



US DEPARTMENT OF DEFENSE
**BLAST INJURY RESEARCH PROGRAM
COORDINATING OFFICE**

BLAST-INDUCED MILD TRAUMATIC BRAIN INJURY (mTBI): CURRENT STATE OF THE SCIENCE

**Military Medicine Partnership Conference and Expo
Ellicott City, Maryland
6–8 March 2017**



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The opinions and assertions contained herein are the private views of the author and are not to be construed as official or reflecting the views of the Department of the Army or the Department of Defense



Agenda

- PCO Background
- International State-of-the-Science (SoS) Meeting Format and Process
- SoS Meeting Outcomes





Roles and Responsibilities



PCO Supports EA Responsibilities (DoDD 6025.21E):

- Execute DoD Blast Injury Research Programs
- Recommend Blast Injury Prevention & Treatment Standards
- Share Blast Injury Research Information
- Analyze & Prioritize DoD Blast Injury Research Needs
- Coordinate DoD Blast Injury Research Issues

2001 OEF

2003 OIF

2006

2007

2007

Congress directs SECDEF to designate an EA responsible for coordinating DoD blast injury research

Public Law 109-163, 2006 NDAA, Sec. 256

- DoDD 6025.21E designates SECARMY as the DoD EA
- EA authority flows to CDR, MEDCOM through acquisition channels: SECDEF → USD(AT&L) → ASD(R&E) → SECARMY → ASA(ALT) → CDR, MEDCOM
- ASD(R&E) assigned EA oversight

PCO established at MRMC under CDR, MEDCOM charter to support the EA



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“Blast Injuries” Defined in DoDD 6025.21E

The EA is responsible for coordinating research that addresses the entire spectrum of blast-related injuries and spans DoD and Service research programs and communities, both medical and non-medical

PRIMARY

- Blast lung
- Eardrum rupture and middle ear damage
- Abdominal hemorrhage 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")





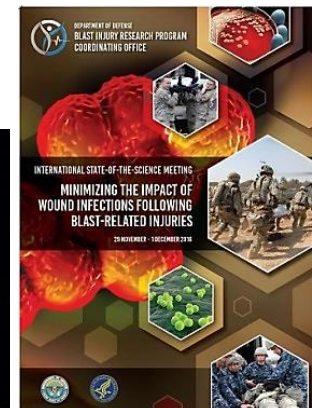
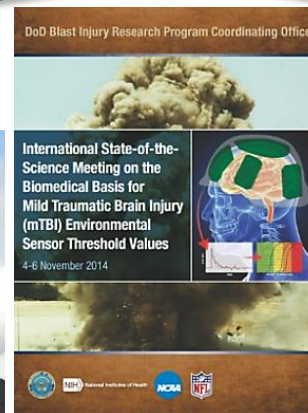
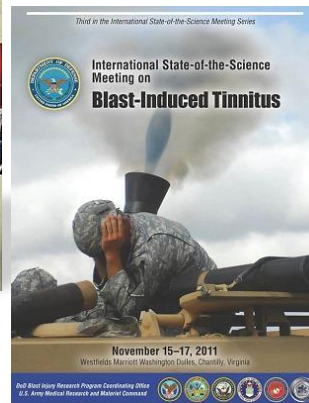
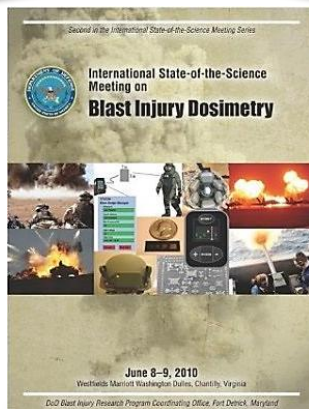
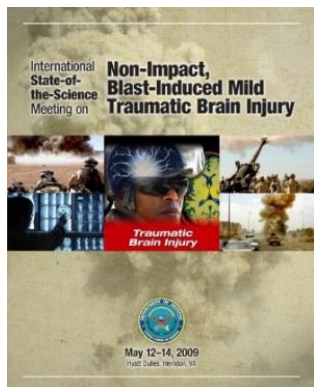
International State-of-the-Science (SoS) Meeting Series



PCO established the SoS Meeting Series in 2009 to support EA responsibilities mandated in DoD Directive 6025.21E:

- ❑ Identify blast injury knowledge gaps
- ❑ Inform research needed to fill the gaps

2009 2010 2011 2014 2015 2016



SoS proceedings are publicly available at <https://blastinjuryresearch.amedd.army.mil/>

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➤ SoS meetings follow a unique and proven format that:

- ❑ Brings together the world's experts from academia, DoD, other government organizations, industry, and allied nations
- ❑ Is inclusive of diverse disciplines: Biomedical, Engineering, Operational
- ❑ Focuses on a very specific medical research topic, chosen by stakeholders
- ❑ Identifies what is known and what is unknown about the topic of interest
- ❑ Identifies critical knowledge gaps that require medical research to fill



Advances in blast injury research require multidisciplinary approaches. SoS meetings exemplify what can be achieved when diverse communities and disciplines come together.

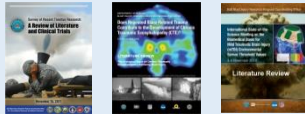


SoS Meeting Process



Pre-meeting

- Select topic
- Conduct literature review
- Assemble diverse participants



Expert Panel

Meeting

Opening Plenary – “Setting the Stage”

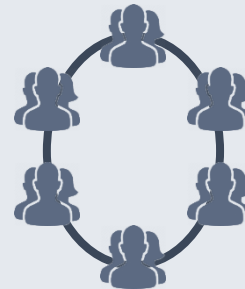
- Define requirements
- Frame the problem
- Review current & future solutions



Stimulate discussion

Challenge assumptions

Working Group Sessions

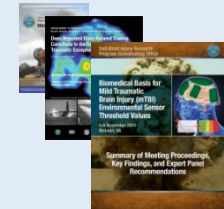


Answer set of predetermined questions

Ask difficult questions

Post-meeting

- Synthesize working group findings
- Identify knowledge gaps & make recommendations
- Publish proceedings



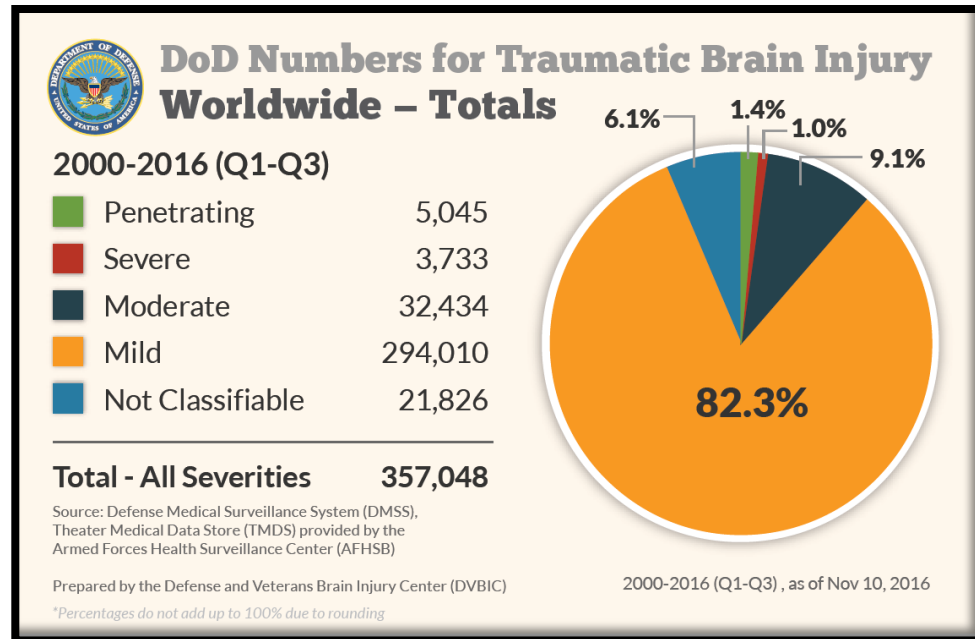
- Transmit findings to blast injury research program planners



Traumatic Brain Injury (TBI) is a Significant Health Issue for Service Members



- Not all TBIs are caused by blast – Since 2000, more than 80 percent of all TBIs were diagnosed in a non-deployed setting (*DVBIC, 2016*)
- Almost 80 percent of TBIs sustained in OIF/OEF are blast-induced (*Hoge et al. 2008; DVBIC, 2016*)
- Overall, more than 80 percent of TBIs are mild. Objective mTBI diagnostics do not exist (*DVBIC, 2016*)

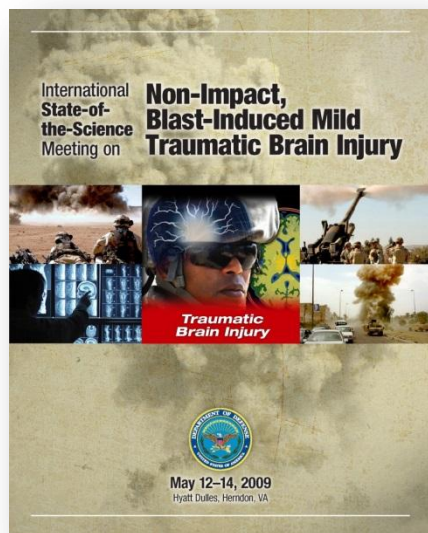




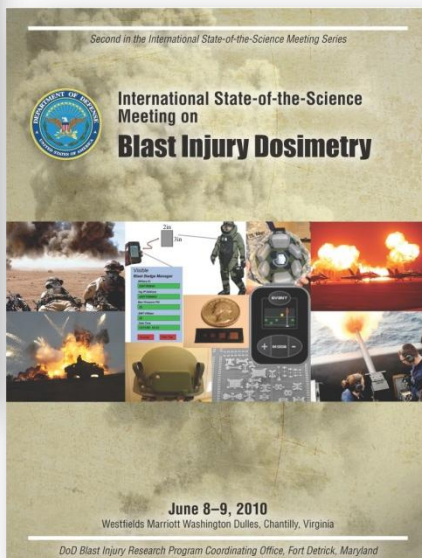
Four SoS Meetings Have Focused on Aspects of Blast-Induced Mild TBI (mTBI)



2009



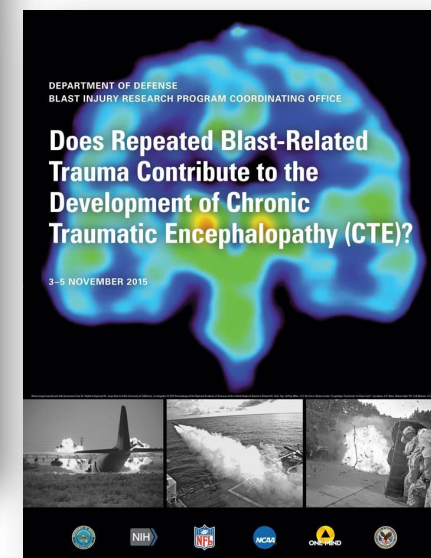
2010



2014



2015

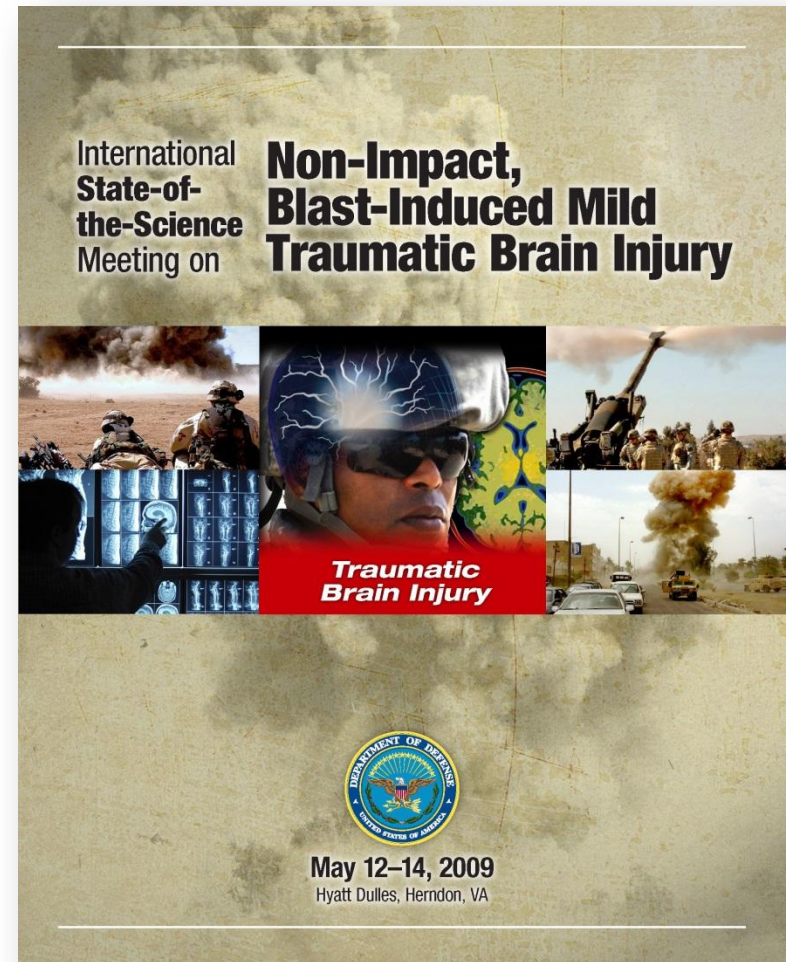


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Assessed the current state of knowledge on the existence and injury mechanisms of non-impact, blast-induced mTBI


- Is non-impact blast exposure associated with mTBI?
- What are the injury mechanisms?



International
State-of-
the-Science
Meeting on

Non-Impact, Blast-Induced Mild Traumatic Brain Injury

*Traumatic
Brain Injury*



May 12-14, 2009
Hyatt Dulles, Herndon, VA

The poster features a collage of images: soldiers in a desert, a soldier in a helmet with a lightning bolt, a tank, and a car crash. The text is set against a textured, parchment-like background.




What did we learn?

- Evidence animal studies that this injury can occur; but with many caveats
- Only one documented case report; lack of detailed blast exposure conditions
- Insufficient evidence to support one injury mechanism
- Insufficient data to support changes to personal protection systems
- Need for validated computational and animal models


Explored ways to record blast exposures and to correlate these exposures with acute injuries or chronic health effects

- What blast exposure data are required to predict mTBI?
- What sensor technologies are available now?
- What biomedical research has been done and what is needed to correlate blast exposure with injuries

Second in the International State-of-the-Science Meeting Series



International State-of-the-Science Meeting on **Blast Injury Dosimetry**



June 8-9, 2010
Westfields Marriott Washington Dulles, Chantilly, Virginia

DoD Blast Injury Research Program Coordinating Office, Fort Detrick, Maryland





What did we learn?

- DoD lacked an ability to record and document blast-related exposures and correlate those exposures with mTBI incidence
- Sensor technologies are more advanced than our biomedical understanding of mTBI – More collaboration is needed
- Need a long-term, cohesive dosimeter development strategy that includes a multidisciplinary task force to lead the effort



Biomedical Basis for mTBI Environmental Sensor Threshold Values



Reviewed the science underlying the current mTBI thresholds associated with environmental sensors

- Do existing injury thresholds predict mTBI?
- What are challenges for developing thresholds that predict mTBI?

DoD Blast Injury Research Program Coordinating Office

International State-of-the-Science Meeting on the Biomedical Basis for Mild Traumatic Brain Injury (mTBI) Environmental Sensor Threshold Values

4-6 November 2014

The poster features a central image of a brain with green sensor locations. To the right is a diagram of a head with a brain scan and a graph. The bottom of the poster displays logos for the Department of Defense, NIH, NCAA, and NFL.

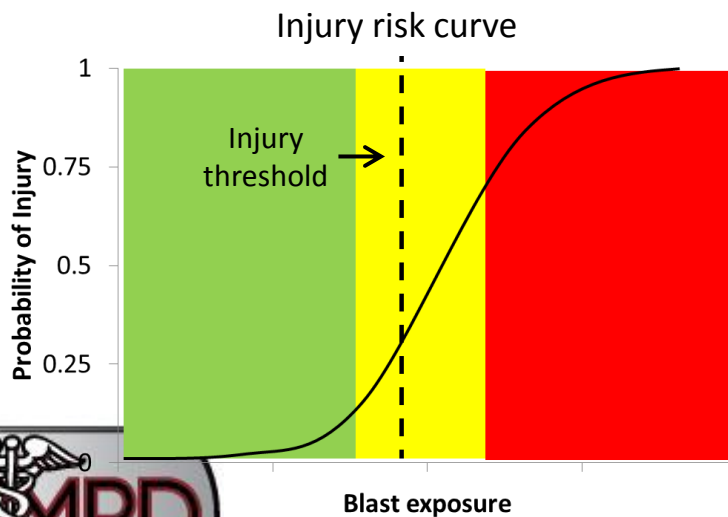


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What did we learn?

- Biomedically-valid mTBI thresholds do not exist – Absence of an injury risk curve
- Attempts to correlate sensor data with clinical outcomes have been unsuccessful
- Fielded sensors lack performance standards or clearly-defined purpose
- Greater coordination and information sharing between sensor development and TBI biomedical communities is imperative





Does Repeated Blast-Related Trauma Contribute to the Development of Chronic Traumatic Encephalopathy (CTE)?



Examined the links between repeated blast-related trauma, neurodegeneration, and CTE

- What are the pathological features of CTE?
- What are the risk factors for CTE?
- How do we research the development of CTE resulting from repeated blast exposure?
- How do we detect CTE early? (premortem versus postmortem)
- How do we prevent, mitigate, or treat neurodegeneration following repeated blast exposure?

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Does Repeated Blast-Related Trauma Contribute to the Development of Chronic Traumatic Encephalopathy (CTE)?

3-5 NOVEMBER 2015

Small images at the bottom of the poster show: 1. A military aircraft on a runway. 2. A large explosion or blast. 3. A soldier in a combat environment.

Logos at the bottom of the poster include: DOD, NIH, NFB, ACBA, ONE MIND, and the Department of Defense seal.





What did we learn?

- Existing scientific evidence is insufficient to link blast-related TBI with CTE
- Need for an accessible brain bank and tissue repository
- Need for longitudinal and prospective studies to identify risk factors and spatiotemporal development of CTE
- Need for biomarkers, standardized clinical diagnostic criteria, and validated animal models



Where do we go from here?



Knowledge Gap

Identified Solution

Insufficient evidence to support specific injury mechanisms of blast-induced mTBI

Need to develop and validate animal and computational models

Sensor technologies are more advanced than our understanding of mTBI and biomedically-valid mTBI thresholds

Need increased collaboration and information sharing between sensor development and TBI biomedical communities

Lack of scientific evidence linking blast-related TBI with CTE

Need prospective, longitudinal research, identification of biomarkers, and standardization of clinical diagnostic criteria





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Questions?



For additional questions after the conclusion of the conference, send an email message to usarmy.detrick.medcom-usamrmc.mbx.mmpd@mail.mil

