More than 17,000 U.S. warfighters were diagnosed with traumatic brain injury (TBI) in 2017 alone [1]. Combat-related head injuries can result from falls, vehicle accidents, bullets, shrapnel, and blasts from explosions—all of which can result in TBI [2]. Because a variety of events can cause TBI, methodologies for rapidly diagnosing (as well as understanding physical mechanisms that lead to it) are imperative for developing treatment and prevention strategies. Rapid diagnostic techniques and predictive models for TBI could minimize long-lasting effects of TBI for U.S. warfighters.

**Identifying TBI Using Blood Tests**

In conjunction with the U.S. Army, Banyan Biomarkers developed the Brain Trauma Indicator (BTI), an FDA-approved test that measures brain protein markers, specifically ubiquitin carboxy-terminal hydrolase-L1 (UCH-L1) and glial fibrillary acidic protein, to rapidly determine the severity of a head injury. These markers are elevated in an individual’s blood for up to 12 hours following a head injury [3], offering objective indicators for the presence of TBI. Therefore, BTI may allow DoD medical professionals to determine the severity of a head injury and identify follow-up treatments within hours.

Historically, “medical professionals had to rely on symptom reporting and other more subjective means to evaluate patients with few signals of more serious head injury [3].” Measurable symptoms for TBI can have a delayed onset (sometimes taking years), preventing the rapid diagnosis of TBI [4]. Using biomarkers for head trauma assessment allows for a more objective approach to TBI diagnoses. The development of a rapid and objective methodology for TBI diagnosis represents a promising path forward for better understanding preventative strategies for this injury. The U.S. Army Medical Research and Materiel Command expects to begin limited testing of BTI in fiscal year 2019 [3], with the hope that rapid confirmation of the injury can prevent long-term medical effects.

**Anticipating TBI Using Predictive Modeling**

Modeling tools that simulate blast loading to the human are integral in developing TBI prevention technologies and methodologies. In collaboration with the DoD, researchers at Sandia National Laboratories are conducting macro- and microscale TBI simulations in the development of these predictive models [5]. Using the National Library of Medicine’s Visible Human dataset, researchers constructed an anatomically correct virtual head-neck model for blast simulation testing [6]. The researchers are investigating the effect of three different stress wave energy quantities (isotropic tensile energy [ITE], isotropic compressive energy, and deviatoric shear energy [DSE]) on an individual’s brain [6].

Results indicate the independence of ITE and DSE from blast direction, a factor previously theorized to influence the severity of TBI [6]. Findings suggest that TBI-mitigating helmet designs should be engineered to protect the head based on the blast wave’s energy — not its direction. These findings will likely drive the development of novel head protection gear capable of mitigating the prevalence of blast-induced TBI in U.S. warfighters.

**Conclusion**

Advances in rapid diagnostics methodologies and predictive modeling for TBI represent promising avenues toward TBI prevention.
and effects-mitigation technologies capable of protecting the U.S. warfighter from long-lasting symptoms related to this injury. Diagnostic capabilities like BTI, which utilize objective biomarkers instead of symptoms with delayed onset, will drive a deeper understanding of the human body’s physiological responses to TBI. Such an understanding will allow for the development of TBI prevention and risk-mitigation technologies. Similarly, predictive modeling of blast-induced TBI enhances understanding of the physical mechanisms actually causing TBI.

REFERENCES


ABOUT THIS PUBLICATION:

All information regarding non-federal, third party entities posted on the HDIAC website shall be considered informational, aimed to advance the Department of Defense (DoD) Information Analysis Center (IAC) objective of providing knowledge to the Government, academia, and private industry. Through these postings, HDIAC’s goal is to provide awareness of opportunities to interact and collaborate. The presence of non-federal, third party information does not constitute an endorsement by the United States DoD or HDIAC of any non-federal entity or event sponsored by a non-federal entity. The appearance of external hyperlinks in this publication and reference herein to any specific commercial products, processes, or services by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or HDIAC. HDIAC is a DoD sponsored IAC, with policy oversight provided by the Under Secretary of Defense for Research and Engineering (USD (R&E)), and administratively managed by the Defense Technical Information Center (DTIC). For permission and restrictions on reprinting, please contact publications@hdiac.org. Any views or opinions expressed on this website do not represent those of HDIAC, DTIC, or the DoD.