



DoD Medical Research Program for the Prevention, Mitigation and Treatment of Blast Injuries

**International State-of-the-Science Meeting on Non-
Impact, Blast-Induced Mild Traumatic Brain Injury**
Hyatt Dulles, Herndon, Virginia, May 12–14, 2009

Summary of Meeting Proceedings

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Presented by

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Program History and Functions

PROGRAM HISTORY

- Secretary of Defense established the DoD Blast Injury Research Program in July 2006 in response to Congressional mandate (Section 256, FY06 NDAA)
- Objective is to coordinate medical research focused on the Prevention, Mitigation and Treatment of Blast Injuries
- Governing regulation is DoD Directive (DoDD) 6025.21E—Medical Research for Prevention, Mitigation, and Treatment of Blast Injuries, 5 Jul 06
- SecArmy is Executive Agent (EA)—delegated to ASA(ALT) who delegated to Cdr, MEDCOM
- Program Coordinating Office (PCO) established at USAMRMC in June 2007

PCO FUNCTIONS

- Identify blast injury knowledge gaps and determine funding requirements for research that closes the gaps
- Coordinate research programs across DoD to foster collaboration and eliminate duplication of effort
- Identify opportunities to leverage expertise from industry, academia, and federal agencies to solve blast injury problems
- Serve as “one-stop-shopping” for blast injury research information:
<https://blastinjuryresearch.amedd.army.mil>



Unique
to
Blast

Defining "Blast Injuries" (DoDD 6025.21E)

PRIMARY

- Blast lung
- Eardrum rupture and middle ear damage
- Abdominal hemorrhage and perforation
- Eye rupture
- **Non-impact, blast-induced mTBI?**

SECONDARY

- Penetrating ballistic (fragmentation) or blunt injuries
- Eye penetration

TERTIARY

- Fracture and traumatic amputation
- Closed and open brain injury
- Blunt injuries
- Crush injuries

QUATERNARY

- Burns
- Injury or incapacitation from inhaled toxic fire gases

QUINARY

- Illnesses, injuries, or diseases caused by chemical, biological, or radiological substances (e.g., "dirty bombs")

***Psychological trauma (including PTSD)**

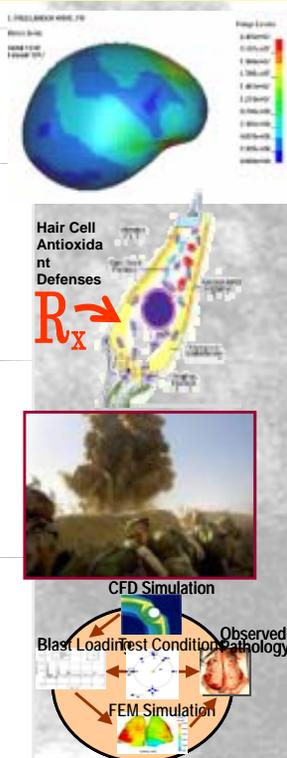
*Added based on latest research suggesting a high risk of developing PTSD following a concussion



Key Blast Injury Research Topics

Injury Prevention

- **Existence and mechanism of non-impact, blast-induced mTBI?**
- **Drugs to prevent and treat blast-related hearing loss**
- **Analysis of combat injuries and PPE performance (JTAPIC)**
- **Multi-effect blast injury models to improve protective equipment**
- **Resilience enhancement and prevention of PTSD**



Acute Treatment

- **Diagnostics and neuroprotectant drugs for TBI**
- **Hemorrhage control & blood products**
- **Treatment of psychological trauma**
- **Damage control orthopedics**
- **Pain management**



Reset

- **Tissue engineering and prosthetics**
- **Return-to-duty Standards**
- **Recovery of function**





International State-of-the-Science Meeting on Non-Impact, Blast-Induced Mild Traumatic Brain Injury

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➤ Purpose: critically examine research on the relationship between blast exposure and non-impact blast-induced mild traumatic brain injury (mTBI)

➤ Attended by >75 experts from DoD, VA, DOT, academia, and industry. Included Canada, Japan, the Netherlands, Sweden, and United States

➤ 27 short presentations by scientists and engineers studying non-impact blast-induced mTBI, ranging from blast physics and mathematical modeling to animal tests and neurocognitive studies in humans

➤ Participants divided into four workgroups, charged with discussing and answering **four key questions**





Four Key Questions

1. Is non-impact blast exposure associated with a physical mTBI?
2. If so, is there substantial evidence to support one mechanism as the most plausible explanation for how non-impact blast exposure is associated with mTBI?
3. What research questions warrant further study, and will close the knowledge gaps regarding any association between non-impact blast exposure and mTBI?
4. How can researchers standardize research methods to facilitate research synthesis of comparable studies?





Review Panel

- ❖ **Colonel Karl E. Friedl, Ph.D.
(Panel Chair)**
Director, Telemedicine and Advanced
Technology Research Center, U.S. Army
Medical Research and Materiel Command
- ❖ **John D. Joannopoulos, Ph.D.**
Francis Wright Davis Professor of Physics,
Massachusetts Institute of Technology, and
Director, Institute for Soldier Nanotechnologies
- ❖ **Steven G. Kaminsky, Ph.D.**
Vice President of Research, Uniformed
Services University of the Health Sciences
- ❖ **Erik G. Takhounts, Ph.D.**
Office of Applied Vehicle Safety Research,
Human Injury Research Division, National
Highway Traffic Safety Administration



Finding 1: Definition of mTBI

There is agreement that the current definition for mild TBI does not meet the needs for clinical assessment of brain injury.

- Mild TBI is currently defined by the event and through the self-reporting of symptoms.
- The working definition at this time is any post-event exposure alteration of mental state at the time of injury, any loss of consciousness lasting 30 minutes or less, or post-traumatic amnesia lasting less than 24 hours.

Finding 2: Existence of the Injury

There is evidence from clinical and animal studies that non-impact, blast-induced mild trauma to the brain can occur

- Statistically significant differences in DTI-based fractional anisotropy between mTBI associated with blast and impact only mTBI
- Statistically significant differences in Event-Related Potentials between blast and non-blast exposures in human studies
- Evidence of disturbed phase synchrony following blast exposure
- Differences in fMRI results between Breacher instructors and students
- Alterations in inflammatory markers in animal studies
- Physiological, histological, and/or behavioral differences between blast and non-blast exposures in shock tubes with rodents
- Low level axonal and glial damage/reactivity in porcine models

Finding 3: Caveats

There are limitations to the study observations

- Clinical studies are limited by a low number of cases. They also lack detailed information of the exposure conditions at the time of injury
- Translation of findings from animal studies to humans is limited by the uncertainty of scaling relationships, as well as biological and behavioral differences
- Laboratory exposures that produce brain injury in animals are limited by the lack of knowledge of real world exposure conditions

Finding 4: Body Armor Protection

These observations have become particularly relevant given the improved survivability due to protection of the torso by body armor.

Several studies have demonstrated that body armor provides protection against primary blast effects to the lungs and other air-filled organs, which are usually the first affected systems in a blast.

Finding 5: Injury Mechanism

There is insufficient evidence to support one mechanism of insult or physiological response as the most plausible explanation for non-impact blast-induced mTBI

- Blast insults include shock waves, toxic gases, thermal injuries, electromagnetic pulses, and acceleration.
- Biophysical responses include biomechanical (e.g., strain rates, stresses, flexures), chemical, vascular surge, cavitation, and shock wave-induced piezoelectric electromagnetic alterations.
- Physiological responses include vasospasm, hemorrhage/micro-bleeds, intracranial pressure, neuronal damage (synaptic, dendritic, cell body), inflammatory responses, and alterations in neurotransmitters.

Finding 6: Protection

There are *insufficient data* on the nature of non-impact, blast-induced mTBI to make recommendations on how to better protect Soldiers.

There is a need to assess and leverage neurobiological, neurobehavioral, and biophysical research funded by the DoD's Traumatic Brain Injury/Post-Traumatic Stress Disorder program and other federal programs that pertain to this matter.

Finding 7: Key Knowledge Gaps

Key knowledge gaps on the association between non-impact blast exposure and mTBI, and actions to pursue, include:

- Components and thresholds of a blast responsible for the insult and injury
- Clinical correlates associated with non-impact blast exposure
- Validated computational and analytic models
- Neuropathological data surrounding blast injury in humans
- Sharing of data across research entities
- Recovery of historical blast injury research data
- Scientifically informed protection, prevention, and treatment strategies for blast-related mTBI

Finding 8: Key Recommendations

- Standardize research methods to facilitate comparisons
- Emphasize the importance of the inclusion of proper control groups and protective equipment in experimental design
- Encourage reporting of findings in peer-reviewed literature
- Provide better documentation of experiments and modeling
- Support national recommendations to adopt common data elements on brain injury and psychological health
- Establish a research data repository
- Develop a simple, far-forward post-blast evaluation platform (including balance, hearing, smell, and oculometrics)
- Encourage interactions between clinicians and engineers
- Create specialized IPTs to review emerging findings



Points of Contact

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