



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

DoD brain Injury Computational Modeling Expert Panel

**“Head Protection Summit”
PM Soldier Protection and Individual Equipment
Springfield, VA
16-17 Feb 2011**

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*The views expressed in this presentation are those of the authors
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Agenda

- ✓ DoD Blast Injury Research Program History and Governing Directive
- ✓ Executive Agent (EA) Responsibilities and Program Coordinating Office (PCO) Functions
- ✓ Defense Health Program TBI Research Approach
- ✓ PCO Initiatives
 - ❑ State-of-the-Science Meeting on Non-Impact, Blast-Induced mTBI
 - ❑ DoD Brain Injury Computational Modeling Expert Panel
 - ❑ Blast Injury Prediction Tool Assessment Process (BIPTAP)



DoD Blast Injury Research Program Background

Program History

- Established by SECDEF in Jul 06 in response to Congressional mandate (Section 256, FY06 NDAA)
- Objective 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 (Executive Agent) delegated to ASA(ALT) then to Cdr, MEDCOM
- Program Coordinating Office (PCO) established at USAMRMC in Jun 07

Key PCO Functions

- Identify blast injury knowledge gaps and prioritize research to fill gaps
- Oversee the JTAPIC Program to enhance Warfighter survivability
- Recommend blast injury prevention standards, including protection equipment performance standards for DoD
- Leverage expertise from industry, academia, and federal agencies to solve difficult 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*



Program Responsibilities

(DoDD 6025.21E, Medical Research for Prevention, Mitigation, and Treatment of Blast Injuries)

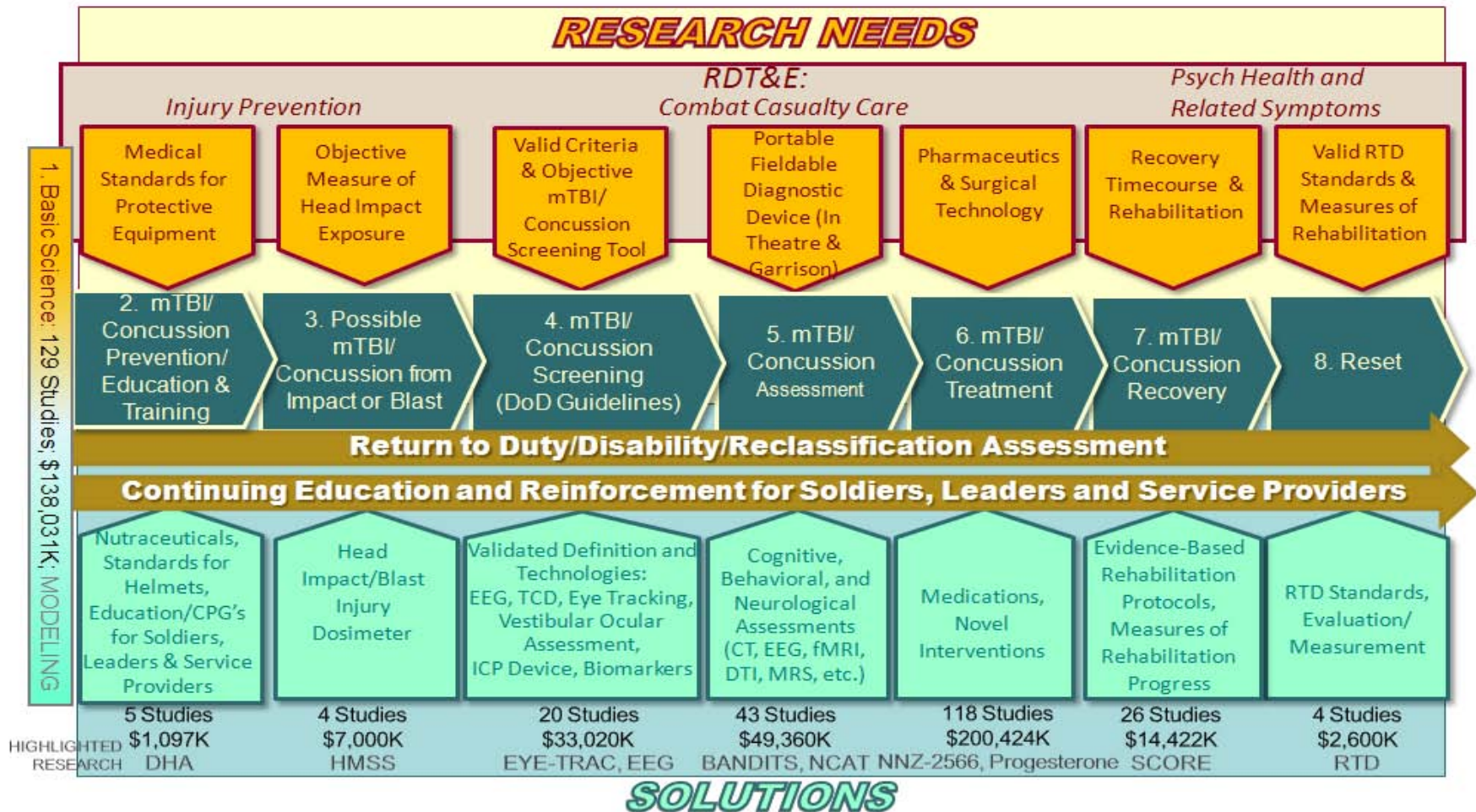
Responsibilities and Functions	DDR&E (ASBREM Chair)	ASD (HA) (ASBREM Co-Chair)	SECARMY (EA)	SECNAV & SECAF	USUHS	CJCS	USSOC	JIEDDO
Oversee EA	✓							
Approve Blast Injury Research Programs	✓							
Ensure new technology is transitioned to DoD Components	✓							
Assist in requirements development and needs assessments	✓	✓		✓			✓	✓
Approve blast injury prevention, mitigation & treatment standards		✓						
Ensure MHS information systems support the EA		✓						
Program, budget and execute DDR&E approved program			✓					
Support joint database for improving protection systems (JTAPIC)			✓					✓
Recommend blast injury prevention, mitigation & treatment standards			✓					
Appoint ASBREM Reps			✓	✓	✓	✓	✓	✓
Coordinate all blast-injury efforts and requirements through the EA				✓	✓	✓	✓	✓



Defense Health Program

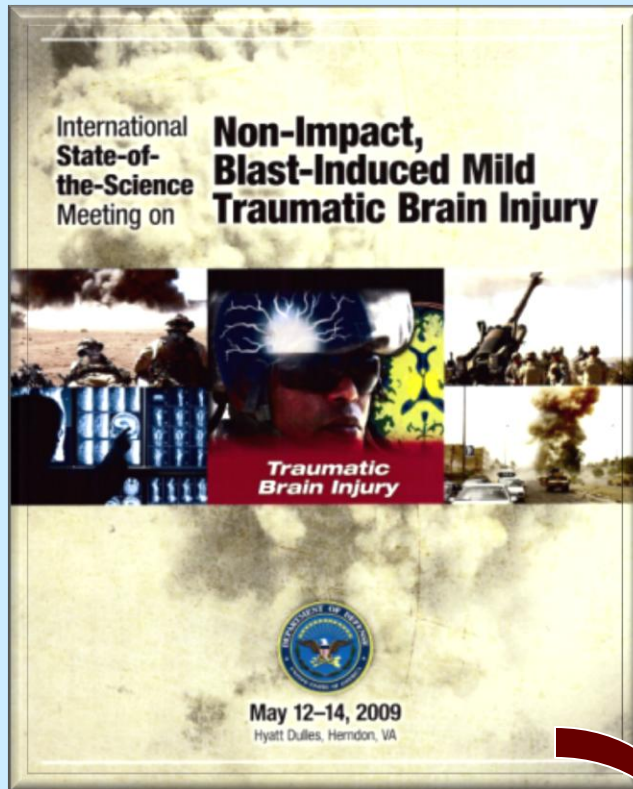
TBI Research Approach

Continuum of TBI Care Determines Research Approach





1st International State-of-the-Science Meeting Non-Impact, Blast-Induced mTBI (May 12-14, 2009, Chantilly, VA)

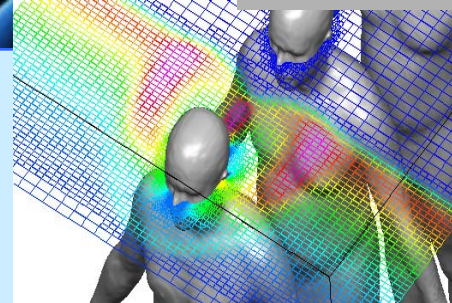
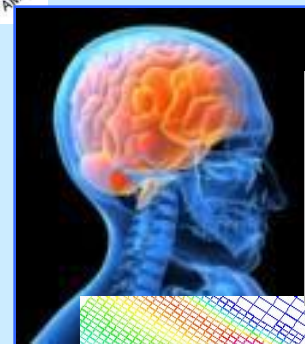


**Established DoD Brain
Injury Computational
Modeling Expert Panel**

- ❖ Assessed what we know and don't know about the existence and mechanisms of this injury
- ❖ Attendees from DoD, VA, DOT, academia, and industry (Canada, Japan, the Netherlands, Sweden & USA)
- ❖ Key Findings:
 - ✓ Evidence from clinical and animal studies that this injury can occur, **but with many caveats**
 - ✓ Insufficient evidence to support one injury mechanism
 - ✓ Insufficient data to support changes to Warfighter protection systems
- ❖ Identified knowledge gaps and recommended improvements in research project coordination and data sharing

DoD Brain Injury Computational Modeling Expert Panel

- ❑ **Objective:** To assess the state-of-the-science in computational modeling of non-impact, blast-induced mTBI and to integrate DoD research efforts to accelerate the transition of preventive and treatment strategies
- ❑ **Institutions represented:** DoD, other government agencies, academia, industry, and international researchers & clinicians
- ❑ **Deliverables (starting March 2011):**
 - ✓ Develop TBI community bench marking (model specifications, sharing, comparative analyses, and validation)
 - ✓ Laboratory Benchmarks to Support Model Validation (In-vitro, animals, and surrogate)
 - ✓ Validation strategy (In-vitro to in-vivo and scaling from animal to human)



communications
Jaycor



Focus on injury mechanism and “translating” mathematical models to support prevention and treatment strategies

Brain Injury Computational Modeling Challenges

- Developing validated constitutive models for material properties of skull, cerebrospinal fluid (CSF), and brain tissue, particularly for large strain rates and for perfused tissue
- Developing mechanical dose-response models of brain tissue dysfunction
- Developing an objective method to measure blast exposure
- Modeling impact (obtaining the correct parameters for contact and friction) between brain and cranium
- Developing benchmark loading paradigm to facilitate model comparison and validation
- Determining how to properly account for the presence of large cerebral blood vessels, bridging veins, and brain perfusion
- Developing adequate models of tissue response/mechanical injury (material failure)
- Modeling soft tissue
- Exploring the issue of cavitation
- Developing criteria for animal models that reproduce injury (determining endpoints)
- Establishing linkages to neurobiology
- Establishing solid models across multiple geometric scales
- Solving brain biomechanics equations using finite element method solvers for soft tissue (overcoming numerical difficulties)
- Simulating long-time transient brain biomechanics during secondary injury development (e.g., edema, hematoma, and herniation)
- Understanding how mechanical energy translates into a concussion
- Coupling whole body and the brain
- Understanding thresholds for injury (e.g., determine whether closed head injury thresholds for TBI in civilians can be applied to mTBI)



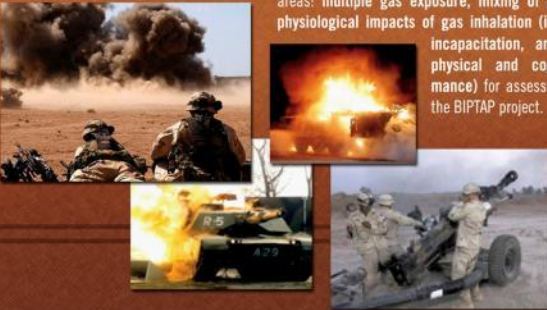
Blast Injury Prediction Tool Assessment Process (BIPTAP)



Medical Standards for Blast Injury Prevention: Fire Gas Inhalation

**Conference • February 2-4, 2010
Westfields Marriott, Chantilly, VA, USA**

Sponsored by the U.S. Army Medical Command's Blast Injury Research Program Coordinating Office (PCO), this year's BIPTAP conference will focus on potential medical standards that can address the pressing issue of fire gas inhalation injury and its impact on the warfighter. Conference attendees will include leading experts drawn from the Department of Defense, government, academia, and industry. The Johns Hopkins University Applied Physics Laboratory (JHU/APL) is interested in gathering information on computational fire gas inhalation models that address one or more of the following areas: multiple gas exposure, mixing of gases, and the physiological impacts of gas inhalation (including injury, incapacitation, and impacts on physical and cognitive performance) for assessment as part of the BIPTAP project.



For more information or to register, please visit www.biptap.com.

APL
The Johns Hopkins University
APPLIED PHYSICS LABORATORY

BLAST INJURY PREDICTION TOOL ASSESSMENT PROCESS

- Fulfills EA responsibility to identify and recommend **blast injury prevention standards** to ASD(HA) for approval and DoD-wide application
- Initial focus on tools for assessing fire gas inhalation injury and performance effects to support health hazard and combat vehicle crew survivability assessments
- Johns Hopkins University/Applied Physics Laboratory developing the process for the PCO:
 - Identify relevant blast injury prediction models
 - Establish independent review panel
 - Establish review criteria
 - Host evaluation conference
 - Recommend standards to PCO
- PCO will staff recommendation to ASD(HA)



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