine for concussion detection and management in youth sports are becoming widely available
- These technologies should serve to *strengthen, not replace*, the clinical and highly personalized diagnosis of concussion.
- Concussion technologies should be used as tools and not as a surrogate for trained medical personnel
- Concussion technologies and rapid interventions could potentially reduce medical costs, increase detection, prevent secondary injuries (more severe) and improve overall safety of youth contact sports



Movie

Telemedicine for TBI in the Military



Outcomes from a US military neurology and traumatic brain injury telemedicine program



Objective: "This study evaluated usage of the Army Knowledge Online (AKO) Telemedicine Consultation Program for neurology and traumatic brain injury (TBI) cases in remote overseas areas with limited access to subspecialists
Results: ... **TBI subspecialty teleconsultation is a viable method for overseas providers in remote locations to receive expert recommendations for a range of neurologic conditions.**"

Yukhnevici L, Lippman C, Neely E, Hazzelbrock R, Gifford R, Alphonso A, Tsao J. Outcomes from a US military neurology and traumatic brain injury telemedicine program. *Neurology*. 2012;79(12):1237-1243.

Head Health Network: A Model for the Future



EVERY PLAYER IN THE HEAD HEALTH NETWORK RECEIVES:



<http://headhealthnetwork.com/about-us/>