Department of Defense Warfighter Brain Health Research Strategy

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1. INTRODUCTION

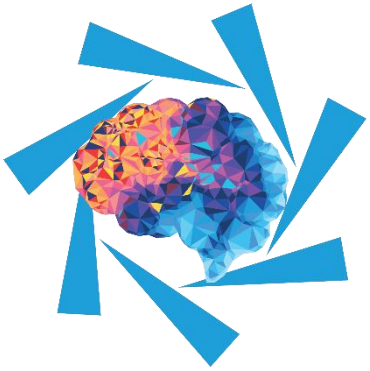
This document provides guidance for the Department of Defense (DoD) medical and operational research and development (R&D) activities to coordinate, optimize, and advance warfighter brain health (WBH) science. The WBH Research Strategy accompanies the Department's WBH Initiative Strategy and Action Plan [1], fulfills an implementation task from the WBH Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities and Policy Change Recommendation (DCR) [2], and expands upon the WBH Initial Capabilities Document (ICD) [3]. The WBH Research Strategy also complements and draws information from recently completed capabilities-based assessments performed for the Military Health System [3,5-12] and incorporates the Defense Health Agency's (DHA) Traumatic Brain Injury (TBI) Strategic Research Plan [13].

WBH is defined as the physical, psychological, and cognitive status that affect a warfighter's capacity to function adaptively in any environment and impacts readiness, operational capability, mission effectiveness, and the goal to achieve overmatch or superior lethality [1]. Therefore, research on WBH aims to develop innovative knowledge, solutions, and capabilities that address the brain health needs of the warfighter, optimize WBH in all environments, and enhance force health protection and warfighter readiness to include countering known and emerging hazards and threats that may cause TBI or other adverse brain health effects.

Although strides have been made in WBH, there are still gaps in knowledge and materiel capabilities that further research needs to close. Though brain injuries have been studied and researched for decades, understanding the consequences of brain injuries and co-occurring conditions took on heightened importance following the start of overseas contingency operations in 2001. Once data and analysis of injury and casualty rates began to flow through the military medical and operational research communities, clinicians and researchers jumped into action to determine ways to better understand, prevent, mitigate, and treat such injuries and co-occurring conditions. Immense strides in military medical research have been made between 2001 and now with incredible improvements to casualty rates and a reduction in preventable deaths. Many of these improvements addressed the loss of limb and eyesight, but a number were for injuries to the brain. Warfighters remain at risk of exposures, brain injuries, and other wounds during military activities, especially those that involve combat.

1.1 Vision

This WBH Research Strategy outlines R&D on brain health hazards, threats, and operational requirements with the goal of rapidly transitioning products and practices to optimize WBH and performance.



2. WBH RESEARCH AREAS

The DoD WBH Research Strategy is broken down into seven WBH Research Areas (Sections 2.1-2.7). The DHA TBI Strategic Research Plan, focused on TBI Capability Requirements and medical components of WBH, also aligns to these areas as depicted in ***Figure 2-0 WBH Research Strategy Alignment***. High-priority WBH and TBI Capability Requirements to be addressed by WBH research are described in the DoD WBH Initiative Strategy and Action Plan [1], WBH ICD [3], and DHA TBI Strategic Research Plan [13].

This section summarizes the medical and operational WBH Research Areas and high-level research activities associated with each. It aims to describe the research focus areas that DoD will transition into medical materiel and knowledge products to enhance WBH and readiness.

WBH Research Areas	DHA TBI Strategic Research Plan Priorities
1. Identify Hazards and Threats to WBH	Assessment Tool Development (T2)
2. Surveil WBH	
3. Recognize Changes in WBH	
4. Improve Warfighter Cognitive and Physical Performance	Cognitive Restoration and Enhancement (T7)
5. Protect Warfighters	Countermeasure Development (T1)
6. Assess and Diagnose Warfighter Brain Injuries	Point of Injury Stabilization (T3) Complex Injury Stabilization (T4)
7. Treat and Rehabilitate Warfighter Brain Injuries	Treatment Development (T5) Clinical Practice Guideline Development (T6)

Note: Only the primary alignment is represented in this depiction as each WBH Research Area or TBI Priority may align to multiple Priorities or Research Areas.

Figure 2-0 WBH Research Strategy Alignment

2.1 Research Area 1: Identify Hazards and Threats to WBH

To sustain or restore cognitive and physical performance we must understand the known and emerging hazards and threats to brain health. Examples (not prioritized) include, but are not limited to the following:

- Ballistic Projectiles
- Blast (e.g., underwater and subterranean exposures) [14]
- Blunt force impact
- Chemical/Biological
- Directed energy (e.g., pulsed high power microwave)
- High G acceleration/recoil
- Other environmental hazards
- Pressure fluctuations (e.g., aviators)

Key Activities in Research Area 1:

- Investigate WBH Hazards and Threats in:
  - Operating Environments
  - Training Environments
  - Garrison Environments
  - Off-Duty Environments

The ability to identify known and emerging brain health hazards and threats will allow DoD to monitor warfighters and implement actions to reduce risks of adverse health effects. Research should focus on understanding the wide variety of brain health hazards and threats to enable improved monitoring, documentation, and safety measures (which includes the mitigation and health/performance effects) in response to brain health hazards and threats. For instance, blast exposures and associated TBI research has been of particular interest in recent years in part in response to the National Defense Authorization Act for Fiscal Year 2018 (FY18 NDAA) Section 734 [14], FY19 NDAA Section 253 [15], and FY20 NDAA Sections 717 and 742 [16]. Warfighters may be at risk of brain exposures or injuries in operational, training, garrison, and off-duty environments. Therefore, activities in all environments should also be examined to understand the inherent risks to brain health which may indirectly impact force health, readiness, and performance.

2.2 Research Area 2: Surveil WBH

Key Activities in Research Area 2:

- Identify Components of WBH Readiness
- Develop Ways to Baseline WBH
- Inform WBH Risk Assessments
- Develop Ways to Track and Monitor WBH

WBH research and its application in the field should focus on improving surveillance-related capabilities [17]. Such research will inform monitoring changes to individual and collective brain health over time. Research in these areas should allow for identification of baseline WBH parameters and variations over time due to brain health hazards and threats. In addition, research will elucidate the incidence and circumstances of all brain health hazards and threats within the military to identify risk factors and variables in various settings (operations, weapons training, combatives, parachute training, etc.); identify the environmental or contextual ranges (e.g., for sensors and gauges) to accurately identify a brain exposure; and understand the effects of

personal factors (demographic, sex, gender, genetic, medical history, injury, and exposure history) on the warfighter response to brain exposures and development of injury symptoms. Data from such research will inform health surveillance and decision-support capabilities of deployed and garrison personnel [12].

2.3 Research Area 3: Recognize Changes to WBH

Considering the variety of brain health hazards, threats, and range of exposure levels, research is needed to identify and quantify the relationship between exposures and health outcomes, including long-term and late-presenting effects. Exposure factors also affecting injury severity may include extreme environments and altered physiological states that occur alone or in combination with other brain hazards and threats. Accurate dose-response curves as opposed to a single "line-in-the-sand' (e.g., 4 pounds per square inch for all human blast injuries) will inform understanding the effects of exposures and the development or revision of return to duty protocols. These risk curves are also important to inform development of non-invasive assessment tools to help frontline responders recognize changes in a warfighter's brain health. In this regard, artificial intelligence/machine learning may be applied to identify changes based on a wide variety of factors. Without known dosage levels and associated risk curves, warfighters may be inadvertently exposed to brain health hazards and threats that lead to acute, long-term, or late effects. Because exposures and their effects may occur over time and lead to decreasing brain health, it is important to understand how various brain health hazards and threats interact with warfighters in the short- and long-term.

Key Activities in Research Area 3:

- Develop Ways to Track and Monitor Brain Exposures
- Develop Ways to Identify Accumulation of Brain Exposures in Warfighters
- Determine Changes in WBH Status and Readiness

2.4 Research Area 4: Improve Warfighter Cognitive and Physical Performance

Warfighters perform demanding jobs, with combat as one of the most physically and cognitively demanding activities a human can engage in. While the military has historically prioritized the physical fitness of warfighters, it must also elevate the importance of cognitive fitness and health.

Key Activities in Research Area 4:

- Determine Warfighter Cognitive Health Baselines
- Identify Ways to Assess Warfighter Cognitive Performance
- Identify and Develop Mechanisms to Improve Cognitive and Physical Performance

To achieve and sustain optimal cognitive performance and brain health, this Research Area focuses on developing ways to improve warfighter cognitive and physical performance. Understanding the mechanisms underlying cognitive and physical performance outcomes and how they occur (i.e., their relationship to single and multiple brain exposures and brain injuries) is needed to devise better tools and capabilities to improve outcomes. Research focusing on the effects of deployment tempo and the cognitive and physical processes underpinning role-specific military tasks will enable DoD to adjust its guidance and solutions accordingly. The DoD

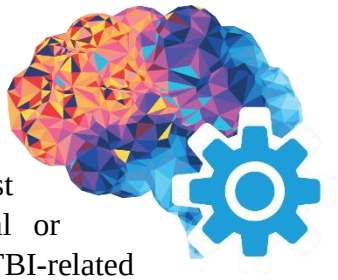
Cognitive Monitoring Program, which will monitor and assess the cognitive performance of all warfighters, will be a key tool in gathering data ripe for analysis to determine how cognition is affected during a warfighter's career and lead to new insights for guidance, training, education, and capabilities to improve and restore warfighter cognitive performance.

2.5 Research Area 5: Protect Warfighters

Key Activities in Research Area 5:

- Develop Knowledge Products on WBH Threats
- Develop and Improve Protective Measures and Materials

Building upon the Research Areas related to surveillance (Research Area 2) and recognizing changes in WBH (Research Area 3), it is important to conduct research focused on protecting WBH. Such research may, for example, determine the allowable number of rounds to which warfighters can be exposed during training and operations based on a given weapon's properties, the warfighter's body position (e.g., prone, sitting, kneeling, standing), the training needed to ensure proficiency or mastery, and the environmental conditions (e.g., being indoors, being outdoors, being in a trench) that make a warfighter vulnerable to brain health hazards and threats. This research should also enable understanding of the long-term risks and consequences of various exposures, such as repetitive exposure to blast across a warfighter's career, as is often the case for breachers or range personnel. In addition, research efforts should inform the identification or development of materials that improve personal or collective protective equipment (e.g., vehicularly-integrated and PPE-embedded sensor systems that can assist with classification and measurement of blast exposures); supplemental or modified training methods (e.g., virtual or augmented reality) and/or operational activities to reduce overall TBI-related exposure; and knowledge products which provide guidance on exposure ranges for various injury conditions [1],[12].



2.6 Research Area 6: Assess and Diagnose Warfighter Brain Injuries

Key Activities in Research Area 6:

- Develop and Improve Means to Assess Warfighters for Return-to-Duty
- Develop Improvements to Diagnosing Warfighter Brain Injuries

Better management of WBH requires improved capabilities to recognize, assess, and diagnose brain injuries. Therefore, research is needed to develop and validate objective tools and tests for brain injury status at any level of care, in any environment, including tools based on biomarkers, sensory system status, blood products, neuroimaging, neurocognitive status, and other histologic, radiographic, molecular, and physiologic characteristics which may emerge as foundational understanding of brain injuries improves. Novel classification systems are also needed to better characterize brain injury beyond clinical severity or physical mechanism of injury. In turn, these research advancements can inform improvements in medical and operational decision-making.

Alongside research on brain injury assessment tools and tests, research is needed to improve understanding of the onset and progression of brain injury symptoms over time, distinct from those caused by other stressors, exposures, and disease conditions. In this regard, research should aim to identify and validate standardized clinical criteria for diagnosis and prognosis of symptom trajectory for patients experiencing brain injury and/or other brain health dysfunction. Of particular interest are characterizing the effects of brain injuries and symptom progression on occupational performance and military readiness in warfighters [9]. Critical to assessing effects of brain injuries over time, including late and long-term, is the stringent documentation of exposure characteristics, environmental context, treatment interventions, and subsequent health outcomes. However, research is needed to improve mechanisms of longitudinal documentation and analytic tools and techniques (e.g., artificial intelligence and machine learning) for WBH and related data.

Research must also consider the role of family members, peers, leaders in recognizing the signs and symptoms of brain injuries. This is particularly important for mild TBI (mTBI) and chronic traumatic encephalopathy which may go un/underreported in part due to less severe and sometimes delayed signs and symptoms. Without visible symptoms following brain exposures or injuries, gaps exist in understanding delayed outcomes and associated care. Ultimately, research efforts should aim to adapt as the patterns and understanding of brain injuries evolve in any environment where military activities occur (e.g., subterranean, aeromedical) and in coordination with other stakeholders beyond the warfighters themselves.

2.7 Research Area 7: Treat and Rehabilitate Warfighter Brain Injuries

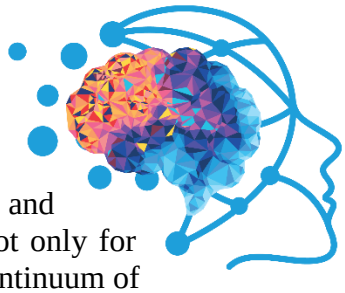
Key Activities in Research Area 7:

- Improve WBH Treatments, Protocols, and Guidelines
- Improve WBH Rehabilitation, Protocols, and Guidelines
- Improve Treatment and Rehabilitation Documentation

As acute trauma healthcare and rehabilitation treatments continue to improve for severe and complex injuries, surviving warfighters are increasingly experiencing chronic or long-term effects as well as late-presenting brain health detriments. Extended or specialized medical treatment, rehabilitation and health monitoring may therefore be indicated for the tenure of active service as well as throughout retirement. The military medical research community must continue to identify acute treatments and rehabilitation protocols to ensure optimal health readiness throughout active service as well as high quality of life for veterans experiencing long-term and late-presenting effects of brain health hazards following retirement. Many years of longitudinal research may be needed to sufficiently understand long-term and late effects of brain exposures to develop and optimize treatment and rehabilitation protocols. Sustained research is needed to understand, develop approaches, apply those approaches, and subsequently reduce or eliminate short- and long-term effects of brain injuries and other conditions, especially when considering solutions to reduce polymorbidities and secondary sequelae of brain injuries [4],[9]. Comparative efficacy research should be conducted to determine the impact of interventions and associated recommendations (e.g., the optimal timing of mitigation actions/interventions and rehabilitation strategies to improve outcomes).

Over time, hazards and threats to WBH may change and drive a need to revisit associated

understanding of related mechanisms and impacts. These changes may include a shift to responding to new hazards and threats affecting warfighters to include those that would benefit from cognitive and motivational interventions or strategies to affect high-risk behaviors [12]. As brain health hazards and threats evolve and limitations in resources and understanding perpetuate, research efforts should also aim to support development of training technologies that are able to effectively model TBI symptom trajectory with and without treatment [6].



Long-term and late effects of brain injury may not be observed while warfighters are still on active duty and, if they are, the specialty care needed may not be delivered solely in military treatment facilities. Therefore, it is important to coordinate with the Department of Veterans Affairs and other government and non-government agencies, industry, and academia to conduct research to understand and mitigate long-term consequences and late effects of known and emerging WBH hazards and threats. This coordination is critical not only for clinical research but also for the seamless transition across the full continuum of care as patients leave military service.

3. CONCLUSION

The Department aims to retain optimal force readiness and improve veteran quality of life. As brain health has emerged as an essential medical topic for the military, so too has increased focus on optimization, maintenance, and recovery of WBH. This research strategy has outlined seven key research areas which provide a foundation for improved brain health readiness including but not limited to TBI. As force lethality and overmatch remain a fundamental goal of military training and combat, adequate care for service members must also match the level of health threats faced within garrison and deployed environments.

Brain exposures and injuries will likely remain an issue in future conflicts, particularly for those that could involve militaries with similar offensive capabilities as ours. Warfighters will need to train on legacy and new weaponry, some of which may present a health threat to the operator, necessitating changes in training protocols while preparing for combat operations and activities. While new patterns may emerge based on experience during combat and medical care, it is likely that such brain health hazards and threats will continue to be an unfortunate consequence of operations and may be further complicated by the need for prolonged care in deployed and garrison settings. Even with significant improvements over the past 20 years, there are many areas of research needed to ensure effective understanding, surveillance, diagnosis, treatment, and rehabilitation of brain exposures and brain injuries. Advancing the science on WBH is a critical step in providing the best care possible to our nation’s warfighters. Warfighters give their time, energy, and sometimes their bodies in service to the United States; the Department must do everything it can to ensure those sacrifices are neither forgotten nor disregarded once a warfighter leaves active service.

4. REFERENCES

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[4] DoDI 6490.04, Mental Health Evaluations of Members of the Military Services, DoD, 2020

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[13] TBI Strategic Research Plan, DHA, 2023

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[15] FY19 NDAA Section 253

[16] FY20 NDAA Sections 717 and 742

[17] Todd E. Rasmussen, MD; Reilly, P.A.; and Baer, D.G. Why Military Medical Research? Military Medicine, Volume 179, Issue suppl_8, August 2014, Pages 1–2, https://doi.org/10.7205/MILMED-D-14-00245

1. APPENDIX

1.1 Detailed WBH Research Strategy Alignment

Note: Only the primary WBH ICD and DHA TBI SRP Priorities alignment is represented in this depiction as each objective or priority may align to multiple ICD Sub-Capabilities and WBH Research Areas.

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
LOE 1: Optimize Cognitive and Physical Performance	1a. Establish cognitive and physical performance baselines to identify performance changes	4. Improve Warfighter Cognitive and Physical Performance	3. Recognize Changes in WBH 4. Improve Warfighter Cognitive Performance	24.Conduct research to understand the mechanisms underlying cognitive performance improvements to devise better cognitive performance improvement tools, capabilities, and supplements.	T7. Cognitive Restoration and Enhancement
	1b. Enhance current cognitive and physical performance to achieve superior lethality and readiness	4. Improve Warfighter Cognitive and Physical Performance	4. Improve Warfighter Cognitive and Physical Performance	24.Conduct research to understand the mechanisms underlying cognitive performance improvements to devise better cognitive performance improvement tools, capabilities, and supplements.	T7. Cognitive Restoration and Enhancement
	1c. Restore cognitive and physical performance after brain exposures or injury	4. Improve Warfighter Cognitive and Physical Performance	3. Recognize Changes in WBH 4. Improve Warfighter Cognitive Performance	25.Conduct research to understand cognitive outcomes and physiological changes from single brain exposures.	T7. Cognitive Restoration and Enhancement
	1d. Raise awareness and convey best practices that maximize cognitive and physical performance	4. Improve Warfighter Cognitive and Physical Performance	3. Recognize Changes in WBH 4. Improve Warfighter Cognitive Performance	26.Conduct research to understand cognitive outcomes and physiological changes from multiple brain exposures.	T7. Cognitive Restoration and Enhancement
				27.Conduct research to understand the relationship between deployment tempo and maintenance/restoration of WBH.	
				28.Conduct research to identify safe, effective, and useful candidate neuroprotective measures for warfighters to use pre- and post-injury.	
				29.Conduct research to identify the cognitive processes underpinning the role-specific operational tasks regularly performed by warfighters.	
				30.Develop neurocognitive assessment tools that enable an accurate understanding of a warfighter's cognitive readiness for military activities and readiness requirements prior to a	

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
				brain exposure.	
				31.Develop ways to objectively assess cognitive performance following brain exposures or injuries.	
				32.Develop validated metrics to assess cognitive performance and capacity to test the safety and efficacy of candidate interventions.	
LOE 2: Identify, Monitor, and Mitigate Brain Exposures	2a. Understand the known and emerging threats and hazards to brain health	1. Identify Hazards and Threats to WBH	1. Identify Threats to WBH	1.Conduct research to understand militarily-relevant parameters that cause blast injury to the brain (e.g., acceleration effects, blast overpressure).	T2. Assessment Tool Development
				2.Conduct research to understand the effects of multiple concussive or sub-concussive blast exposures on acute and long-term physical, psychological, and cognitive outcomes.	
				3.Conduct research to determine how blast exposures affect sensory systems acutely and over the long-term.	
				4.Conduct research to identify and understand the risks to brain health from common off-duty environments and activities (e.g., sports, substance use, supplement use).	
				5.Conduct research to understand the brain health effects of infectious diseases (e.g., COVID-19).	
				6.Conduct research to understand the causes, symptoms, and sequelae of unconventionally-acquired brain injuries (UBI).	
				7.Conduct research to understand the interaction between UBI and other types of exposures or injuries.	
				8.Conduct research to understand how different DE sources cause brain injuries and what the effects of those brain exposures are on the warfighter.	
				9.Conduct research to understand how chemical, biological, radiological, and nuclear weapons or capabilities affect WBH.	

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
	2b. Monitor warfighters for brain exposures	2. Surveil WBH 3. Recognize Changes in WBH	2. Surveil WBH	10.Conduct research to determine the prevalence of all brain injuries within the military to identify risk factors and variables in various settings (operations, weapons training, combatives, parachute training, etc.).	T2. Assessment Tool Development
				11.Conduct research to identify the environmental or contextual thresholds for sensors and gauges to accurately identify a brain exposure.	
				12.Conduct research to understand the demographic, sex, gender, genetic, medical history, injury, and exposure history factors that affect how warfighters respond to brain exposures and injuries.	
				13.Develop sensor and gauge technologies that accurately record, store, transmit, and analyze data on the brain exposures warfighters are subjected to in training or operational environments without compromising operational security.	
				14.Develop user-friendly/acceptable sensor systems (e.g., embedded, mounted, attached, and/or warfighter-worn) to comprehensively characterize aspects of single and repeated blast exposures, including distance, mechanism, magnitude/dosage, environmental barriers, warfighter-specific conditions, and usage and effectiveness of protective equipment.	
				15.Develop sensors for all types of WBH exposures (e.g., toxic substances, psychological insult, blunt impact, acceleration, DE) to augment self-reporting and other surveillance capabilities.	
				16.Develop models to support medical planning to forecast numbers and types of brain injuries that could occur due to adversary actions during conflict in the future	

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
				operating environment.	
			3. Recognize Changes in WBH	17.Conduct research to identify the brain exposure "dosage" that can lead to minor, major, and severe trauma to the brain as well as the long-term or late effects of those doses.	
				18.Conduct research to identify how brain health degradation occurs from cumulative brain exposures from various sources.	
				19.Conduct research to understand the effect of co-occurring conditions to brain exposures and injuries that influence functional outcomes for warfighters, including performance.	
				20.Conduct research to understand the impact of extreme environments and altered physiological states (e.g., extreme heat/humidity, extreme cold, outer space, low-gravity/weightlessness) on WBH.	
				21.Develop tools that help frontline responders recognize changes in a warfighter's brain health through non-invasive assessments.	
				22.Develop an accurate dose-response curve for human blast injury.	
				23.Develop an accurate biomedical model of the human head to test impact or other exposures' effects on the human brain.	
	2c. Reduce risks of brain exposures that may negatively impact brain health	5. Protect Warfighters	5. Protect Warfighters	33.Conduct research to determine the allowable number of rounds to which warfighters and training personnel can be exposed, based on a given weapon's properties, the warfighter's body position, the needed training to ensure proficiency or mastery, and the environmental conditions.	T1. Countermeasure Development
LOE 3: Prevent, Recognize, and Minimize the Effects of TBI	3a. Reduce risks of TBI that may negatively impact brain health	5. Protect Warfighters	5. Protect Warfighters	34.Conduct research to understand the long-term risks and consequences of single or repeated blast exposure, including repeated exposure across a warfighter's lifecycle (e.g.,	T1. Countermeasure Development

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
				for breachers or range/training personnel).	
				35.Conduct research to develop new materials/alloys/hybrid materials that will improve individual or collective protective equipment.	
				36.Conduct research to develop supplemental training methods (e.g., virtual/augmented reality) to reduce overall blast exposure.	
				37.Develop guidance for warfighters and training personnel on the allowable number of rounds to which warfighters can be exposed in training situations or on ranges, based on their body position (prone, sitting, kneeling, standing) and environmental conditions (e.g., being indoors, being outdoors, being in a trench).	
				38.Develop vehicularly-integrated and personal protective equipment (PPE)-embedded sensor systems that can assist with classification and measurement of blast trauma.	
				39.Develop head protection concepts that reduce brain rotational movement and shear forces in blunt head impacts for warfighters operating in-ground and aviation environments without compromising head movement necessary during operations.	
				40.Develop tailored protective options and measures that mitigate or eliminate the risks of brain exposures or injuries.	
				41.Develop countermeasures that mitigate hazardous brain exposures in any environment.	
				42.Develop countermeasures that alleviate the effects of brain exposures and injuries while maintaining combat effectiveness, including immediate and sustaining treatments for chronic pain that do not degrade performance.	

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
				43.Develop new materials/alloys/hybrid materials that can improve PPE.	
	3b. Educate stakeholders regarding the signs and symptoms of TBI and a means to report it	6. Assess and Diagnose Warfighter Brain Injuries	3. Recognize Changes in WBH	21.Develop tools that help frontline responders recognize changes in a warfighter's brain health through non-invasive assessments.	T2. Assessment Tool Development
	3c. Reduce the effects of TBI on brain health and performance	6. Assess and Diagnose Warfighter Brain Injuries	3. Recognize Changes in WBH 6. Manage Warfighter Brain Injuries	44.Conduct research to identify and characterize objective and validated biomarkers of brain injuries resulting from different injury mechanisms (e.g., blunt, blast, DE).	T3. Point of Injury Stabilization T4. Complex Injury Stabilization
	3d. Optimize medical care to return warfighters to full duty following TBI	6. Assess and Diagnose Warfighter Brain Injuries	3. Recognize Changes in WBH 6. Manage Warfighter Brain Injuries	45.Conduct research to identify appropriate standards of performance for objective WBH assessment tools.	T3. Point of Injury Stabilization T4. Complex Injury Stabilization
				46.Conduct research to identify and validate standardized clinical diagnostic criteria for brain injuries.	
				47.Conduct research to improve understanding of onset and progression of brain injury symptoms, including how to distinguish them from symptoms caused by other stressors or exposures, to improve brain injury detection and screening.	
				48.Conduct research on the efficacy of interventions/efforts to help family members recognize traumatic brain injury (TBI) signs and symptoms and provide support to warfighters.	
				49.Develop and validate objective assessment and diagnostic tools and tests for brain exposures and injuries, including tools/tests based on biomarkers, sensory system status, blood biomarkers, neuroimaging, neurocognitive status, and others as basic science improves, all with the aim of supporting assessment and diagnosis at any level of care in any environment.	
				50.Develop and validate objective tools and	

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
				tests that distinguish among different types of brain injuries (e.g., blast, blunt, DE, toxic material, UBI)	
				51.Develop a classification system to better characterize TBI beyond clinical severity or physical mechanism of injury.	
				52.Develop ways to distinguish between a diagnosis of TBI and other physical and psychological health conditions.	
				53.Develop ways to reliably predict symptom trajectory for patients who might have TBI, post-traumatic stress disorder (PTSD), or both insults simultaneously.	T5. Treatment Development T6. Clinical Practice Guideline Development
				54.Conduct research to identify evidence-based approaches to treat and manage mild traumatic brain injury (mTBI), especially in the deployed and prolonged care settings.	
				55.Conduct research to identify the effectiveness of individual and cohort-based treatments for brain injuries.	
		7. Treat and Rehabilitate Warfighter Brain Injuries		56.Conduct research to understand and treat the acute and long-term effects of blast-induced mTBI.	
				57.Conduct research to improve the ability to treat co-occurring TBI and psychological health conditions, including PTSD.	
				60.Conduct research to understand how brain injuries and brain health degradation affect occupational performance and military readiness in warfighters and how it can be mitigated.	
				61.Conduct research to understand and treat the relationship between pain (acute and chronic) and brain injuries.	
				62.Conduct research to understand and mitigate the link between brain injury and risk of opioid overuse and/or dependence.	
				63.Conduct research to understand and	

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
				mitigate the relationship between stress (acute and chronic) and brain injuries.	
				64.Conduct research to understand and mitigate the relationship between genetic factors and warfighters' progression and recovery from brain exposures and injuries.	
				66.Conduct research to understand outcomes and gaps in care for warfighters who show no visible symptoms following brain exposures or brain injuries.	
				67.Conduct research to understand and mitigate the risk to warfighters of developing chronic traumatic encephalopathy (CTE), including the risk of developing CTE after multiple sub-concussive exposures or other non-head trauma-related factors (e.g., gender, age, genetics); development of CTE after blast-related trauma; and the effect of co-occurring conditions (e.g., sleep disturbances, mental health conditions, substance abuse) on CTE progression.	
				68.Develop clinical practice guidelines to treat and manage brain injuries in any military environment (operational, training, aeromedical, etc.) as science evolves.	
				69.Develop consistent clinical outcome measures, experimental factors, and statistical modeling and methodologies between studies regarding brain exposures and injuries.	
				70.Develop and validate clinical decision-support tools and technologies to aid in the management of WBH injuries.	
				71.Develop and validate decision-support tools and technologies to support return to duty and progressive return to activity decisions.	
				73.Develop, rigorously test, and implement novel treatments for TBI and other	

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
				degradations to brain health that are appropriate for use in a variety of relevant scenarios.	
				74.Develop best practices regarding treatment of common sequelae of TBI and other threats to brain health based on rigorous comparative efficacy data.	
LOE 4: Reduce or Eliminate Long-Term and Late Effects	4a. Understand the characteristics and causes of the long-term consequences of known and emerging brain exposures and/or TBI	6. Assess and Diagnose Warfighter Brain Injuries	3. Recognize Changes in WBH	2.Conduct research to understand the effects of multiple concussive or sub-concussive blast exposures on acute and long-term physical, psychological, and cognitive outcomes.	T5. Treatment Development T6. Clinical Practice Guideline Development
				3.Conduct research to determine how blast exposures affect sensory systems acutely and over the long-term.	
				17.Conduct research to identify the brain exposure "dosage" that can lead to minor, major, and severe trauma to the brain as well as the long-term or late effects of those doses.	
				56.Conduct research to understand and treat the acute and long-term effects of blast-induced mTBI.	
				65.Conduct research to understand the impact of early interventions and rehabilitation strategies for TBI and related conditions on long-term outcomes.	
				72.Develop models to forecast the long-term and/or late effects of brain exposures, TBI, and co-occurring conditions in order to improve functional outcomes.	
	4b. Mitigate long-term and late effects of TBI through effective treatment and rehabilitation	7. Treat and Rehabilitate Warfighter Brain Injuries	7. Resolve Warfighter Disposition	56.Conduct research to understand and treat the acute and long-term effects of blast-induced mTBI.	T5. Treatment Development T6. Clinical Practice Guideline Development
				58.Conduct research to understand and mitigate the long-term interaction between age-related decline and TBI-related neurodegeneration.	
				59.Conduct research to understand and mitigate long-term and late effects from brain	

DoD WBH Initiative LOEs	DoD WBH Initiative Objectives	WBH Research Strategy Research Areas	WBH OV-5a Sub-Capabilities	WBH ICD Solutions	DHA TBI SRP Priorities
				injuries, especially those that prevent warfighters from returning to optimal or functional brain health required for military service.	
	4c. Collaborate with the VA and other government agencies to provide a seamless transition of care for those with long-term and/or late effects			70.Develop and validate clinical decision-support tools and technologies to aid in the management of WBH injuries.	T5. Treatment Development T6. Clinical Practice Guideline Development
LOE 5: Advance Warfighter Brain Health Science (all encompassing)	5a. Align brain health research and acquisition to current and emerging threats and operational requirements		8. Assess Effectiveness of WBH Enterprise		
	5b. Maximize WBH research opportunities for partnerships with other government agencies, industry, and academia		8. Assess Effectiveness of WBH Enterprise		
	5c. Enable researchers to have access to valid data regarding brain exposures and injuries and related brain health effects		8. Assess Effectiveness of WBH Enterprise		
	5d. Translate research findings into knowledge and materiel products, practices, and policies to maintain and optimize WBH		9. Adapt WBH Enterprise		