Rapid mTBI Neurological Visualization Assessment Within Forward Operating Battlefield Environments And During Air Transport

Mark H Myers, PhD

NeuroDyne Inc.

THE UNIVERSITY OF TENNESSEE HEALTH SCIENCE CENTER.

Abstract

Introduction - Mild Traumatic Brain Injury (mTBI) remains a significant readiness challenge in operational environments, where it is frequently underdiagnosed due to reliance on subjective assessments and the lack of rapid, objective, field-deployable diagnostic tools.

Capability Description: NeuroDyne has developed a machine learning–powered, wireless EEG platform, SeizureSenz^{TM}, that enables real-time neurologic monitoring and triage for TBI in operational environments. The system uses proprietary dry electrodes to capture objective brain activity, replacing subjective assessments with data-driven decision support.

Materials/Technical Approach - EEG signals were acquired using a wireless, dry-electrode platform and processed using machine learning–based signal analysis to identify patterns associated with neurologic impairment. Pilot data from several colleges within the Memphis, TN area provided 35 mTBI subjects that featured TBI injuries from football, soccer and cheerleading activities, and 35 non-injured controls were collected in clinical lab settings to evaluate the system's ability to detect differences in neural activity compared to non-injured control cohorts and TBI cohorts who had gone through rehabilitation.

Results – Measurable differences in neurologic signals between mTBI patients and non-injured controls provided an approximate 5 μV separation between cohort means. These findings indicate that mTBI is associated with detectable changes in neural activity, including low-frequency shifts and increased cortical amplitude, supporting real-time identification of neurologic impairment. The platform also demonstrated rapid assessment capability, reducing evaluation time by approximately 67% compared to MACE2 protocols (5 minutes vs. 15+ minutes).

Applicability to Medical Roles of Care: The platform supports Role 1 by enabling rapid, objective neurologic assessment to inform triage in austere environments. During en route care, it enables continuous monitoring and status tracking across the continuum of care. At Role 2, it provides objective data to support clinical decision-making and improve readiness for intervention.

Impact to the Warfighter: The platform's mobile algorithms process EEG signals in real-time provides alerts within 5 minutes.

Introduction

Traumatic Brain Injury (TBI) is a leading cause of death and disability worldwide, encompassing a spectrum of injuries ranging from minor blows and impacts to the head to severe penetrating trauma, each capable of producing lasting motor and cognitive deficits or death [1,2]. The scale of this burden in the United States is striking: between 1999 and 2020, more than 1,026,185 TBI-related deaths were recorded among adults aged ≥25 years [3][4].

NeuroDyne's TBI Platform directly addresses this gap through an AI-powered electroencephalographic (EEG) monitoring system that detects TBI by analyzing real-time brain wave activity rather than basing diagnosis solely on clinical assessment (**Figures 1 and 2**).

NEURODYNE

www.neurodyneinc.com

mhmyers@neurodyneinc.com

(901) 603-3817

Figure 1. Specifications: Inches: 20.22 x 16.38 x 6.1" , Weight: 8 lbs.

Figure 2. NeuroDyne TBIDetect™ AI-Powered EEG Monitoring Platform. The system integrates a wearable dry-electrode EEG cap (left) with a mobile recording interface (right) and cloud-based analytics dashboard (top). The active electrode array enables high-fidelity neural signal acquisition without conductive gels, while the companion mobile app manages real-time data streaming, signal quality monitoring, and secure transfer to NeuroDyne's cloud AI engine for automated event detection and clinical review.

Methodology

The core algorithmic approach utilizing Phase Lock Value (PLV) and Amplitude Lock Value (ALV) calculated from the Hilbert transformed EEG signal for time-series analysis has been robustly validated (Seizure Prediction and Detection via Phase and Amplitude Lock Values). This original PLV/ALV methodology yielded 100% sensitivity and precision in initial human subject testing for seizure detection, validating the efficacy of the core synchronization and time-series feature extraction capabilities required for the temporal analysis. This algorithmic approach has been proven to work in the most challenging environments outside a hospital setting (**Figure 3**).

Figure 3. TBIDetect can be utilized on the battlefield for rapid triage, during transport and within a medical facility for continuous assessment.

Our NSF Phase I work directly addresses this by creating a highly portable, technically validated, and user-friendly platform that can be utilized in austere environments (**Figure 4**).

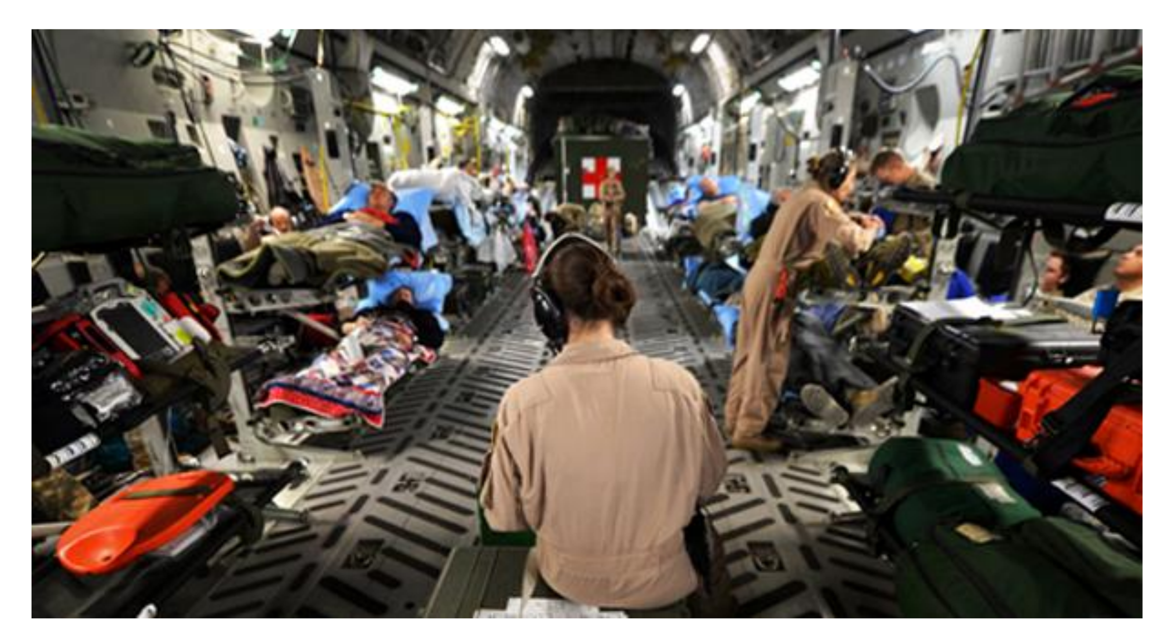

Figure 4. NeuroDyne's sensor technology provides EEG data acquisition in the most challenging environments**.**

Results

Analysis for a soccer athlete after taking a hit in front of her head. displays the emergence of the TBI incident over time (y-axis) and location by electrode (x-axis). We see the gradients of the incident, like the epicenter of earthquake activity, where the emergence of the epicenter begins to form signifying the highest neuronal damage. (**Figure 5**).

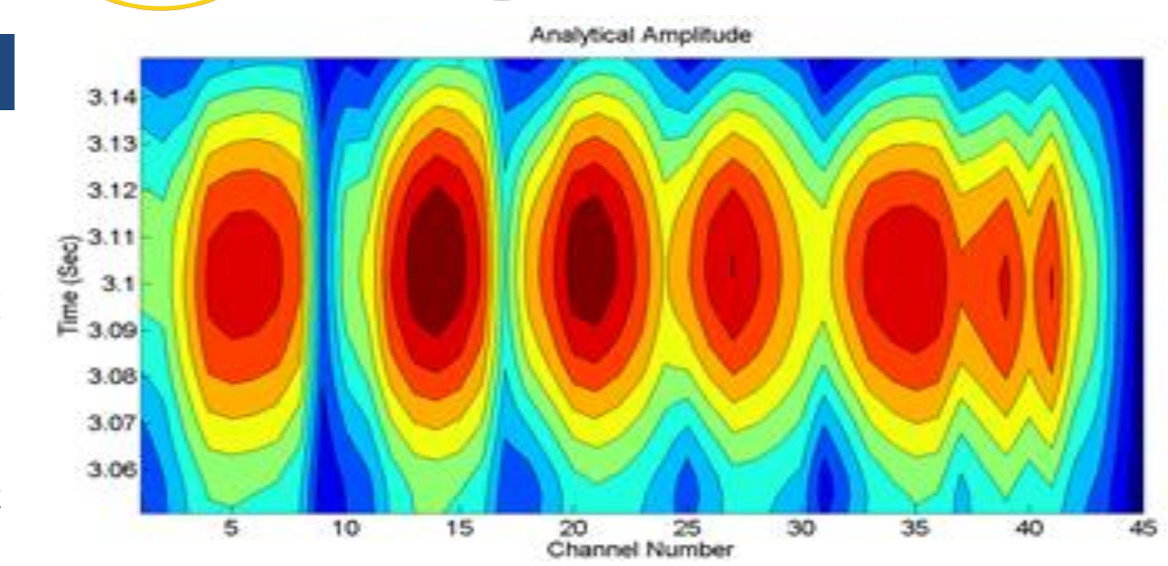

Figure 5. Gradients of the incident, where the epicenter of the injury can be seen. Injury from the concussion is seen as emergence of neural activity over time and across the cortex.

Neighboring electrodes show the gradations from the center of the injury, where damage is extended to electrodes 21, 22, 23 and 19 in magenta. The next series of slightly less damage is extended to electrodes 15, 16, 11, 12, 13, 30, 36, 29, 8, 27, 33 and 25 in red (Figure 4). The next set is in orange. Neighboring electrodes demonstrate neural network damage based on the epicenter peak, where connecting neural populations have been affected (**Figure 6**).

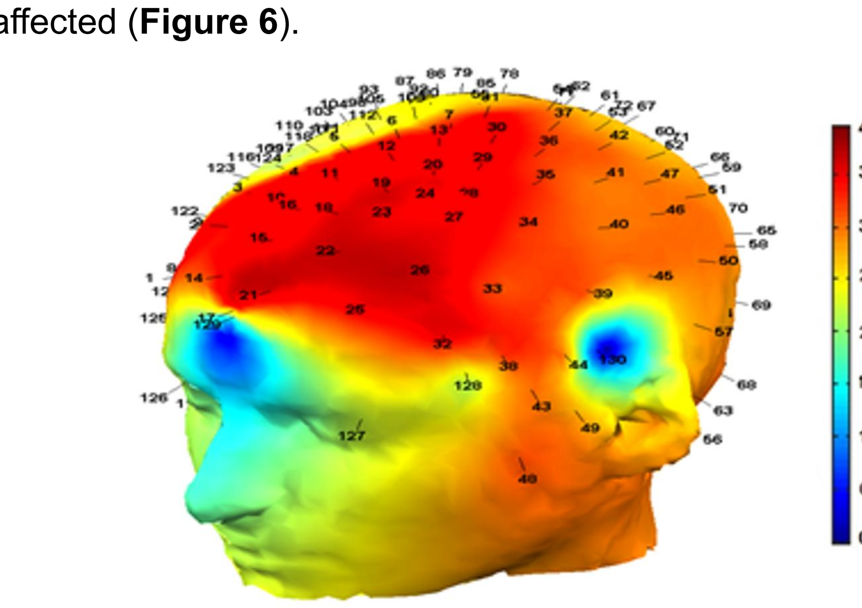

Figure 6. A 3-D display of the peak of the injury followed by neural network damage to neighboring electrodes.

Conclusion

The device is currently being used in preliminary testing among college athletic cohorts. EEG data has been collected from patients from this device with mild Traumatic Brain Injury. The current results show an 89% accuracy and precision rate for prediction and detection of seizure activity.

"With the Director of Research of CSTARS Cincinnati on board with this neurological triage assessment tool, you can always count in the 59 MDW to support the NeuroDyne effort."

Scott F. Walter, PhD, PE, Director of Technology Transition/Transfer, 59 MDW/ST Office, JBSA-Lackland, TX.

Working with:

24th Special Operations Wing & 59th Medical Wing

References

1. Ginsburg J, Smith T. Traumatic Brain Injury. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2026 Jan 28]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK557861/
2. Bramlett HM, Dietrich WD. Long-Term Consequences of Traumatic Brain Injury: Current Status of Potential Mechanisms of Injury and Neurological Outcomes. J Neurotrauma. 2015 Dec 1;32(23):1834–1848.
3. Dawood MH, Fazli Y, Lund S, Qazi SU, Tahir R, Masood AZ, et al. Mortality trends of traumatic brain injuries in the adult population of the United States: a CDC WONDER analysis from 1999 to 2020. BMC Public Health. 2025 Feb 5;25(1):482.
4. Faul M, Xu L, Wald MM, Coronado V. Traumatic brain injury in the United States: emergency department visits, hospitalizations, and deaths, 2002-2006. Atlanta: Centers for Disease Control and Prevention; 2010. https://stacks.cdc.gov/view/cdc/5571.