CBD S+T

CONFERENCE 2022

Sessions

Approaches to Characterizing the Threat from Chemical and Biological Agents

Genetic Engineering Technologies and Detection of Gene Editing

DTRA Session Chairs: Dr. Giselle Roman Hernandez, Mr. Charles Hong, and Mr. Steve Francesconi

Genetic engineering involves the manipulation of an organism's genes by introducing, eliminating, or rearranging specific genes using methods of modern molecular and synthetic biology. Genetic engineering poses as a potential emerging threat to the Joint Force due to the rapid development in this field over the past 5+ years that offer both promise and peril. Specifically, genetic engineering is an emerging threat to the Joint Force due to the ability for these manipulated organisms to evade current detection and diagnostic capabilities. This necessitates novel investments to understand and detect when a potential pathogen has been modified, provide enhanced warning to end users, and inform better decision-making in the battlespace. The impact from genetic engineering technologies on our defense posture over the next several years is unknown, leading to questions on the current state of the technologies as well as what novel detection and diagnostics solutions will be required to augment the understanding of intentional or inadvertent manipulation of living organisms.

With regard to microbes or pathogens, synthetic biology is expected to expand the range of what could be produced or potentially make pathogens more harmful with improved ease and decreased time. Moreover, from the host perspective, human genomic, transcriptomic, and translational modifications can directly influence the recommended treatment or clinical outcome before the immune system is overwhelmed or before loss or reduction of combat readiness.

This topic aims to understand the state of existing technologies, capabilities, programs, and potential that a broad array of genetic engineering approaches can offer. Understanding and detecting genetic engineering will allow for rapid response, mitigate impact, and ultimately inform if a genetically modified hazard poses a threat to the warfighter and mission.

Overcoming Limitations of Organ-on-Chip (OoC) Technologies to Advance the Characterization and Medical Management of Chemical and Biological (CB) Threats

DTRA Session Chairs: Dr. Lalena Wallace and Dr. Sweta Batni

Organ-on-Chip (OoC) technologies (also known as microphysiological systems (MPS)) have been in development for well over a decade, bringing with them the promise of significantly decreasing animal testing as well as faster, more efficient, and cheaper drug development, toxicological prediction, and disease pathophysiology investigation. OoC technologies have great relevance for predicting human response to chemical and biological (CB) threat exposures, as well as for assessing the safety and efficacy of candidate medical countermeasures. Furthermore, emerging data science approaches such as Machine Learning will be key to the successful use of data from OoC systems and their predictive power.

As dramatic advances have moved these technologies forward, they have also revealed new challenges. The Joint Science and Technology Office (JSTO) is interested in applications of OoC technologies to CB defense, identifying the current challenges associated with these technologies, and discussing solutions for overcoming these challenges to advance the technology and maximize its impact on CB defense. This topic will focus on highlighting solutions related to existing challenges associated with current OoC technologies and how these solutions will aid the CB Threat Analysis and Medical Countermeasure Development areas. Specific areas of interest for this topic include but are not limited to the following:

- Current state-of-the art technologies associated with increasingly complex Multi-OoC platforms.
- Strategies to overcome challenges associated with linking multiple OoC systems (i.e., developing “Body-on-a-Chip” technologies).
- Limitations and solutions associated with using OoC data for Artificial Intelligence/Machine Learning (AI/ML) platforms and vice versa (i.e., how current/future AI/ML platforms can be adapted/developed to meet the needs of OoC data production).
- Reproducibility, training, verification, validation, and standardization of OoC data sets.
- Collection, storage, retrieval, and standardization of OoC data sets for individual and collective systems.
- Lessons learned and best practices for utilizing OoC data sets in predictive algorithm development.

Threat Agent Defeat Modeling and Testing

DTRA Session Chair: Mr. Bruce Hinds

This session will focus on a range of advances within the chemical and biological testing realm to include instrumentation and algorithm development, implementation of novel capabilities in test and operational environments, and the use of test data for the continued validation and improvement of modeling and simulation capabilities.

Developing Medical Countermeasures Against Biological Threats

Broad-spectrum Therapeutics for Viral Diseases: a Medical Countermeasure Platform for Emerging Threats

DTRA Session Chairs: Dr. Jay Vasudevan and Mr. Michael Johnson

The U.S. Food and Drug Administration (FDA) approval of remdesivir for COVID-19, a drug previously evaluated in clinical trials against Ebola, has demonstrated the usefulness of broad-spectrum therapeutics, those that are efficacious against multiple viral threats, in countering emerging viral threats. The time of therapeutic development against emerging threats is expedited and cost minimized by leveraging both safety and efficacy data of broad spectrum drugs/drug candidates that has been collected for related viral diseases. In this sense, broad-spectrum therapeutics are both a medical countermeasure and a platform, or bridge that can be used to address emerging threats of the future.

The strategy of developing broad-spectrum therapeutics typically includes the initial discovery and evaluation of drug candidates against multiple existing threats, followed by the advanced development of one or each of them sequentially, as resources permit. Novel broad-spectrum therapeutic candidates that are efficacious against bioweapon (BW) threats are needed for evaluation, as are broad spectrum discovery and evaluation platforms. Such candidates and platforms will help to build a therapeutic armamentarium, with associated safety and efficacy data that can be used to advance therapeutic candidates against BW threats for FDA approval, as well as serve as a platform for countering emerging threats of the future. Approaches being considered (but NOT limited to) are:

- Identification of pathogen and/or host based targets common to virus families
- Platforms for discovery and evaluation of broad-spectrum therapeutics
- Therapeutics targeting viral disease pathways that cause acute morbidity/mortality (e.g. encephalitic inflammation)

Challenges Faced in the Planning, Deployment, and Adoption of a Layered Medical Defense Strategy

DTRA Session Chairs: Dr. Julie Barbaras and Dr. Amanda Horstman-Smith

First-generation prophylactic and therapeutic medical countermeasures, when evaluated as the sole medical intervention, rarely meet all military efficacy requirements in biodefense settings. Nonetheless, these first-generation MCMs do have some level of efficacy and, when used in conjunction or layered over time, may prove efficacious, in total, and even permit a return on decades of discovery research invested.

While the technical challenges to establishing an efficacious layered medical regimen are many, so too are the logistical, regulatory, education/training, doctrinal, and policy challenges in the practical adoption of a medical layered defense strategy. This session is intended to identify the challenges in deploying integrated layered defense medical countermeasures (MCM) beyond the technical and align with fundamental operational doctrinal concepts. Topics of interest include, but are not limited to:

- The degree to which evaluation of layered products should follow a regulatory path versus a test and evaluation paradigm whilst ensuring robust safety, toxicity, and risk analysis.
- Understanding and leveraging the mechanisms by which clinical practice guidelines are promulgated and adopted within the military medical community
- Understanding and integrating the medical planning and logistics system into MCM development and, in particular, into ensuring that layered MCM are co-assembled.
- Strategies to plan layering of MCMs to broaden the protective barrier against additional targets such that preparation for future threats is maximized.
- Strategies to enable flexibility in Concepts of Use (CONOPS) to maintain Warfighter lethality in contaminated environments
- The regulatory interplay between Surgeons General and FDA in approving the use of medical strategies in Service members.

Combatting Emerging Biological Threats – Bridging Mucosal and Systemic Immune Responses

DTRA Session Chairs: Dr. John Trefry and Dr. Traci Pals

Pandemic preparedness or combating new and emerging threats has traditionally focused on systemic immune responses; for example, measuring the antibody response in the blood, typically Immunoglobulin G (IgG), brought on from immunization via intramuscular delivery of a vaccine. Recent international research presented by The World Health Organization for combating SARS-CoV-2 infection has questioned the protection offered by such approaches versus controlling the spread of pathogens when facing a respiratory threat. The vaccines deployed in response to the COVID-19 pandemic demonstrated clear evidence of protection from severe disease for an individual after vaccination; however, this protection did not extend to prevention of infection or ability to transmit the infection. To be prepared for the next pandemic or emerging threat, balanced immunity across immunological compartments of the host will be essential to design vaccines to not only provide adequate protection but also to control the outbreak. This session will address the data available to bridge mucosal immunity with systemic immunity as well as how prophylactic strategies might be adapted to trigger robust responses for both. Central to this issue will be topics specifically addressing how to bridge mucosal and systemic immunity such as, but not limited to:

- Differential antibody response by class and compartment
- Importance of neutralizing antibodies and effector function across compartments
- Cell mediated responses across compartments
- Impact of immunization route on immune responses
- Strategies to affect immune responses across immunological compartments
- Promoting memory and durability between mucosal and systemic immune responses
- Models and tools for understanding differences between protection and control of pathogens to limit spread

Combatting Emerging Biological Threats – Preparing for the Future Today

DTRA Session Chairs: Mr. Dale Taylor and Dr. Revell Phillips

The mission of the Medical Futures Team is to identify and support innovations in Medical Countermeasures (MCM) discovery processes, biotechnology platforms, model systems and preemptive novel solution sets that ensure rapid MCM development against any biological threat. Until recently, the strategic importance of biological weapons of mass destruction (BWMD) was confined to biological agents developed by the now disbanded US offensive biological program and adversary nations during the cold war. The COVID-19 pandemic has demonstrated that we cannot wait for a threat to arrive on our door-steps before we begin looking at technologies and MCMs to combat a novel or emerging threat. The Discovery of Medical Countermeasures Against New and Emerging threats (DOMANE) enabling technologies thrust is building a MCM discovery processes, biotechnology platforms and model systems that utilize known BWMD threats to create a system that is forward focused and anticipates changes in the threat landscape. Call to action: Have you ever wanted to be a futurist? Here is your opportunity. We invite you to bring your imagination, expertise and research experience to show us what you anticipate rapid MCM development will look like in the next 5-20 years. Inputs on factors that will improve costs, schedule and efficacy of rapid MCM development, including innovative strategies to fully integrate the workflow, are of interest. If DOMANE is your research domain, we encourage you to let your imagination create shockwaves and submit your abstracts for the 2022 CBD S&T Conference.

Combatting Emerging Biological Threats – Understanding Host Immunity for Rapid Response

DTRA Session Chairs: Dr. Julie Barbaras and Ms. Daphne Stanley

The topic area focuses on multidisciplinary investigations of human immune response and protection that could guide vaccine development to prepare for potential unknown biological threats and gain insights on vaccine-induced immune protection and naturally acquired immunity in the context of identification of universal correlates of protection. The efforts on human immune response and protection studies will help answer the questions related to the intracellular pathogen, bacterial and viral pathogenesis and their impacts on host immunity. Most importantly, the identification of key mechanisms used by the human immune system to respond to invading microbes and other exogenous biological threats is expected to be utilized in generating broader and more robust prophylactics. Key to this, is understanding how approved vaccines and/or infection enhances immunity and promotes durable immunological memory. Topics of interest include but are not limited to:

- Prioritize new vaccine host targets to counter potential unknown biological emerging threats
- Increase understanding of host immune response and develop tools to define the level of immunity
- Differential immune response profiles associated with different types of vaccines and modes of administration
- Strategies to advance vaccine platforms and adjuvants to enhance the protective response to combat emerging biological threats
- Advances in technology to develop a broad vaccine and investigate the knowledge gap in the quest of a universal vaccine Strategies to trigger the body to produce broadly neutralizing antibodies

Developing Medical Countermeasures Against Chemical Threats

AI/ML and Virtual Human Platforms for Threat Agent Hazard Assessment and Medical Countermeasure Discovery and Drug Development

DTRA Session Chairs: Dr. Sweta Batni, Dr. Alison Director-Myska, and Dr. David Hone

For decades we have seen the use of a variety of computational tools including, but not limited to,

- Physics-based epidemiological monitoring;
- Mathematical modeling of the host;
- Quantitative structure-activity relationship (QSAR) models;
- Physiological based (PB) pharmacokinetic (PK) and pharmacodynamic (PD) modeling and simulation;
- Predictive adsorption, distribution, metabolism, excretion and toxicity; and
- Molecular docking,

to aid us in understanding the hazards posed by chemical and biological threat agents and also in developing medical countermeasures to prevent and/or treat their adverse effects. The recent leaps and bounds made with artificial intelligence and machine learning tools has resulted in a pairing with the more familiar in silico models to developing virtual humans as a way to run virtual clinical trials to speed drug development and approval. Such virtual human platforms could be used not only for clinical trials, but may also help us better understand host response to threat agents and repurpose existing medical countermeasures or discover and develop novel medical countermeasures while reducing or eliminating the need for animal models. This topic seeks to explore the following areas:

- How can such virtual models be applied in the CB Threat Agent Host Response and Medical Countermeasures Discovery and Development portfolios?
- Can such virtual humans be used at multiple levels of understanding threat agent interaction with the human as well as in the drug development process, or are they best used only as a substitute for clinical trials?
- How do the challenges for virtual human platforms within the CB space compare to those for medical science in general?
- What are the potential quick wins available in this area?

Polyclonal Antibodies against Multiple Chemical Threats

DTRA Session Chair: Dr. Alison Director-Myska

Monoclonal and polyclonal antibodies (Abs) can be generated for rapid removal or degradation of circulating small molecules, including chemical threat agents (e.g., refs 1-4 for examples of opioids and one psychoactive substance). Chemical threats span a wide variety of molecules including organophosphate nerve agents, opioids, choking agents, blood agents, blister agents and psychomimetic agents. Ab-based protective medical countermeasures (MCMs) which rapidly sequester or destroy chemical agents at the time of exposure would reduce or eliminate the need for additional protective measures. Because classes of chemical agents have different chemical structures, modular approaches which are agnostic to specific chemistries are of particular interest.

The session will focus on methods and techniques for the rapid design and testing of humanized or fully human polyclonal Abs with the following properties:

- Efficacy against a variety of chemical threats
- Minimum 10 and desired 30 day half-life in circulation
- Intramuscular route of administration preferred
- Storage at room temperature (10°C to 35°C) preferred

The novel methods and/or techniques must have demonstrated the successful development and testing of Abs against multiple small molecules in cell culture or preferably in vivo.

1. "Prophylactic vaccination protects against the development of oxycodone self-administration" in Neuropharmacology. 2018 Aug; 138:292-303. doi: 10.1016/j.neuropharm.2018.06.026. Epub 2018 Jun 22.
2. "Opioid Dose- and Route-Dependent Efficacy of Oxycodone and Heroin Vaccines in Rats" in J Pharmacol Exp Ther. 2018 May; 365(2):346-353. doi: 10.1124/jpet.117.247049. Epub 2018 Mar 13.
3. "A new algorithm to convert a normal antibody into the corresponding catalytic antibody" in Sci Adv. 2020 Mar 25; 6 (13):eaay6441. doi: 10.1126/sciadv.aay6441. eCollection 2020 Mar.
4. "Pharmacokinetic Approach to Combat the Synthetic Cannabinoid PB-22" ACS Chem Neurosci. 2021 Jul 21; 12(14):2573-2579. doi: 10.1021/acschemneuro.1c00360. Epub 2021 Jul 13.

Repurposing to Speed Chemical and Biological Medical Countermeasure Discovery and Development

DTRA Session Chairs: Dr. Alison Director-Myska and Dr. David Hone

Conventional drug discovery and development processes in the United States often take over a decade, and cost billions of dollars to travel from initial concept and/or need to an FDA approved drug available for use. The time and costs can be higher in the realm of medical countermeasures for chemical and biological weapons (CB MCMs) due to the need to do studies with highly toxic / infectious agents under chemical or biological safety and surety controls and the need to use the animal rule for FDA approval. This makes it difficult for the US Chemical and Biological Defense Program to maintain the interest and support of our customers and stakeholders. Therefore, a need exists to identify, develop and field CB MCMs more rapidly at less expense. The large pharmacopeia of existing approved drugs paired with the scientific advances made in many areas including but not limited to:

- Microphysiological / organ-on-a-chip systems;
- Artificial intelligence (AI) and machine learning (ML) algorithms for data analytics;
- AI/ML algorithms for molecular docking, predictive absorption, distribution, metabolism, excretion, and toxicity

open the doors to the possibility of rapidly screening these approved drugs for safety and efficacy to repurpose them as CB MCMs. Research efforts employing such techniques for rapid repurposing of approved drugs and/or candidate compounds with adequate human safety data (i.e. successful Ph I but insufficient efficacy in Ph II/III to attain FDA approval for the target indication) for novel CB prophylactic or therapeutic MCM purposes holds the promise of decreasing both the time and the cost of our development and fielding efforts.

A 2019 review of drug repurposing and its challenges (http://dx.doi.org/10.1038/nrd.2018.168) identified the following needs:

- Improved, integrative platforms for data analysis
- Access to preclinical and clinical compounds
- Access to phase II–IV clinical trials data
- Expanding safety assessment of repurposed drugs
- Increased funding and incentives for drug repurposing efforts

Both HHS and DoD through BARDA's Repurposing Drugs in Response to Chemical Threats (ReDIRECT), DTRA RD CB's Discovery of Medical Countermeasures Against New and Emerging threats (DOMANE), and JPEO CBRN's Rapid Acquisition and Investigation of Drugs for Repurposing (RAIDR) are investing in this area.

This topic seeks presentations about drug repurposing to speed Chemical and Biological Medical Countermeasure (CB MCM) drug development, approval and fielding. Presentations can be about ways to improve the technologies identified (or others that may support repurposing) or ways to address the challenges facing the area. Presentations about repurposing specific drugs to meet CB MCM requirements may also be considered.

Enhancing Warfighter Understanding through Detection and Diagnostics Capabilities

From Sensing to Making Sense

DTRA Session Chairs: Dr. Chia-Wei Tsai and Mr. Tyler Miller

Chemical and biological threat detection and characterization capabilities are improving at a rapid pace, yet raw, disparate data alone are limited in usefulness for decision making. The fusion of threat detection information with data analytics advances culminates in comprehensive solutions to aid in Integrated Early Warning (IEW). Data fusion pushes detection as far left of the threat as technically possible and offers warning capability at threat deployment. Sensor technology advances have led to low size, weight, and power (SWAP) micro-sensors that are versatile in how they are able to sense the threat and can be used for multiple missions including reconnaissance and surveillance. Advances in micro-sensor technologies include, but are not limited to, photonics, colorimetric, and microelectromechanical systems (MEMS). All sensors must have potential to be integrated or share data to provide a wider understanding of the threat and enable IEW, turning a point or stand-off detector into an array of detectors with wider applications, efficiency, and functionalities.

Advances in data analytic methods can serve a wide variety of roles from enabling sensor technology, reducing false alarm rates, and turning complicated sensor data into actionable information. Furthermore, the improvements in data processing techniques allows reduction in time needed to realize and to fuse critical signatures and features in data from various sensors. Therefore, this session will explore innovative end-to-end solutions from detecting threat material to converting data into a useable format for situational awareness. Additionally, this session aims to highlight the important and necessary interaction between hardware and software.

Next-Generation Bioaerosol Detection & Identification

DTRA Session Chairs: Mr. Charles Hong and Mr. Steve Francesconi

The Biological Threat Detection portfolio supports the DoD's modernization goal to deliver biological threat detection capabilities that will enable the Joint Force to fight and win in CB-contested environments. Current bioaerosol detection technologies tend to be too large and cumbersome for facile field employment, or require expert users to analyze and interpret results. In addition, many devices for biological detection, collection, and identification are not modular in design, such that when assay components and hardware need to be refreshed, a considerable amount of development time could be required. The next generation of remote bioaerosol technology should aim to be threat-agnostic and designed to enhance agility and maneuverability. The overall, focus of this topic is toward presentations on biological aerosols and integrated solutions combining detection, collection, and identification of a variety of agents (bacterial, viral, toxin). The ability to include modular design in an overall platform capability for rapid assay design, development and validation is an example of agile technology for fieldable capabilities. The future capability needs to be built for the warfighter to use minimal training and to provide a high-level of fidelity whether there is a bioaerosol threat present and why it poses an impact to an operational mission.

Revolutionary Diagnostics – Nontraditional approaches for Developing Breakthrough Capabilities Against Emerging Threats

DTRA Session Chair: Ms. Kathleen Quinn

The Joint Science and Technology Office (JSTO) Medical Diagnostic Portfolio supports the mission of the Department of Defense (DoD) and Chemical Biological Defense Program (CBDP) to increase Warfighter performance by delivering state of the art diagnostic capabilities that inform medical countermeasures. Warfighters require an integrated layered defense against biological and chemical threats to include monitoring and diagnosis of threat agents, with the goal to provide results at the earliest indication of exposure. While existing medical diagnostic programs focus on the traditional Select Agent list, the next generation of diagnostics must push beyond this list to better prepare for surprise. Right now, emerging threats are the priority. We have seen firsthand during the COVID-19 pandemic that investments in diagnostic tools that can address new and evolving threats is desperately needed, and having these capabilities ready is paramount for protecting all people.

We are seeking to identify next generation platforms that may combine immunodiagnostic detection with molecular sensing, and other novel sensing technologies to achieve a diagnostic product that is disease agnostic and has an open-architecture that can respond quickly to an emerging threat. These platforms should allow the Warfighter to easily collect minimally invasive samples types from individuals in remote environments and obtain a quick answer to allow a response to the diagnosis of an emerging threat.

Toxin Diagnostics – Development of Novel, Fieldable Technologies to Diagnose Toxin Exposure

DTRA Session Chair: Dr. Patricia McMahon

Toxins are an incredibly diverse group of agents that may be used by adversaries to cause morbidity, mortality, and undermining mission effectiveness. Warfighters need rapid, sensitive, and definitive identification of traditional and emerging toxin threat agents to support early warning, prepare for the unknown, and be positioned to provide appropriate antidotes or supportive care to counter the threat in a timely manner. Rapid identification of toxins can inform appropriate care, reduce morbidity, and save lives. Toxin diagnosis therefore can screen for potential exposure of high threat agents, inform medical countermeasure (MCM), as well as provide situational awareness to military leadership to adopt appropriate strategies for Force Health Protection.

The Joint Science and Technology Office (JSTO) seeks diagnostic assays, platforms, or devices to diagnose exposures from naturally-occurring, synthetic and/or aerosolized toxins. Diagnostic platforms may combine multiple sensing strategies to rapidly identify whole toxins and/or toxin metabolites using agnostic or specific detection technologies, comparable against reference laboratory methods. Open-architecture platforms are preferred and read out displays should allow a non-technical user to clearly understand and interpret the results. These platforms will aid in the development and utilization of novel diagnostics to protect the Warfighters from naturally-occurring or synthetic biological toxins. Additional concepts should aim to focus on the discovery of:

- Activity assays integrated into portable diagnostic devices and platforms
- Host response biomarkers and/or metabolites that change upon toxin exposure
- Capture mechanisms for trapping and concentrating toxins for diagnostic identification
- Identification in a variety of clinical sample types
- Leveraging machine learning concepts and tools that will readily adapt current platforms to emerging toxin threats
- Portable and scalable instrumentation and assay consumables, that can be used to diagnose suspected toxin exposure in a field hospital or clinic

Generating Actionable Information in the Digital Battlespace

Bio-Fi: Leveraging the Power of Biological Big Data for Advanced Analytics and Modeling of Chemical and Biological Threats

DTRA Session Chairs: Dr. Sweta Batni and Dr. Christopher Kiley

The rapid expansion in the volume and sources of chemical and biological (CB) data in conjunction with advances in high performance computing and software analytic platforms has engendered powerful data mining and enhanced computational analytic capabilities beyond traditional means of mathematical/statistical based methodologies for modeling the epidemiological and host effects from CB threat agents.

The objectives of the Bio-Fi portfolio area are to develop decision support software and analytic tools integrating human performance and health effects data to mitigate CB threats, enhance operational readiness and mission effectiveness, and facilitate medical planning for CB threats.

This session is focused on exploring the nexus of the human biological system and emerging data analytics' capabilities for enhanced data storage, mining, and modeling and simulation capabilities for health effects and medical response following exposure to CB threats. Areas within scope of this topic area include but are not limited to the following:

- CB threat agent and host modeling, forecasting, and prediction
- CB health and human effects modeling
- Utilizing artificial intelligence/machine learning-based analytics for toxicological prediction and rapid medical countermeasure discovery and development
- Leveraging human performance data to inform human effects modeling for CB threat agents
- Innovations in biological data science: data storage, mining, and analytical platforms
- Best practices for data curation and standardization from experimental sources (***in vitro*** and ***in vivo***) for ***in silico*** modeling and prediction of CB threat agents

eXtended Reality for Chemical and Biological Defense in Tactical and Training Environments

DTRA Session Chairs: Dr. Chia-Wei Tsai and Ms. Kathryn Raymond

From the Sword of Damocles to the Oculus and HoloLens series, the leap in extended reality (XR) technologies have turned once-SciFi elements into tangible toolsets. The Department of Defense has also progressed from head-mounted displays in 1967 to current Programs of Record (PORs) such as the Integrated Visual Augmentation System (IVAS) and the Synthetic Training Environment (STE). The power of XR to unencumber the Warfighter in tactical situations and improve training outcomes has been realized by the broader community and can provide unique capabilities needed in Chemical and Biological Defense (CBD). For example, XR can provide critical CBD mission and hazard situational awareness data via augmented reality (AR) heads-up displays, enhance live training via mixed reality (MR), and achieve full realization of hazard consequences via immersive virtual reality (VR). These capabilities are at the leading edge of next generation situational awareness, battlespace management, and immersive training for the DoD Chemical and Biological Defense Program.

This session demonstrates the use of XR (including AR/VR/MR) and related leading edge technologies to support the following:

- Understanding, assessing, protecting, and mitigating CB threat material
- Brain-computer interfaces (BCI)
- Telepresence and robotic controls
- Artificial intelligence (AI)-driven non-player characters
- Digitaltwin
- Human interest extraction
- Modeling and simulation for realistic hazard emulation
- Human-machine/AI teaming
- Computer vision assisted situational awareness

Harnessing Physiological Data for Early Warning of Threat Exposure

DTRA Session Chairs: Dr. Christopher Kiley and Dr. Tessa Pinon

Recent advancements in wearable technologies provide an opportunity to evaluate the utility of physiological monitoring device data to provide early indications of health status changes. These advancements are shifting the paradigm for detecting chemical and biological (CB) exposure from traditional lab-based diagnostics following symptom onset to non-invasive, continuous monitoring of Warfighters' health. An earlier warning of a negative health exposure (e.g., infection) could allow for an earlier intervention or treatment, thereby increasing Warfighter survivability and availability to perform mission-essential duties.

Physiological data can provide vital information about the health status of a Warfighter and existing science and technology investments have worked to develop predictive algorithms based on physiological signals such as electrocardiogram (ECG) wave forms, oxygen saturation, and blood pressure, obtained from commercial-off the shelf (COTS) devices in order provide information into a Warfighter's health status. The possibility to expand these algorithms to further push the early warning time to the left, utilize contactless sensing technologies and data, and expand and generalize their use for other diseases and hazards offers exciting opportunities for research and development.

This session is focused on harnessing human physiological data for early warning of CB threat exposure. It seeks to highlight the following:

- Development and validation of advanced analytics and early warning algorithms that alert to potential human exposure to a pathogen or chemical agent
- Suitability of wearable COTS devices or unmanned contactless monitoring technologies to collect biometric data such as cardiac data (i.e., heart rate, heart rate variability, ECG waveforms), respiratory rate, oxygen saturation, and temperature data from individuals
- The infrastructure to securely transmit, process, and store these data at all echelons

Innovations in Next Generation CB Threat Characterization and Assessment for Decision Support

DTRA Session Chairs: Mr. Rick Fry and Ms. Kathryn Raymond

The Joint Science and Technology Office is interested in innovative methods to fuse hazard sensing, characterization, and prediction and assessment for real-time operational support and tactical decision support tools. Mobile systems such as Nett Warrior and the Tactical Assault Kit (TAK) have shown the ability to increase situational awareness, decrease reaction and decision times, collaborate and allocate resources and personnel critical to the mission, and augment operational capability. These platforms maximize the ability to leverage advances in chemical and biological (CB) threat characterization. This session is focused on the future of chemical/biological threat assessment for situational awareness and decision support.

This session is focused on the future of CB threat assessment for situational awareness and decision support. It seeks to highlight the following:

- Advancements in hazard prediction and leveraging data from TAK for real-time operational support; utilize blue force tracking and integrated sensor architecture data as inputs into TAK decision support tools such as the chemical, biological, radiological, and nuclear (CBRN) Effects Tool and CBRN Routing plug-ins
- Improvements towards an automated end-to-end CB decision support process from early detection to mitigation in order to unencumber the Warfighter; connect disparate sensors and TAK plug-ins as well as processes to reduce manual entry requirements and reduce estimation error proliferation
- Utilization of non-CBRN data for CB hazard characterization and situational awareness; examples include satellite imagery and acoustic sensors for source term estimation (STE)
- State-of-the-art methods for enabling timely and accurate warnings and intelligent responses, such as STE, sensor modeling, and new meteorological forecasting/now-casting capabilities

Mitigating CB Contamination for the Warfighter and Mission

Mitigation - Science and Technology Advances for Chemical and Biological Contamination Mitigation

DTRA Session Chairs: Dr. Bernadette Higgins and Dr. Glenn Lawson

This topic area seeks presentations on fundamental and applied science and technology that improves systems (chemistry, formulation, and application) for personnel, equipment, or wide area decontaminants, material coatings, and destruction of chemical and biological (CB) threats. Research and data should describe technologies that enhance Joint Force survival through increased effectiveness and responsiveness of decontamination to render CB threats harmless without harming personnel or materiel, demonstrate improved efficacy across a broad range of CB threats, and reduce water and logistical need. Presentations should also describe how technologies may sustain the Joint Forces and mission by limiting the spread of contamination to promote rapid reduction in Mission Oriented Protective Posture (MOPP) levels. Presentations may include research and supporting data on, but not limited to:

- Reducing or eliminating CB contamination of personnel and personal effects as well as sensitive and non-sensitive equipment
- Improved or new CB contamination mapping technologies to reduce logistical requirements of decontamination and ensure mitigation effectiveness
- Autonomous methods and systems for equipment decontamination that reduce troop-to-task for contamination mitigation operations to visualize and manage hazards across the battlespace
- Improved coatings, including bio-inspired coatings, that reduce CB contamination retention to facilitate decontamination
- Methodologies that improve characterization, verification, and validation for decontamination materials and systems that incorporate operational relevance and improve the cost and time effectiveness of testing
- Products with the capability to clean and/or recycle decontamination waste effluent

Protecting the Warfighter from CB Threats

Protection - Science and Technology Advances for Chemical and Biological Protection

DTRA Session Chairs: Dr. Kendra McCoy and Ms. Wendy Mills

This topic area seeks presentations on fundamental and applied science and technology for development and assessment of advanced materials and systems for chemical and biological (CB) protection. Research and data should describe technologies that prevent exposure of skin, eyes, or lungs to liquid, vapor, and aerosol hazards, that are lighter, cooler, smarter, and may be effectively-integrated into physical protection to enable Joint Forces to fully complete the mission. Presentations should also describe how technologies may integrate into the Joint Force layered protection paradigm to enhance individual survival and unencumber by reducing the physical burden and cost of individual and collective protection as well as the operational impact of contaminated environments. Presentations may include research and supporting data on, but not limited to:

- Improved technology usability and encumbrance (i.e., increased time-on-target, improved functionality [mobility, vision], and decreased thermal burden or logistical requirements
- Improved technology integration and interoperability with current and developmental combat systems
- Technology protecting against the full spectrum of threats that supports the full range of military operations, with scalable manufacturing processes
- Dynamic, multifunctional materials for protective garments that are chemically/biologically responsive, bio-mimetic, antimicrobial, or have the capability to resist, absorb, or destroy contamination
- Multifunctional reactive materials for all hazards, individual or collective protection air filtration enhancements, engineering standards, and guidelines e.g., high-efficacy filters or temporary filtration systems able to better protect DoD facilities against CB threats, with lower lifecycle costs
- New, enhanced protective equipment characterization, verification, and validation methodology that improves operationally-relevant testing of materials and systems as well as the cost and time of testing
- Leveraging surface chemistry in operando methods to study real-time behavior of agents in simulated, operationally-relevant environments

Warfighter Integration

The Impact of Giving Warfighters a Voice in Early Technology Development

DTRA Session Chairs: Mr. Bryan Horner and Dr. Brendon Miller

Warfighter collaboration from the onset of an idea or concept through the advanced technology demonstration ensures emerging technologies actualize into relevant, unique, integrated, warfighter-centric technologies that will modernize and elevate battlefield capabilities. Translating employment concepts along with key operational parameters and attributes early in the technology process not only sparks innovation but allows DoD to examine and assess the impact of current and planned solution sets on the Joint Forces ability to effectively conduct and continue missions in tomorrow's complex CBRN environment, however developing effective warfighter engagement opportunities can be challenging.

These sessions will highlight several areas with discussion across the CBDP initiatives spaces of Integrated Layered Defense (ILD) and Integrated Early Warning (IEW), Preparing for surprise, or the employment of Artificial Intelligence/ Machine Learning (AI/ML), which include:

Describing the current JSTO collaborations between the S&T and Warfighting communities that demonstrate the use of warfighter feedback to create a better understanding of warfighter needs or to optimize the applicability and utility of developing technology concepts especially as they relate to initiatives within the CBDP.

Proposing new collaboration venues that could be used to gain meaningful end user feedback. Or to outline gaps that exist between the two communities (S&T and Warfighter) and the current/future engagement efforts that could be used to close these gaps, such as understanding the underlying technical and operational challenges associated with field demonstrating or articulating requirements for CBDP initiatives.

Exploring the Innovative approaches for how organizations to include US federal government, DoD and international partners engage and collaborate with User communities to optimize the utility of innovation in all phases of development to spark innovation, optimize the utility of capabilities, and potentially expedite the delivery of capabilities that enable Warfighter and our allies to outmatch adversaries.