



Request for Project Information (RPI)
MTEC-18-08-Open Concepts
October 1, 2018

Background:

The Medical Technology Enterprise Consortium’s (MTEC) mission is to assist the U.S. Army Medical Research and Materiel Command (USAMRMC) by providing cutting-edge technologies and supporting effective life cycle management to transition medical solutions to industry that protect, treat, and optimize Warfighters’ health and performance across the full spectrum of military operations. MTEC is a biomedical technology consortium collaborating with multiple government agencies under a 10-year renewable Other Transaction Agreement (OTA), Agreement No. W81XWH-15-9-0001, with the U.S. Army Medical Research Acquisition Activity (USAMRAA). MTEC is currently recruiting a broad and diverse membership that includes both “traditional” and “non-traditional” government contractors representing large businesses, small businesses, academic research institutions, and not-for-profit organizations.

This RPI contains background material and guidance for preparing Project Information Paper submissions to MTEC.

As a result of MTEC member feedback at the MTEC Annual Membership Meeting in April 2018, MTEC has issued this “Open Concepts RPI” to provide existing and potential MTEC members with an opportunity to demonstrate current capabilities and concept/technologies that may address military medical capability gaps. Performers are encouraged to submit concepts/technologies under this RPI that they would like the Government to consider when developing the technical research topics to be included in upcoming Requests for Project Proposals (RPPs) expected to be released in fiscal year 2019. The Government is interested in receiving project ideas related to all of its technology focus areas (described below).

Project Information Papers Authors must:

- Use the Project Information Paper template provided herein.
- Focus on prototype technologies that have **not** been submitted to MTEC under previous RPIs or RPPs. The Government is already aware of prototype concepts submitted in response to previous MTEC solicitations, and therefore, such concepts are not allowed to be resubmitted here. **This RPI is intended only for submission of new concepts to MTEC, not direct resubmissions or modifications of previously**

submitted concepts. Entities with new or novel approaches, processes, cost share, private funding, and/or teaming arrangements are encouraged to submit ideas through this RPI.

- Describe your technological solutions related to the greater technology focus area (described below) as applicable. Project Information Papers may also describe enabling, cross-cutting technologies that enhance several prototypes/products within multiple technology focus areas.
- Describe projects that are based on logical reasoning and sound scientific rationale. They should not be exploratory in nature and do require a foundation of preliminary data.
- Suggested concepts/technologies must fit the definition of a “prototype,” and regulatory requirements for the Food and Drug Administration (FDA) must be considered where appropriate. As defined in the DoD OTA Guide dated January 2017, a prototype project can generally be described as “a preliminary pilot, test, evaluation, demonstration, or agile development activity used to evaluate the technical or manufacturing feasibility or military utility of a particular technology, process, concept, end item, effect, or other discrete feature. Prototype projects may include systems, subsystems, components, materials, methodology, technology, or processes. By way of illustration, a prototype project may involve: a proof of concept; a pilot; a novel application of commercial technologies for defense purposes; a creation, design, development, demonstration of technical or operational utility; or combinations of the foregoing, related to a prototype.”

Technology Focus Areas (refer to Appendix I for more information on the Research Areas of Interest):

1. **Military Infectious Diseases Research Program (MIDRP):** This technology area focuses on vaccines, drugs, vector detection assays, and novel therapeutics to treat multidrug-resistant organisms in combat wound infections, as well as vector control measures for insect vectors that transmit naturally occurring endemic diseases with demonstrated or potential capability to decrease military operational effectiveness. Malaria, dengue, and bacterial diarrhea are the main areas of interest for the MIDRP. The MIDRP also has programs in multidrug-resistant bacteria and fungi, Rickettsial diseases, emerging infectious diseases (e.g., chikungunya virus, Zika virus) not found on the Defense Threat Reduction Agency (DTRA) biothreat list. The MIDRP is also interested in Project Information Papers incorporating a systems biology approach. Systems biology is the study of systems of biological components, which may be molecules, cells, organisms, or entire species. The MIDRP does not fund research on any biological or chemical warfare threats or cancer. Research efforts that focus on novel technologies and/or Investigational New Drug (IND)-enabling preclinical and clinical studies to facilitate the development of preventive and treatment therapies for the above-mentioned research areas are of interest to the MIDRP.
2. **Combat Casualty Care Research Program (CCCRP):** This technology area provides integrated capabilities for current and future operations to reduce the mortality and morbidity associated with major combat-related trauma across the spectrum of combat casualty, care including point of injury and pre- or out-of-hospital care, the spectrum of en-route care, and facilities-based treatment.

- a. A primary emphasis of the CCCRP is to identify and develop medical techniques, knowledge products, and materiel¹ (medical devices, drugs, and biologics) for early intervention in life-threatening battle injuries and prolonged field care² (PFC). Because battlefield conditions impose severe constraints on available manpower, equipment, and medical supplies available for casualty care, the CCCRP places a premium on medical interventions that can be used within the battle area or as close to it as possible, before or during medical evacuation. Preferred medical techniques and materiel that can be used by combat medics must be easily transportable (i.e., small, lightweight, and durable in extreme environments and handling); devices must be easy to use and require low maintenance, with self-contained power sources as necessary. The CCCRP is interested in existing materiel for which concept and/or patient care efficacy have already been demonstrated, but that require improvement to meet military requirements. The CCCRP is also interested in Project Information Papers that incorporate a systems biology approach.
- b. Research efforts are needed in principles and technologies to enhance self- and buddy-aid, also referred to as tactical care; techniques, methods, or materiel to improve basic and advanced life support for all injured persons; monitoring, sustainment, and management of all injured casualties during episodes of delayed care or PFC; and enhanced capability for triage of large numbers of casualties and staged treatment in the field. The principal causes of death among Service members who die within the first hour of wounding are hemorrhage and traumatic brain injury (TBI).
- c. The CCCRP supports additional aspects of casualty care. These include drugs, devices, and/or novel surgical techniques to decontaminate, debride, protect, monitor, repair, and/or stabilize hard and soft tissue wounds to mitigate secondary tissue damage; orthopedic and maxillofacial trauma repair strategies; and the prevention and/or mitigation of wound infection and disease in austere environments. The CCCRP is also interested in the development of sensors; diagnostic and prognostic algorithms; data gathering or capture modalities; processors to improve our capability for remote triage, monitoring, and management of casualties; and products to maintain casualties during prolonged evacuation.
- d. The CCCRP also supports the conduct of military-relevant clinical research aimed at translating knowledge or materiel from basic and preclinical trauma research into clinical practice. This includes, but is not limited to, single- and multi-center clinical trials performed in the civilian setting to clarify

¹ Materiel is defined as equipment and supplies of a military force.

² Prolonged field care is defined as field medical care, applied beyond “doctrinal planning timelines” by a North Atlantic Treaty Organization (NATO) Special Operations Combat Medic (NSOCM) or higher, in order to decrease patient mortality and morbidity. PFC utilizes limited resources and is sustained until the patient arrives at an appropriate level of care. Rasmussen TE, Baer DG, Cap AP, et al. 2015. Ahead of the Curve. *J Trauma Acute Care Surg* 79: S61-64.

the safety, efficacy, and optimal use of products stemming from the previously mentioned research areas.

- e. The CCCRP supports the conduct of military-relevant, large data research projects including the use of large databases of common elements from trauma research projects (preclinical, translational, and clinical). Such studies should directly contribute to or effectively enable the data-driven conduct of combat casualty care. Examples include, but are not limited to, post-hoc analysis of data from completed trauma research projects, meta-analyses of a number of otherwise separate but completed studies, and the ability to harmonize data from planned or ongoing but otherwise separate research studies.

3. **Military Operational Medicine Research Program (MOMRP)**: This technology area aims to develop effective countermeasures against military-relevant stressors and to prevent physical and psychological injuries during training and operations in order to maximize the health, readiness, and performance of Service members and their families, in support of the Army Human Performance Optimization and Enhancement, Human Dimension, Multi-Domain Battle, and the DoD Total Force Fitness concepts. The MOMRP is divided into four Research Areas of Interest (with examples of types of research efforts shown in parentheses): (1) *Environmental Health and Protection* (performance optimization and biomarker validation during heat/cold/altitude exposures); (2) *Injury Prevention and Reduction* (countermeasures against aviation stressors; blast, blunt trauma, and accelerative injury prevention strategies; neurosensory injury protection; injury return-to-duty standards and strategies; and physiological mechanisms of musculoskeletal injury); (3) *Physiological Health and Performance* (performance and recovery nutrition, weight balance optimization, cognitive health and performance sustainment in the face of operational challenges, restorative sleep, and establishment of a physiological basis for resilience to operational and environmental stressors); and (4) *Psychological Health and Resilience* (post-traumatic stress disorder [PTSD], suicide prevention, resilience [including military families], substance abuse prevention, and violence prevention within the military).

- a. The MOMRP provides the planning, programming and budgeting of biomedical research to deliver products and solutions to Service members and their families that address readiness, health, and performance throughout the deployment cycle and Service member lifecycle. The MOMRP is centered on cutting-edge scientific research and bringing “Science to the Service member” on the battlefield and at home in a relevant, timely manner.
- b. The MOMRP supports research focused on solving critical problems facing the military today and in the future. Service- and platform-specific issues are addressed through close coordination with all Services to prevent unnecessary duplication of effort.
- c. The MOMRP is particularly interested in products that incorporate integrated biomedical approaches (e.g., systems biology). Project Information Paper authors are encouraged to leverage existing resources and infrastructure to support lifecycle logistics and sustainability.

4. **Clinical and Rehabilitative Medicine Research Program (CRM RP)**: This technology area focuses on the innovations required to reset our wounded Service members, both in terms of duty performance and quality of life. Innovations developed from CRM RP-supported research efforts are expected to improve restorative treatments and rehabilitative care to maximize function for return to duty (RTD) or civilian life. Medical technologies (drugs, biologics, and devices) and treatment/rehabilitation strategies (methods, guidelines, standards, and information) that will significantly improve the medical care our wounded Service members receive within the DoD healthcare system are of particular interest. Implementation of these technologies and strategies should improve the rate of RTD of Service members, the time to RTD, clinical outcome measures, and quality of life, as well as reduce the hospital stay lengths, clinical workload (patient encounters, treatments, etc.), and initial and long-term costs associated with restorative and rehabilitative or acute care.
- a. Development and validation of in-vitro and in-vivo assessment models that represent military-relevant conditions in wounded Service members, as well as those that incorporate a systems biology approach, are of interest to the CRM RP when they can be used to identify and describe, in a predictable manner, the safety and efficacy of novel technologies in patients.
 - b. The CRM RP focuses its efforts on the following research areas: neuromusculoskeletal injury (including limb trauma and amputation), sensory systems impairment (including hearing, balance, tinnitus, and vision), acute and chronic pain, and regenerative medicine. While research topics of highest priority and interest are listed in Appendix 1 for each of these areas, Project Information Papers for topics that align within an overall research area will also be considered, except as specifically noted. TBI research Project Information Papers will only be considered if the focus is related to one or more of the following: hearing, balance, tinnitus, vision, or pain related to TBI. Novel manufacturing technologies necessary to translate innovative therapies or devices into clinical development are a focus.
5. **Medical Simulation and Information Sciences Research Program (MSISRP)**: This technology area's mission is to explore the implications of models and technology for medical education and for the provision, management, and support of health services in the military. The MSISRP plans, coordinates, and oversees a responsive world-class, tri-Service science and technology program focused on three areas of research.
- a. The first area is focused on improving military medical training through medical modeling, simulation, educational gaming, assessment systems, interoperable training platforms, and objective training metrics.
 - b. The second area is focused on developing, researching, and/or improving technologies and informatics that support Theater and Operational Medicine, such as the capture, movement, storage, usability, use, and sharing of health-related data for better clinical care, strategic planning, process development, and software applications.

- c. The third area is focused on the Multi-Domain Battle, an operational environment involving greater dispersion and near isolation over great distances, which is likely to cause severe restrictions on mobility for medical missions and shortfalls in both human and materiel human resources due to area denial challenges. Combat units will need to be more self-sufficient and less dependent on logistical support. Combatant commanders with increased sick or wounded Soldiers will face degradation of medical resources and encumbered combat effectiveness without new combat casualty management and Force multiplication strategies.

Submission Information:

Project Information Paper submissions **are due no later than Friday, November 30, 2018 at noon Eastern Time** using the submission form located here: <https://secure.ati.org/mtec/mtec-rpi.html>. Project Information Papers submitted after the due date will not be accepted under any circumstances. There is no limit on the number of Project Information Papers that a single organization can submit. **Submission in response to this RPI is open to both members and non-members of MTEC.** However, MTEC membership is required to submit a response to future FY19 MTEC RPPs. Information regarding upcoming RPPs will be posted to the MTEC website (mtec-sc.org) and FedBizOpps (fbo.gov) to notify interested parties.

To join MTEC, please visit <https://mtec-sc.org/how-to-join-2>.

MTEC RPI Submission Review:

1. MTEC intends to provide an initial review of all Project Information Papers submitted in response to this RPI to evaluate their objectives, relevance, and maturity as they relate to military needs. However, if the number of submissions becomes too large to make timely responses, MTEC may close the solicitation period early and without warning. Therefore, early submissions are highly encouraged. MTEC will provide the initial review on a rolling basis, so feedback should be provided within a relatively short period after submission and will afford the submitter a chance to update the Project Information Paper prior to referral to the Government. During the course of this review, MTEC may ask the submitter clarifying questions or provide suggestions that could improve the submission. MTEC intends to provide a short paragraph back to the submitter that describes why the Project Information Paper may or may not be a strong response for the relevant Government Sponsor to consider.
2. Submitters who receive feedback from MTEC will be given an opportunity to update their Project Information Papers based on the feedback provided. The submitter will be given additional time to update the Project Information Paper based on the feedback. The cover of the feedback letter will provide a due date for the revised Project Information Paper.
3. MTEC will then forward all RPI submissions to the Government for consideration as suggested topics to be solicited under a future RPP(s).

Points of Contact:

For inquiries regarding this announcement, please direct your correspondence to the following contacts:

- Technical questions –
Dr. Lauren Palestrini, PhD, MTEC Director of Research, lauren.palestrini@officer.mtec-sc.org,
Mr. Bill Howell, MTEC Chief Operating Officer, William.Howell@tunnellgov.com
- Administrative questions - Ms. Kathy Zolman, MTEC Program Manager, kathy.zolman@ati.org
- Membership questions - Ms. Stacey Lindbergh, MTEC Executive Director, execdirect@mtec-sc.org

Military Technology Enterprise Consortium (MTEC) Project Information Paper Template

[3 page limit. 11 point (or larger), Single-spaced, single-sided, 8.5 inches x 11 inches). Smaller type may be used in figures and tables, but must be clearly legible. Margins on all sides (top, bottom, left, and right) should be at least 0.5 inch. **These project ideas will be shared with various potential sponsors. Please do not include proprietary information.**]

MTEC-18-08-Open Concepts

Date: [Insert Date of Submission]

MTEC Technology Objective (select only one): [Infectious Disease, Combat Casualty Care, Military Operational Medicine, Clinical and Rehabilitative Medicine, Medical Simulation and Information Sciences]

Title: [Insert descriptive title of project]

Principal Investigator (PI): [Insert PI name, organization, email address, phone number]

Confirmation by PI that this Project Information Paper describes a new concept to MTEC, and is not a direct resubmission or modification of a previously submitted concept: [Yes or No]

Background: [Provide a clear description why and how the proposed project fits into the MTEC mission. Describe how the technology addresses an unmet need in military and civilian markets, if applicable. Describe the current status of the prototype technology.]

Objectives: [Provide a description of the overall purpose and specific objectives of the proposed project.]

Project Design: [Outline the proposed methodology in sufficient detail to show a clear course of action. Provide a proposed period of performance.]

Anticipated Outcomes: [List milestones and deliverables from the proposed work. Provide a description of anticipated outcomes from the proposed work.]

Anticipated Regulatory and Commercialization Strategy: [Provide a brief description of the anticipated regulatory pathway and commercialization plans.]

Technology Readiness Level (TRL): [Please indicate the TRL stage in which the project will start as well as anticipated TRL level at project completion. A table with the description of TRLs can be found: <https://mtec-sc.org/wp-content/uploads/2016/12/TRL-definitions.pdf>]

TRL at Project Start:

TRL at Project End:

Team: [Briefly state the qualifications of the PI, key personnel, and organization(s) to perform the work.]

Cost: Do not provide budget detail – only provide a total estimated budget for each major milestone/objective. This information will be used to provide the MTEC and Government with a reasonable representation of the amount of funding required to advance the project.



APPENDIX I: RESEARCH AREAS OF INTEREST

I. Military Infectious Diseases Research Program

A. Research and Development Toward Preventive Measures for Infectious Diseases

- **Vaccines:** The development of vaccines to protect the Warfighter is a priority for the MIDRP. Vaccines can be administered prior to deployment, thereby protecting the Warfighter by preventing disease, obviating the need for prophylactic medication, and reducing the medical logistic burden. The MIDRP supports studies to characterize infectious disease agents and their mechanisms of pathogenesis, utilizing various approaches to identify and evaluate vaccine candidates in animal models and humans, as well as studies of protective immune responses to these agents.
- **Anti-Parasitic Drugs:** The MIDRP supports research efforts for discovery, design, and development of drugs to prevent malarial infections. This includes drug synthesis, characterization of modes of action, screening for antimalarial activity, in vitro and in vivo research using animal models, and drug resistance mechanisms. Investigations into parasite metabolism, structural biology, genomics, proteomics, and metabolomics focused on identification of potential novel targets for drug intervention are also relevant to the MIDRP.
- **Vector Control Products:** The MIDRP supports investigations focusing on arthropod vectors and arthropod vector-borne diseases (primary malaria, dengue, and scrub typhus). Current studies target vector-pathogen-human interactions, vector control measures (including personal protective equipment), and risk assessment (including identification and classification of vectors, improved surveillance techniques, and field-deployable assays for detecting pathogens in their vectors).
- **Combat Wound Infections:** The MIDRP supports research to inform and/or facilitate product development to detect, prevent, treat, and manage combat wound infections. Investigations in this area include characterization of the mechanisms of biofilm formation in wounds, the mitigation of biofilm formation in wounds, novel therapies for wound infection treatment, and methods to understand the dynamics of microbial communities in infected and healing wounds. In addition, novel chemical classes and/or biologics to prevent or treat combat wound infection and/or biofilm formation are of interest.

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B. Research and Development of Therapeutic Measures for Infectious Diseases

Therapeutic drug development (including studies to screen, synthesize, and develop therapeutic drugs for malaria and other military-relevant infectious agents) is secondary to prophylactic drug development within the MIDRP (see above). However, efforts to advance novel drug delivery systems (i.e., sustained-release reduce toxicity or targeted drug delivery) would be considered. In addition, MIDRP supports investigations into the development of novel medical countermeasures and innovative treatment approaches (e.g., chelators, phage, antimicrobial peptides, quorum-sensing inhibitors, and host immune augmentation) against multidrug-resistant organisms in combat wound infections and pathogenic biofilm formation. Given modest pharmaceutical industry interest in developing and marketing vaccines for orphan diseases, the MIDRP is also interested in applications for the development of products leading to FDA-licensed treatment options and broadly active therapeutics against multiple endemic disease threats.

II. Combat Casualty Care Research Program

- A. Research and development of technologies to stop blood loss, resuscitate the casualty, and limit the immediate, short-, and long-term deleterious consequences of severe hemorrhage:** Research focused on the pre-hospital setting including point of injury, the initial “Golden Hour” after injury, and scenarios in which a casualty cannot be transported through traditional levels of care (i.e., prolonged field care [PFC]) are of high interest. Included in this area of interest are diagnostics and therapeutics to predict, diagnose, prevent, and treat coagulopathy of trauma and non-invasive or minimally invasive sensors to detect and warn of impending vascular collapse and/or significant tissue damage due to perfusion deficits. Examples of specific products include local and systemic hemostatic agents or devices (exovascular or endovascular) for control of vascular disruption and subsequent compressible and non-compressible hemorrhage, treatments to sustain or enhance oxygen delivery and perfusion of vital tissues and organs, and equipment and procedures for effective fluid resuscitation and enhanced resuscitation fluids. Also of interest are the improved preservation, storage, transportability, and processing of red blood cells, platelets and plasma, and other blood or blood-like substitutes.
- B. Research and development of technologies to diagnose and to limit the immediate, short-, and long-term impairments that follow TBI and spinal cord injury:** Research specializing in “polytrauma” accounting for the impact of hemorrhagic shock and failure to oxygenate and/or ventilate as brain injury progresses is of interest to provide insight leading to improvements in clinical practice guidelines. Included in this area of interest are non-invasive or minimally invasive sensors or assays to rapidly diagnose the severity of brain and neurological injury within the battle area (or as close to it as possible) and drugs, biologics, or other agents to mitigate the progression of neurotrauma/secondary brain injury such as

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post-injury neural and immune cell overstimulation, inflammation, cell loss, and/or neurologic dysfunction.

- C. Research and development of technologies to diagnose and reduce acute secondary organ damage:** Secondary damage to organs frequently occurs after severe trauma and resuscitation. The CCCRP is interested in materiel and/or devices that can reduce acute secondary organ damage such as ischemia/reperfusion injury, cell death, general organ failure, and secondary brain/spinal cord damage. Technologies to sustain or support single- and multiple-organ injury and failure are also of interest to the CCCRP. These objectives include methods to reduce cellular demand for oxygen and metabolic substrates and therapeutics to modulate the immune response to traumatic injury as well as single- and multiple-organ support or replacement technologies (extracorporeal). In addition, the utilities of these modalities during (and the effects of longer distance) en-route care on the critically injured casualty are also of interest.
- D. Research and development into the impacts of transport:** An important element of combat casualty care is the transport of patients from the initial point of injury and throughout the continuum of care. Accordingly, the CCCRP is interested in improving and maintaining optimal clinical outcomes for en-route care including PFC. Identifying feasible ways to mitigate the stresses of flight and/or transport (such as hypobaria, hypoxia, vibration, and g-forces) in an austere/constrained environment and the impact on clinical outcomes (such as healing rates, pain, infection rates, etc.) are particularly important. Additionally, establishing either timeframes or ways to measure the appropriate time to transport patients with critical injuries (including neurotrauma, burns, lung injuries, and musculoskeletal injuries) are a critical element to improving outcomes.

III. Military Operational Medicine Research Program

- A. Injury Prevention and Reduction:** This area of research addresses the requirement to provide the biomedical basis for countermeasures that prevent and mitigate Service member injuries and performance decrements occurring in training and operational environments, decrease attrition and medical cost, minimize personal impact to the Service member, and promote readiness. The primary need of the Injury Prevention and Reduction portfolio is the development of validated injury criteria utilizing animal models and postmortem human subjects against blunt and ballistic threats that will inform the development of helmets and body armor. Coordination with DoD labs such as the U.S. Army Aeromedical Research Laboratory, U.S. Army Research Laboratory (ARL) Survivability, Lethality, and Analysis Directorate and/or ARL Weapons and Materials Research Directorate is encouraged. Other research areas of interest include: developing and validating return-to-duty (RTD) clinical assessments and physical performance standards following neurosensory and musculoskeletal injury; understanding the physiological impact of exposure to repetitive low-level blast in order to validate military safety standards and

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health hazard assessment prediction tools to prevent brain, sensory, and lung injury; understanding the bioeffects from exposure to, and developing injury thresholds against, directed energy threats (e.g., laser, microwave, and radiofrequency waves); and developing interventions to mitigate neurosensory and musculoskeletal injury risk and optimize performance in complex military systems, and develop and validate assessment tools and strategies to promote Service member physical performance optimization (individual and group). In addition, this research includes the development of policy, training, planning/management tools, knowledge and materiel solutions, status monitoring systems, interventions, and reset solutions to sustain Service member health and operational effectiveness.

B. Psychological Health and Resilience: The Psychological Health and Resilience research program area is interested in research aimed at maximizing resilience and psychological health and decreasing PTSD, depression and anxiety disorders, suicide, and risk behaviors (e.g., substance abuse, anger/aggression, sexual harassment and assault, and interpersonal violence within the military). Additional psychological health areas of interest include military-related grief, guilt, or loss issues; moral injury; interdisciplinary and comprehensive prevention and life-skills training strategies to reduce negative psychological health trajectories; and reduction of stigma and other barriers to psychological healthcare-seeking. MOMRP has interest in understanding and addressing psychosocial/psychological health challenges unique to military families, women Service members, Reserve and Guard, and lesbian, gay, bisexual, and transgender Service members. This research area focuses on the development and validation of effective training and prevention interventions, screening and assessment strategies, and treatment and rehabilitation interventions that address the psychological health topic areas. In addition, this research area focus may include development and validation of effective evidence-based training and prevention interventions for concussion/mild TBI. Research areas of particular interest include foundational studies to generate and validate theories and elucidate underlying mechanisms of psychological disorders and treatment response; studies addressing comorbidities (including, but not limited to, PTSD, concussion, alcohol and other drug abuse, sleep disturbance, mood disorders, suicidality, and psychosocial factors); studies focused on enhancing translation, implementation, and uptake of evidence-based strategies and treatments; research focused on establishing validated objective RTD standards following psychological injury; and research focused on systems approaches to psychological health. Proposals/Applications are encouraged that incorporate and evaluate leveraging of technology (e.g., telemedicine, remote monitoring, biosensors, advance immunologic testing, and health information technologies), and leverage existing resources and infrastructure to support lifecycle logistics and sustainability. Also of interest are rigorous studies on integrative medicine and complementary and alternative medicine (CAM) approaches spanning mind/body, movement, natural products, non-Western medicine approaches and spiritual practices, along with validation studies of CAM therapies. Research topics of particular interest include those directed at evaluating efficacy of

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cognitive training approaches to promote resilience and prevent/mitigate acute negative responses to psychological trauma and promote readiness; and the development of a systematically applied set of therapeutic services designed to reduce cognitive dysfunction and restore functions that can be restored and/or improve quality of life.

- C. Physiological Health and Performance:** This area of research develops biomedical countermeasures to sustain Service member health and operational effectiveness. It informs military policy, training, clinical practice guidelines, and the development of materiel solutions to establish, sustain, optimize, and monitor Service member health, physiological factors of resilience, and cognitive and physical performance throughout the military lifecycle, including training, deployment, reset, and injury recovery cycles. This research area aims to prevent or mitigate the negative effects of operational and training stressors on the readiness, performance, and fitness of Service members, as well as safely enhance performance with evidence-based pharmacological and non-pharmacological personalized strategies based on a systems medicine approach. Studies may include, but are not limited to, those that investigate the use of dietary supplements and nutritional and behavioral interventions to mitigate threats to readiness, operational health, and performance. Research also aims to develop healthy sleep and fatigue management strategies, strategies that exploit individual differences in sleep loss resilience, and strategies that promote individualized resilience to various operational stressors and injuries. Physiological health and performance research also encompasses work focusing on overall brain and cognitive fitness. Basic, applied, and advanced research studies utilizing technologies and strategies to monitor and promote Service member and family readiness and health to support the Army Surgeon General's Performance Triad and U.S. Army Training and Doctrine Command Human Dimension Initiative are of interest.
- D. Environmental Health and Protection:** This area of research includes assessment and sustainment of health, Force readiness, and the operational effectiveness of Service members exposed to harsh operational environments including altitude, cold, heat, undersea, and exposure to environmental toxicant health hazards or combination of environmental stressors. Studies may include, but are not limited to, methods for effective monitoring of environmental exposures in individuals and populations and assessment of health risks following exposures to environmental stressors. In addition, this research includes development of policy, training, planning/management tools, decision aids, knowledge and materiel solutions, physiological status monitoring systems, interventions, and reset solutions to sustain Service member readiness, and health and operational effectiveness to environmental stressors encountered during training or operations. Additional research identifies biomarkers of exposure, dosimetry, and risk management to environmental toxicant health hazards, neurological and physical assessment tools for optimizing performance of the Service member exposed to environmental toxicant hazards, and development of portable devices for rapid identification of biomarkers of complex exposures and health effects in support of military operational requirements. Additional

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research focuses on developing wearable solutions that are small size, low weight, cube, and have minimal power requirements for real-time physiological status monitoring in harsh operational environments.

IV. Clinical and Rehabilitative Medicine Research Program

- A. Neuromusculoskeletal (NMS) Injury Rehabilitation:** The NMS Injury Rehabilitation program area seeks research efforts directed toward optimal treatment, rehabilitation, and reintegration following Service-related NMS injury including: Service-related acute and repetitive overuse injury management, limb loss rehabilitation and prosthetic management, and limb trauma rehabilitation and orthotic management. Areas of encouragement include: validation of therapeutic exercise dosage (frequency, intensity, timing, and/or type) and rehabilitation strategies to improve Warfighter function, performance, and quality of life; understanding confounders of optimal rehabilitation; research to develop and validate standardized metrics of function, performance, and quality of life across and beyond the continuum of rehabilitative care; validation of existing short- and long-term reintegration strategies; research to predict and mitigate secondary health deficits following NMS injury; and efforts to develop and validate rehabilitation technologies (e.g., rehabilitation tools, interoperability of devices, prosthetic sockets, orthotic devices, advanced prosthetic control, sensory/proprioception, etc.) for Warfighters with NMS injuries to restore function and quality of life.
- B. Vision Restoration and Rehabilitation:** The Sensory Systems program area is seeking research efforts aimed at understanding and treating traumatic and Service-related injuries (e.g., blast, burn, penetrating, chemical, etc.) to ocular structures and the visual system (e.g., optic neuropathy, corneal scarring, retinal injury, lids and adnexal injuries, and ocular polytrauma, etc.). Additional areas of interest include studies to improve or advance visual system diagnostic/assessment capabilities, and restoration/rehabilitation strategies (including, but not limited to, rehabilitation for multisensory dysfunctions, low vision and blindness, and oculomotor vision disorders) following traumatic injury.
- C. Hearing Loss/Dysfunction, Balance Disorders, and Tinnitus:** The Sensory Systems program area is seeking research efforts to support the development of strategies and technologies (including, but not limited to, medical devices, pharmaceuticals, rehabilitation strategies, and regenerative medicine-based approaches) to restore and/or rehabilitate patients with hearing loss/dysfunction, balance disorders, and/or tinnitus due to trauma (including TBI). This includes research focused on the etiology of injury including studies to support an understanding of the molecular, cellular, and physiological mechanisms underlying hearing loss/dysfunction, balance disorders, and tinnitus. Additional areas of interest include research supporting the development, advancement, and/or validation of objective diagnostics, and treatment/rehabilitative strategies for hearing loss/dysfunction, balance disorders, multisensory dysfunction, and tinnitus after traumatic or Service-related injuries.

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- D. Pain Management:** The primary interest of the Pain Management program area is management of acute and chronic pain associated with traumatic or combat-related injuries. The CRMRP's specific needs include development of alternative interventions to current opioid analgesics for pain management by the medic/corpsman on the battlefield/remote locations; development of intervention strategies for acute pain management in deployed locations, including battlefield and resource-limited environments; development of strategies for management of acute pain under the care of a clinician in non-deployed settings; development of intervention strategies for chronic pain management in deployed locations, including battlefield and resource-limited environments; development of intervention strategies for management of chronic pain under the care of a clinician in non-deployed settings; identification of pain generators and etiology of pain; development of strategies for identifying and addressing biopsychosocial aspects of pain; and development of substance misuse and abuse assessments and treatments in pain management.
- E. Regenerative Medicine and Composite Tissue Engineering:** Regenerative medicine involves the use of innovative technologies such as scaffolds and tissue engineering, growth factors, and cell-based treatments to restore Service members who have suffered combat-related injuries. Research topics of particular interest include those directed toward the use of regenerative medicine-based technologies to repair functional neural deficits (to include all peripheral nerves, visual system, and auditory system but excluding other deficits associated with central nervous system or spinal cord), repair/replace neuromuscular tissue units of the extremities or face including composite facial features (eyelids, lips, and nares), regenerate bone defects (weight-bearing and alveolar), regenerate skin, address vascular repair/revascularization, regenerate cartilage/musculoskeletal connective tissues for the prevention of post-traumatic arthritis, muscle protection/regeneration, vascularized tissue allotransplantation, immunomodulation, and tolerization related to vascularized tissue allotransplantation and wound management and tissue preservation such as promotion of scarless wound healing (not to include infection control).
- F. TBI Rehabilitation:** The sensorimotor clinical rehabilitation line of effort within the TBI program seeks to develop, evaluate, and/or validate rehabilitation intervention strategies (e.g., multitask/dual-task) to address TBI-related sequelae. Interventions should remediate TBI-related deficits including, but not limited to, dizziness, cognitive dysfunction (e.g., attention, memory, or impaired executive function), or sensorimotor deficits (e.g., gaze or gait instability). Intervention strategies should aim to increase patient tolerance for rehabilitation and result in clinically meaningful and measurable improvement in targeted impairments, functional deficits, and barriers to participation. Competitive proposals/applications will address theorized physiologic mechanisms underlying treatment strategy. Clinical research is needed to investigate the optimal delivery of rehabilitation interventions and prescription (i.e., frequency, intensity, timing, and type) and to investigate comparative effectiveness of standard of care and novel intervention strategies.

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Studies that characterize or investigate proposed neural mechanisms of recovery with rehabilitation will be favorably considered. Cognitive rehabilitation studies that utilize a practice-based evidence design to identify clinical best practices and optimal outcomes among active duty Service members and like-aged Veterans with persistent post-traumatic cognitive sequelae are encouraged.

- G. Ecological Assessment:** The Ecological Assessment line of effort within the TBI program aims to develop, evaluate, and/or validate RTD outcome measures following rehabilitation in patients with mild TBI. Outcome measures may integrate novel or commercially available assessment technologies to enhance sensitivity and/or specificity. Outcome measures should be both ecologically valid (i.e., focused on military-specific tasks) and clinically feasible, with an aim to inform RTD/participation decisions in either an operational or garrison-based environment. Outcome measures should quantify and characterize patient impairments, functional limitations, and barriers to participation and have a strong plan for validation in the Warfighter population.

V. Medical Simulation and Information Sciences Research Program

A. The Medical Simulation (MedSim) Portfolio

The Medical Simulation (MedSim) Portfolio is focused on three overarching initiatives: Combat Casualty Simulation Initiative, Medical Readiness Initiative, and Tools for Medical Education. These three science and technology initiatives feed into broader Defense Health Agency programs with programmatic goals in Joint Evacuation and Transport Simulation (JETS) and Point of Injury Training Simulation (POINTS). The JETS program seeks to standardize patient movement training within the Military Health System (MHS) continuum of care while sustaining clinical standards of patient management. The POINTS program seeks to enable Point of Demand, mass-customizable training.

- **Combat Casualty Simulation Initiative (CCSI):** This initiative focuses on simulations that advance combat casualty care. Research in this area will examine the efficacy of modern simulation system technology versus current training models with emphasis on multi-trauma and mass casualty scenarios. The CCSI supports research to inform simulation development and acquisition in ways to develop appropriate fidelity material properties and characteristics that best mimic tissue and respond appropriately to users' actions; develop training assets for high state of combat medical readiness; provide resiliency training prior to deployment to better elicit higher performance under pressure; and to create and evaluate efficient and effective ways to deliver team (collective) training. Goals include:
 - Optimizing critical lifesaving skills and procedures through training and educational simulation systems

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- Developing adaptable, flexible, and interoperable training assets to reflect the continuous changes and modifications in combat-related injuries for high state of combat casualty medical readiness
- Increasing psychological resilience into pre-deployment training and increasing emphasis on mastery of skills and procedures through simulation system training tools
- Creating and integrating more physiologically based algorithms and models into simulation systems (mannequins and/or virtual/augmented/immersive reality) to appropriately and accurately represent tissue behaviors and characteristics
- Increasing emphasis on PFC training and researching and integrating simulation systems to substantially improve communicating and connecting with each other to transfer and accept information/data from one system to another to support a system of system training and education interactive environment
- Developing system of systems interoperable architecture to allow all Services at all roles within the continuum of care to train collectively, either with a modular training system or a collection of training systems to better understand clinical outcomes from a holistic patient perspective instead of as individual skills or procedures
- **Medical Readiness Initiative:** This initiative focuses on medical provider training systems and assessment of competence for sustained military and public medical readiness. Research efforts are aligned with maximizing healthcare professionals' training and investigating how existing medical cognitive and psychomotor skills might degrade. The initiative seeks to research improved intelligent automated assessment systems that will assist in directing and catering the type of training courses an individual needs as well as systems that connect medical training to real-world patient outcomes. This initiative invites research and development toward near-time, pre-intervention rehearsal. Goals include:
 - Identifying, researching, and developing predictive models that may accelerate cognitive, psychomotor, and healthcare behavioral skills (tasks) to a level of proficiency and develop reliable and predictable tools to accelerate development of clinical skills or to minimize skill decay (or degradation)
 - Identifying, researching, and developing simulation system tools that will improve (or allow) ethical, patient-focused, and more predictable pre-surgical/intervention models and pre-surgical/intervention training systems to optimize clinical outcomes
 - Identifying and researching potential predictors (data, markers, classifiers, etc.) for how training or use of any type of simulation system transitions to the real-world and patient outcomes

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- Improving assessment systems of users' cognition, psychomotor skills, and affective behavior before, during, and after (retention) training
- Leading the effort to develop a sustainable medical education lifecycle
- **Tools for Medical Education:** Research and develop next-generation inter-professional, open-source platforms, toolkits, and models to deliver future training systems in combat casualty care and medical readiness to improve the overall health of the Force. Focus is on promoting deliberate practice, enhancing mastery learning, enabling instructors, and preventing skill decay. Outcomes will result in resource sharing, collaborative research, and wide dissemination of knowledge and products to the medical modeling, simulation, training, and education community at large. Goals include:
 - Ensuring that advanced medical simulation tools and system capabilities are ubiquitous and support a diverse set of skills as well as allowing an individual or team to learn more advanced skills on a single device
 - Creating medical models and repositories that can be openly shared for medical simulation system developers and for the medical simulation community at large
 - Researching effective, efficient, elegant, accurate, appropriate, and robust medical models (anatomical, physiological, and/or behavioral) for developing next-generation mannequin prototypes and virtual/augmented/immersive reality simulation systems
 - Democratizing of knowledge and products through training platforms and tools that deliver healthcare content and advocate open-source/open-architectures to allow limited resources to be shared

B. The Health Information Technology and Informatics (HITI) Portfolio

- **Theater/Operational Medicine:** This is the main priority research domain for technologies and data management that improve and document clinical care and support services to the Armed Forces combat and deployment Warfighters. Focusing on providing high-quality healthcare services by improving information accessibility, data management, data movement, remote healthcare delivery, and decision support for Joint Casualty Management, Joint Patient Movement, Joint Performance Enhancement, Joint Medical Logistics and Infrastructure Support, and Joint Theater Medical Command and Control and research for the Armed Forces to promote, improve, conserve, or restore the mental or physical well-being of personnel.

The HITI Theater/Operational Medicine focus area provides technology solutions, software, decision support tools, algorithms, data management, knowledge, and HITI services to enhance the efficiency of healthcare operations in combat and operational environments. The objective of HITI Theater/Operational Medicine research is to ensure delivery of high-

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quality healthcare services through technologies for improved information accessibility and information management and use of emerging/advanced technologies by clinicians caring for injured Service members. The Government plans to use research outcomes to assess critical technology elements and technology maturity, system integration risk, future use feasibility, and, where necessary, technology maturation and demonstration to fulfill critical capability gaps in theater/operational medicine healthcare delivery and support. Particular focus is placed on advanced information management and use of emerging and next generation technologies. The goal is to research technology and data tools/strategies to support Theater/Operation Medicine within the following categories:

- **Joint Casualty Management (JCM)** directly supports medical care in theater/operational environments and sustains a healthy and fit Force. JCM delivers five of the seven Joint Health Services Support capabilities outlined in the new Taxonomy Continuum of Health Care Capabilities developed in Joint Publication 4-02, Health Service Support. The capabilities delivered are expected to be technology and informatics solutions for first responders, forward resuscitative care, theater hospitalization, definitive care, and en route care.
- **Joint Medical Logistics Infrastructure Support (JMLIS)** must establish the principles and practices that will move medical logistics into focused logistics. To integrate into the focused logistics system and to provide the highest quality of care, the medical logistics system must be able to accomplish two primary tasks. The first, accomplished in conjunction with Service Force management and Force design organizations, is to ensure that the medical supplies, materiel, and equipment with which U.S. medical forces deploy include the latest technologies and advances in the medical field. The second task is to ensure that medical supplies, materiel, and equipment are delivered to the right person, at the right place, and at the right time. JMLIS must incorporate new technologies and informatics solutions to provide real-time medical and operational capability and situational awareness of medical logistics operations within the joint area of operations. JMLIS technology and informatics will rapidly integrate advances in research, technology, and doctrine from science, medicine, engineering, information technology, and other areas into fielded capabilities.
- **Joint Patient Movement** supplies and develops solutions for interoperable device data to improve ground and air evacuation capabilities, standardization for device data to improve ability to evacuate the casualty to a treatment site and autonomous device interoperability to support reception/staging en route care operations, and prolonged care in place.
- **Joint Performance Enhancement** supplies and develops innovative data capture, storage, analytics, management, and movement solutions for real-time, non-invasive monitoring of vigilance, subject performance, and enhancement of cognitive abilities for optimal decision making in Warfighter readiness.

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- **Joint Theater Medical Command and Control** will research and validate a Joint Medical Command and Control solution that will synchronize and integrate health and medical force-related information from disparate databases and systems into one efficient, effective command and control capability. The resulting medical decision-based application will utilize intelligence, algorithms, decision support, or other novel approaches to organize and synthesize planning information queried from existing databases. It is anticipated that the data will eventually be migrated to a cloud solution to enable real-time response to anticipated, emerging, or contingency (crisis) situations. The research will enable direction, management, and/or coordination of assigned medical forces, assets, and resources in the accomplishment of assigned missions.
- **Military Healthcare Services:** Research into how healthcare providers and patients can better use health services and population health-related data, information, and technologies to improve health. Efforts to directly impact the way healthcare is provided to the patient, improve medical providers' ability to treat patients, promote health through readiness-centric patient engagement, patient safety-driven medical device information, interoperability, and connected healthcare services. Focus areas are as follows:
 - **Readiness-Centric Patient Engagement Applied Solutions:** Improve readiness through patient-initiated healthcare activities. Provide a user view of information that is comprehensive of healthcare and patient-generated data that can apply analytic and trending algorithms to help providers and patients make better decisions. Provide large volumes of data from agnostic input and devices, from any environment, in real time, to enable usable, actionable information. Develop and apply methods for analysis, interpretation, prediction, and modeling of health system and patient-generated data. The objective is to use mathematical and/or intelligent learning/machine learning tools to extract practical information, usable/actionable clinical knowledge, and/or predict disease or adverse events from health system and patient-generated data.
 - **Patient Safety-Driven Medical Device Information and Interoperability:** Improve systems or applications that will enable medical devices to interact with each other for the purpose of improving patient care, and to integrate health system or patient-generated medical device information seamlessly with an Electronic Health Record system for the purpose of providing effective clinical decision support to assist healthcare professionals and patients in making better clinical and/or lifestyle decisions.
 - **Connected Healthcare Services:** Promote "Healthcare Anywhere" through mobile and telehealth solutions that are usable, and facilitate point-of-injury care and documentation of care in theater/operational medicine environments for Roles 1, 2, and 3.

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– Role 1

This includes the provision of primary care, emergency treatment (resuscitation and stabilization), and preparation for transfer, usually under the guidance of a medical officer. This capability is normally integral to a major land-based unit and also reflects the provision of medical support inherent to an afloat platform.

– Role 2

This includes the reception and sorting of patients as well as the ability to provide elements of damage control resuscitation and the treatment of casualties. This is bolstered by a wider range of medical and nursing interventions and enhanced laboratory and imaging facilities. In addition, this level of care will prepare patients for further transfer with a limited holding capacity to prepare casualties for onward evacuation or for RTD.

– Role 3

This incorporates reception from Role 2 Military Treatment Facilities as well as direct receipt from local incidents. Major specialist facilities are available at this level of care with intensive care, holding, and nursing capabilities. Final sorting of casualties for transfer to Role 4 or RTD will occur here.

- **Health Information Technology Infrastructure and Data Management:** Research to enhance health enterprise infrastructure by implementing superior information technology and communications infrastructure.
 - **Health Data Management:** Improvements to data availability, management, storage, and operational use of Enterprise Health Data. Proposed objectives will ensure the unique identification of each patient, as well as aggregated data strategies for population health and big data.
 - **Health Informatics or Information Technology (HIT) Infrastructure:** Research into system interfaces that will ensure that products or systems work efficiently with other products or systems, present or future, without any unintended restrictions. Improve the ability of medical devices to securely and reliably exchange health system or patient-generated data/information with other devices and with medical documentation and management systems. Research to examine technology integration and clinical/business process integration to reduce implementation barriers with regard to remote health monitoring.
- **Medical Resourcing:** Research to improve financial and personnel management for better delivery of healthcare services. Distribution of healthcare resources around the globe

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through solutions for personnel management and personnel support functions, or interoperable Joint Force research outcomes with concentration on:

- **Medical Personnel Resource Planning and Allocation:** Deliver technologies and solutions for personnel management functions. Research to harness potential novel HITI approaches to efficiently and effectively match incoming patients with a provider and efficiencies gained through HITI mobile technologies for budgetary planning and execution.
- **Education and Training:** Explore technologies to streamline the access to, and management of, educational systems across the MHS. Conduct research to explore the use of HIT in the provision of training. Develop best approaches to leveraging HIT and discovering efficient training delivery across the enterprise. Research to harness potential efficiencies gained through e-textbook interoperability.
- **Financial Planning and Budget Execution:** Research on efficiencies gained through HITI technologies and data management for budgetary planning and execution.

C. Medical Capabilities to Support Dispersed Operations Portfolio

The Multi-Domain Battle, an operational environment involving greater dispersion and near-isolation over great distances, is likely to cause severe restrictions on mobility for medical missions and shortfalls in both human and materiel human resources due to area denial challenges. Combat units will need to be more self-sufficient and less dependent on logistical support. Combatant commanders with an increased number of sick or wounded Soldiers will face degradation of medical resources and encumbered combat effectiveness without new combat casualty management and Force multiplication strategies.

- **Medical Robotics Research** focuses on man-machine teaming in the delivery of medical care and patient handling to include automated patient monitoring and assessment functions for patient hold capabilities, aid in patient extraction from contested areas, and autonomous closed-loop interventions. As robotic capabilities continue to evolve, autonomous and tele-operated semi-autonomous robotic patient support systems could serve as Force multipliers for medical operations for closed-loop patient monitoring and triage as for robotics intervention. In addition to what may be considered contemporary robotics, i.e., an integration of knowledge-based software with electrical and mechanical engineering technologies, or so-called “hard robotics,” one approach to employing robotics for medical applications is the emerging field of so-called “soft robotics.” Soft robotics involves the use of soft and deformable structures in the robotics systems that deal with uncertain and dynamic task environments, e.g., grasping and manipulation of unknown objects, locomotion in rough terrains, and physical contacts with living cells and human bodies. Soft robotics faces a number of fundamental scientific challenges: the studies of unconventional materials are still in their exploration phase; it has not been fully clarified

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what materials are available and useful for robotics applications; tools and methods for fabrication and assembly are not established; the Government does not have broadly agreed upon methods of modeling and simulation of soft continuum bodies; it is not fully understood how to achieve sensing, actuation and control in soft bodied robots; and the Government is still exploring ways to test, evaluate, and communicate the soft robotics technologies.

- **Medical Autonomous and Unmanned Systems** focuses on delivering enhanced autonomous and unmanned medical capabilities such as the delivery of forward resuscitation treatment and emergency resupply of Class VIII products like whole blood as well as closed-loop en route care modules that could enable general purpose unmanned vehicles to perform casualty evacuation (CASEVAC) missions with some level of on-board medical capability and bi-directional interface with remote medical personnel. Focus areas include automating critical care procedures such as physical (pressure-controlled, palpable, tactile) diagnostics and automated therapeutics in the field and to integrate those capabilities into ground and air unmanned systems platforms to enable unmanned CASEVAC missions. Areas of basic research include:
 - Intelligent agent approaches to integration of intelligent algorithms from multiple critical care systems during PFC or extended evacuation. This effort focuses on new approaches for autonomous clustering of individual closed-loop medical systems and intelligent agent algorithms that interact with each other to enable future development of systems that provide care for multiple injuries (polytrauma) while maximizing patient outcomes through physiologic optimization and deconflicting multiple medical procedures.
 - Strategies for interfacing medical intelligent systems, closed-loop diagnostic, and critical care systems into autonomous unmanned ground and air platforms that allow for unmanned and expedited care of combat casualties and extended evacuations in the dispersed field environment.
 - Research in the area of artificial intelligence and perception systems for accurate detection, monitoring, and modeling of human physiology to enable future applied research in autonomous casualty extraction and en route care systems. Autonomous systems for these applications require high-fidelity mapping and identification of the human body, organs, and structures in near real-time for safe physical contact with casualties and interaction with Soldiers.
- **Virtual Health/Telehealth and Decision Support Tools for the Combat Medic** focuses on enabling greater field medical capabilities for the combat medic in the far-forward future battlefield in PFC and austere environments. The task is to research, design, and develop advanced telehealth capabilities and tools as well as automated decision support systems that operate in a pre-hospital context capable of providing greater support for the combat

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medic in the diagnosis, triage, and treatment stages, as well as reachback, if available, either synchronously (real time) or asynchronously (store/forward) to specialty care providers and other expert medical consultants from remote locations (both in-garrison and in-theater).

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