TATRC TIMES
January 2021 • Volume 6, Qtr. 4

A Message from the Director

COL Jeremy C. Pamplin,
Director TATRC

2020 – What a year it has been!

To put it lightly, 2020 was a year of great change. Unexpected challenges, stress, and uncertainties crept into every aspect of our lives, disrupting and reshaping how we behave and interact as a society. One constant through that change, however, has been the spirit of Team TATRC and the incredible efforts that each and every one of the staff has given in support of our mission. For the past eleven months, we have plowed and tilled and planted – a lot of hard work. But they say you reap what you sow, and as a result of all that work, we are growing in size, portfolio, and notoriety! People are noticing the outstanding work this team has done. And I couldn't be more proud.

Though we have weathered the storm this far, we are far from finished. In a way, it's just beginning; as TATRC evolves into its next phase as an Army research lab, there will be more change – in organization, processes, faces, and spaces. What will not change, however, are the values that comprise the very core of TATRC's existence – how we work together, our culture of innovation, our hope in what is possible, and our enthusiasm for discovering the next great thing that makes a difference for Warfighter health and casualty care on the battlefield of tomorrow.

As we return from the holidays, I want to commend Team TATRC on their exemplary work and encourage everyone to keep doing it in the months and years to come. I am thankful to have such dedicated and passionate individuals committed to our mission of fusing data, humans, and machines into solutions that optimize warfighter performance and casualty care, both inside the organization and to you, our extended family of incredible partners and longstanding colleagues across the Nation.

While we continue to face these uncertain times, know that we'll all get through it together and come out stronger in the end, prepared to conquer what is sure to be TATRC's biggest and best year yet!

Cheers and Best Wishes to All of you in the New Year!

IN THIS ISSUE:

TATRC's BHSAI 2B Alert App Named MRDC Invention of the Year!

A big Congratulations is in order for one of TATRC's premier labs led by Dr. Jaques Reifman, SES and Director for the Biotechnology High Performance Computing Software Applications Institute (BHSAI). 2B Alert, a fatigue-management artificial intelligence (AI) tool, and a software system that aims to counteract the negative effects of sleep deprivation and fatigue, was officially awarded and recognized as the USAMRDC's Invention of the Year.

Dr. Jaques Reifman has led this initiative since the project's inception and was presented with a Department of the Army Certificate of Achievement by COL Jeremy Pamplin, TATRC's Director, via a virtual awards ceremony on 3 September. The Certificate of Achievement was signed by our Commanding General, BG Michael J. Talley.

A product of more than ten years of research and development, the 2B-Alert smartphone tool was originally conceived by Reifman's team and additional researchers at the USAMRDC Walter Reed Army Institute of Research (WRAIR). The tool is essentially a bio-mathematical model that uses AI to automatically learn how an individual responds to sleep deprivation – that is, less than seven to eight hours of sleep per night – and then provides countermeasure recommendations customized for that specific individual to reduce or eliminate cognitive deficits caused by that very sleep deprivation. The user can also query the tool for recommendations that lead to heightened alertness during a specific time of the day, such as during a test or military activities requiring increased vigilance. The 2B-Alert tool is available for iPhone and Android smartphones. This effort could both dramatically improve alertness levels and decrease accident and injury levels for Service Members worldwide.

2B-Alert Web tool for optimizing sleep underlies a New York Times story on Army's new Holistic Health and Fitness approach.

Dr. Reifman was assisted and supported by two other key members of the team on the development side of this app and those personnel were also recognized. Dr. Francisco G. Vital-Lopez, a Research Scientist and support contractor for the Henry M. Jackson Foundation at TATRC's BHSAI, developed the algorithm for optimizing the use of caffeine, and invented a unique approach that

2B-Alert App

continued to page 3

TATRC Talks Tech with Talley

The TATRC Team had the opportunity to host MRDC's Commanding General, BG Michael Talley this past July. BG Talley has started the tradition of "quarterly pop in visits" and continues making his way around the command, meeting staff and gaining insightful updates about all of the different research endeavors that each of his units are working on. Team TATRC hosted BG Talley for his 3rd quarter visit which afforded us the opportunity to talk to him about some new and exciting initiatives underway here at TATRC, namely the National Emergency Tele-Critical Care Network (NETCCN) project. And while we got to brief and update him, he in turn shared with us some of the key points of the MRDC Campaign vision. After the briefings wrapped up in our new state-of-the-art conference room, we concluded with an interactive tour, where BG Talley participated in a live demonstration of the NETCCN project.

BG Talley, assisted by a remote expert (Intensive Care Unit specialist), was able to assess, and manage a ventilated patient with a tension pneumothorax, in a simulated COVID-19 field treatment area.

Using the NETCCN system, BG Talley was able to connect with a critical care intensivist with real-time video assist and clinical decision support guides, as he performed an emergency needle decompression on the simulated patient.

BG Talley assisted by a remote expert (Intensive Care Unit specialist), was able to assess, and manage a ventilated patient with a tension pneumothorax, in a simulated COVID-19 field treatment area.

Following the simulated patient care encounter, BG Talley was able to review larger system features including medical data information sharing systems within the NETCCN prototype, real-time remote physiologic monitoring from a range of critical care medical devices, leader dashboards for strategic decision making, and regional and national patient cohorts and care flows in a systems-based simulation.

A big thank you to BG Talley for spending such critical one-on-one time with us and gaining a deeper understanding of the important work taking place at TATRC.

2B-Alert App *from page 2*

identified such optimal caffeine doses instantaneously, opening the door for smart implementations on the 2B-Alert project. Mr. Luke Hartman, a Software Developer and support contractor for the Henry M. Jackson Foundation at TATRC's BHSAI, implemented this very complex algorithm in both Android and iPhone operating systems, enabling commercialization of the 2B-Alert technology. Due to the current pandemic, Dr. Reifman accepted the Certificates of Recognition on behalf of both Dr. Vital-Lopez and Mr. Hartman during the 3 September virtual ceremony.

"It is gratifying to see the research efforts of numerous individuals across many years culminate in a product that will be useful for both the military and the general public, and which promises to increase Warfighter Readiness on a wide scale," said Dr. Jaques Reifman.

Team TATRC is proud of the accomplishments of our colleagues at BHSAI and honored to work with such an esteemed and exemplary group of high performance computing thinkers!

Appreciation & Accolades for our Acquisition A-Team

Service Team 6's efforts have been invaluable to TATRC during the fight against COVID-19.

TATRC was honored to host Ms. Thea Hofgesang, USAMRAA Director, and Service Team 6 members.

TATRC was honored to host Ms. Thea Hofgesang, Director of the U.S. Army Medical Research Acquisition Activity (USAMRAA) and members of USAMRAA's Service Team 6, who are assigned to execute the contracting needs of TATRC, to present them with accolades and awards for their recent acquisition support. Mr. Jeff Bartlett, Contract Specialist, Ms. Cortney Eyler, Contract Specialist, Mr. Chris Sherman, Supervisory Procurement Analyst, Ms. Cheryl Miles, Contract Specialist, and Mr. Jon Gonzalez, Supervisory Contract Specialist have all been instrumental in the critically important research initiatives that Team TATRC has been working on in the face of COVID-19, and their outstanding efforts went above and beyond.

Each of the individuals from Service Team 6 were awarded a Certificate of Appreciation & Recognition, and a TATRC Director's Coin for providing exemplary customer service and expeditious turnaround on the extensive contracting requirements for TATRC's National Emergency Telecritical Care Network (NETCCN) initiative. Their untiring efforts have laid a solid foundation for execution of this extremely vital research initiative in response to COVID-19 and the global pandemic that the world is facing. Their involvement and quick response throughout this deadline-intensive funding period have aided the expansion of advanced medical technology research and development in both national and international arenas alike. Their dedication to our rigorous contracting needs allowed TATRC's subject matter experts to stay focused on furthering the science as well as our mission in support of the Army's response to the COVID crisis.

Thank you to Service Team 6 for being such incredible partners! We appreciate all you do for Team TATRC!

Project 'FOXTROT' Featured in JAMA Ophthalmology Journal

A peer review journal article summarizing the results of deploying the TATRC Digital Health Innovation Center (DHIC) research project known as 'FOXTROT,' was published in JAMA Ophthalmology this past August.

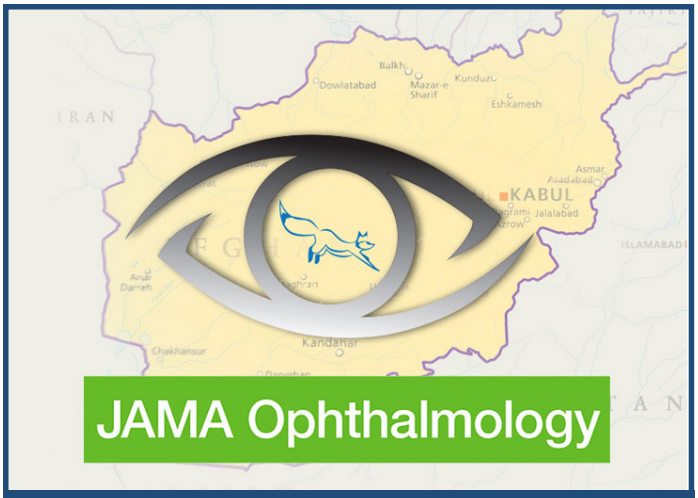
Forward Operating Base Expert Telemedicine Resource Utilizing Mobile Application for Trauma (FOXTROT) was a collaborative effort between Air Force and Army Ophthalmologists and the TATRC DHIC team's research and development staff. This research project was funded by the U.S. Air Force.

The article focuses on the use of the mobile application to support teleconsultations in Afghanistan from September to November of 2019. In this case series of 28 consults, military medics and clinicians at forward operating bases in Afghanistan placed teleophthalmology consults on their mobile phone devices and an expeditionary ophthalmologist deployed to a military hospital in Afghanistan responded. Teleophthalmology consultations prevented the need for some aeromedical evacuations and allowed patients to return to duty in 54% of consults.

A link to the journal article can be found at: https://jamanetwork.com/journals/jamaophthalmology/article-abstract/2769756

The journal citation is:

Gensheimer WG, Miller KE, Stowe J, Little J, Legault GL. Military Teleophthalmology in Afghanistan Using Mobile Phone Application. JAMA Ophthalmol. Published online August 27, 2020. doi:10.1001/jamaophthalmol.2020.3090



Forward Operating Base Expert Telemedicine Resource Utilizing Mobile Application for Trauma (FOXTROT) is featured in JAMA Ophthalmology this past August.

"Team TATRC was honored to be featured in such a distinguished journal as JAMA," stated Ms. Jeanette Little, Lab Manager for the DHIC team. "We are proud to be a part of this partnership and of the recognition Project FOXTROT continues to garner."

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TATRC TIMES
January 2021 • Volume 6, Qtr. 4

Science Director's Corner

Mr. Matt Quinn,
Science Director TATRC

A 'Convergence' of Humans, Data and Machines for Warfighter Performance and Combat Casualty Care

Everyone is hearing a lot about "Project Convergence" these days, but what does it actually mean? According to the Army Futures Command website, "Project Convergence is a campaign of learning to aggressively pursue an artificial intelligence and machine learning-enabled battlefield management system. Because whoever can see, understand, and act first will win." (https://armyfuturescommand.com/convergence/).

Project Convergence envisions that the Army, "as part of the Joint and Combined fight, can rapidly and continuously converge effects across all domains – air, land, sea, space, and cyberspace – to overmatch the adversaries in competition and conflict." (https://www.army.mil/standto/archive/2020/09/14/)

In more concrete terms, Project Convergence will require secure and seamless integration of advanced threat sensing with data, cloud and AI technologies.

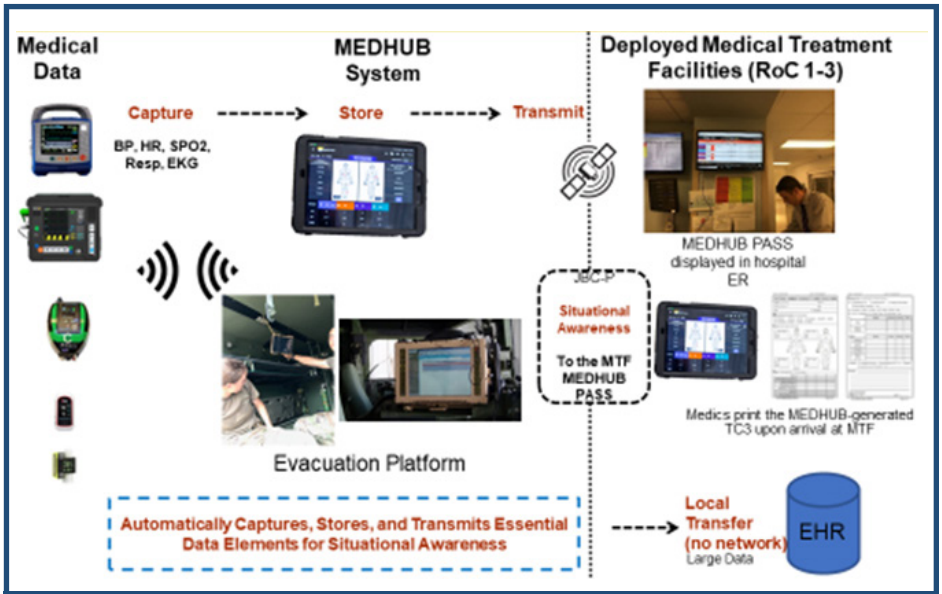
So maybe you're wondering "how does TATRC fit into Project Convergence?"

TATRC's new mission, which is focused on "fusing humans, data and machines into solutions that optimize warfighter performance and combat casualty care," directly aligns with the needs of Project Convergence. In recognition of this, MRDC leadership has challenged TATRC to lead the Command's Project Convergence efforts.

This is not new for TATRC. TATRC has been leading and funding projects that use intelligent systems as a medical force multiplier for years. Project Convergence will demand further integration of manned and unmanned teaming, autonomy, and networked systems to decrease the human burden of casualty care, expand capacity, and increase the lethality of the force.

For example, the MEDHUB system, managed by Mr. Jay Wang at the U.S. Army Medical Materiel Development Activity, supports secure, automatic capture, storage and transmission of data from devices and caregivers in military operational environments to support situational awareness.

TATRC's COVID-focused National Emergency Tele-Critical Care Network (NETCCN) project is a microcosm of Project Convergence as it assembles all of the components of a digital health ecosystem from the sensor to the cloud. In addition, TATRC has incorporated its Warfighter Health Data Commons, the NETCCN, and the broader Technology in Disaster Environments (TiDE) projects as a way to learn from care delivered through



The MEDHUB Operational Overview. Graphic courtesy of our partners at USAMMDA.

Convergence

continued to page 7

MEDRAS Demos Clinical Decision Support System Prototype

Earlier this past summer, Dr. Amy Papadopoulos from TATRC's Medical Robotics and Autonomous Systems Lab (MEDRAS) and Tami Rougeau demonstrated a prototype of a clinical decision support system for Mr. Jay Wang from the U.S. Army Medical Materiel and Development Agency. The demonstration was the final deliverable of a Defense Health Program funded project to develop a baseline proof of concept prototype decision support capability that provides advice to combat medics for immediate care of patients based on a digital knowledge representation of the Joint Tactical Combat Care (TCCC) Guidelines, patient's vital signs and medic generated encounter documentation.

The prototype, developed as a collaborative joint project by two of TATRC lab's, MEDRAS and the Biotechnology High Performance Computing Software Applications Institute (BHSAI), as well as the U.S. Army Institute of Surgical Research, runs on an Android phone, Android tablet, or Android emulator on Windows. The prototype has been integrated with Athena's wireless vital sign monitor (WVSM) and BHSAI's APPRAISE hemorrhage risk detection algorithm. A custom designed GUI, that will later be replaced or modified so that the system can be integrated with BATDOK or MEDHUB, was developed for the prototype that allows the medic to provide information about the casualty's injuries and symptoms, as well as about any interventions such as application of a tourniquet, placement of an airway, or administration of fluid or blood products. Additionally, suggestions, warnings, and questions from the knowledge representation are sent to the GUI for display to the medic.

This demonstration included using the prototype to work through two use cases of typical combat casualty scenarios. One use case took the user through an instance where there was a blast injury with an internal hemorrhage. Given the medic input, the system provided recommendations to the medic resulting in placement of a pelvic binder, IV fluid resuscitation, and administration of ketamine. The second, which was a more complicated use case, involved a complex blast injury with massive hemorrhage and airway compromise. The system guided the user through the application of a tourniquet, insertion of a supraglottic airway, a cricothyrotomy, a needle decompression, placement of a pelvic binder, administration of fluids and pain medication, and treatment for burns.

The project is continuing as an Army funded research project and will be expanded to address the needs of prolonged field care, addressing issues such as lack of resources, longer time to evacuation, and limited trained providers at the point of injury.

TATRC's Dr. Amy Papadopoulos stated, "This is a very exciting project with the potential to make a huge impact at the point of care in austere and prolonged field care environments. I am very honored to be working on this effort as we move it from the initial prototype to an advanced prototype ready for transition."

Convergence from page 6

NETCCN, to inform improvements and translate findings from tele-critical care for COVID, to care in other disaster environments and large scale combat operations.

Transforming the "Golden Day" to a "Golden Window" by treating soldiers at the tactical edge with the right resources to the right place at the right time, will require development of Joint and Coalition "care-webs." It will also require integrating sensors and capabilities at echelon to enable us to see, understand, decide and provide medical care faster to sustain operations.

In the near term, TATRC's primary focus is communicating the importance of incorporating the medical domain as part of the initiative and sharing past and ongoing projects that can contribute. Being at the proverbial table, both during the planning and future of Project Convergence will integrate medical into "Big Army" processes and integrate Joint and Coalition Medical assets into a larger medical intelligent system.

In the longer term, TATRC will become an essential component of the Project Convergence "team" and plan. I look forward to sharing the work of our labs on advancing this important initiative.

Next Up With NETCCN?

NATIONAL EMERGENCY TELE-CRITICAL CARE NETWORK
NETCCN

As described in last quarter's TATRC Times Newsletter, TATRC's National Emergency Tele-Critical Care Network project began in March, with a challenge from MRDC's Commander: "What can TATRC do to address the COVID pandemic?"

TATRC quickly developed a proposal to support the delivery of tele-critical care to places that lacked sufficient capacity to manage "surges" of patients hospitalized with severe COVID-19 symptoms. With initial funding from the CARES Act through MRDC, TATRC leveraged and utilized the Medical Technology Enterprise Consortium Other Transaction Authority (MTEC OTA) and the use of the CMS Alliance to Modernize Healthcare Federally Funded Research and Development Center (Health FFRDC). TATRC and its partners set out on an aggressive plan to prototype, validate and bring teams consisting of clinicians and tele-critical care platforms to the fight against COVID.

The following press release describes how "TATRC'S NETCCN PROJECT DELIVERS MUCH NEEDED TELE-CRITICAL SUPPORT TO COVID HOT SPOTS"

In support of COVID-19 surge response, the U.S. Army Medical Research and Development Command's (USAMRDC) Telemedicine and Advanced Technology Research Center (TATRC) has begun to deploy teams from its National Tele-Critical Care Network (NETCCN) project to COVID hot spots in Guam, South Dakota, Minnesota, Puerto Rico and other locations.

Based on cellular communication networks, mobile technologies and cloud computing, NETCCN teams consist of critical care clinicians and technology partners who are collaboratively developing cloud-based, low-resource, stand-alone health information management systems for the creation and coordination of flexible and extendable "virtual critical care wards." These high acuity, virtual wards bring high-quality critical care capability to nearly every bedside, be it healthcare facilities, field hospitals, or other locations that lack adequate critical care expertise and resources necessary for care of severe COVID-19 illnesses.

Shortly after deployment, over 235 local and distance clinicians have downloaded and begun using a NETCCN platform to manage nearly 100 patients in a hospital or at home, with users conducting over 2,400 synchronous (live video) and asynchronous (messages) exchanges through the platforms.

"When we started the NETCCN project a few months ago, we challenged our performers to empower clinicians to deliver 'anywhere to anywhere' tele-critical care functionality by downloading a simple-to-use smartphone app. Our NETCCN teams have done just that, as evidenced by the rapid adoption, use and integration of NETCCN platforms into the COVID fight," said TATRC Director, COL Jeremy Pamplin.

TATRC is completing a final stage of validation with its NETCCN performers before additional scaling in support of COVID surge response. The U.S. Department of Health and Human Services (HHS) and TATRC recently established a four-year memorandum of understanding (MOA) to fund the acceleration and scale up of NETCCN. The agreement between HHS' Office of the Assistant Secretary for Preparedness and Response (ASPR) and TATRC provides $45 million in initial funding for the transition of the NETCCN platform from a TATRC research and development effort, to an ASPR-led operational deployment solution.

"NETCCN represents the future of disaster response and, for that matter, healthcare," said Dr. Robert Kadlec, HHS' Assistant Secretary for Preparedness and Response. "In the past, not having enough critical care specialists or other qualified clinicians to provide care in a large-scale emergency required physical deployment of clinicians to where they were needed. Adding virtual care solutions to our response portfolio accelerates and expands our ability to respond to hot spots and defeat COVID-19 as well as other future emergencies." The MOA between ASPR and TATRC is effective through 28 September 2024. The agreement also creates a collaborative partnership between ASPR and TATRC for studying and improving the impact of digital health applications that support disaster healthcare.

"TATRC and the military have extensive experience in delivering care and virtual care to frontline caregivers on the battlefield and in the most austere conditions. This partnership not only brings this experience to the fight against COVID, but establishes a learning ecosystem through which we can apply lessons learned to advance our national response capabilities and care for our soldiers around the globe," said BG Michael Talley, Commanding General of MRDC.

TATRC's current four NETCCN clinical-technical teams include:

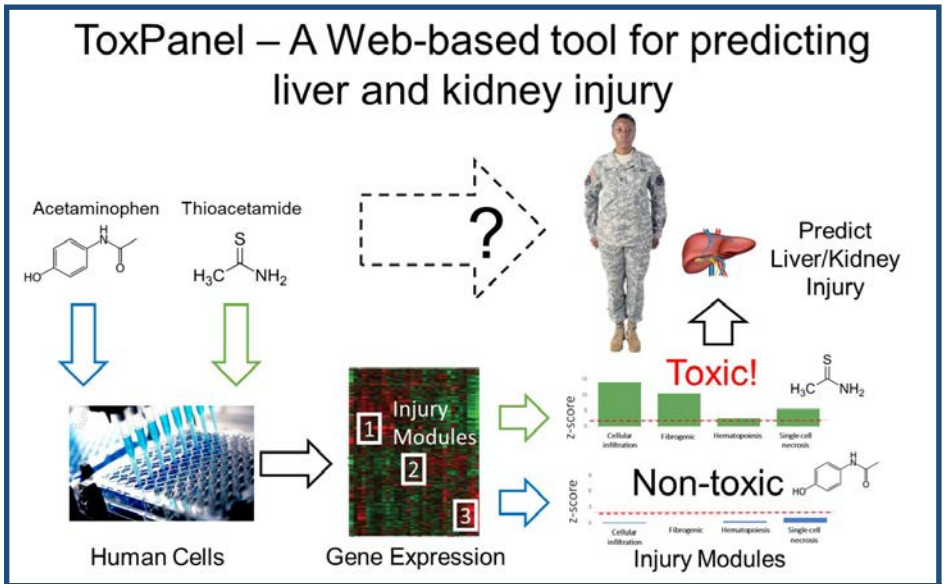
- Avera Health partnered with VitelNet, and DocBox
- Deloitte Consulting, LLP partnered with AWS GovCloud, Decisio Health, Elsevier, Qventus, T6 Health System, Verizon, and Zyter
- Expressions Network, LLC partnered with Mercy ACO Clinical Services, Active Innovations, and SDSE Networks
- The Geneva Foundation partnered with Omnicure, Society of Critical Care Medicine (SCCM) Discovery Network, DocBox, MD PnP Program at Massachusetts General Hospital, and Madigan Army Medical Center (MAMC)/Telemedical Research for Operational Support (TR4OS)

In Silico Methods for Toxicity Testing of Chemicals

The U.S. Army Medical Research and Development Command (USAMRDC) is involved in developing drugs and countermeasures in multiple areas, including military-relevant infectious diseases and chemical biological defense. Drug discovery is a risky and resource-intensive endeavor with high attrition rates due to adverse side effects. For almost three decades, a major focus in drug discovery has been to reduce the attrition rate. Yet, liver and kidney toxicity remain a hurdle, responsible for 40% of failures among new drugs. This has created a strong incentive for toxicology and chemical risk assessment. To determine the safety limits for humans, a number of animal testing parameters are used, including histopathological and clinical chemistry endpoints. Based on ethical and scientific constraints, there is an international consensus to develop and use animal-free methods for toxicity testing of chemicals as much as possible.

A team of scientists and software developers led by Dr. Anders Wallqvist, Deputy Director at TATRC's Biotechnology High Performance Computing Software Applications Institute (BHSAI) is developing effective *in silico* (computational) tools to predict the toxicological properties of unknown compounds. Historically, animal testing has formed the basis for toxicity testing and human safety evaluation of chemicals.

"The assumption with the use of animal models is that the adverse effect identified in the laboratory animal will occur in humans as well. However, there are interspecies (animal-human) and intraspecies (human-human) differences, which are important research questions we are currently investigating," says Dr. Wallqvist.



ToxPanel results for the prediction of liver injury based on gene expression changes in human cells exposed to acetaminophen (blue) and thioacetamide (green). The tall green bars in the histogram (z-score) for thioacetamide indicate a severe toxic response. The histogram for acetaminophen indicates a non-toxic response, with all blue bars below the red dashed line (z-score value of 2).

A major milestone for animal-free testing was the report "Toxicity Testing in the 21st Century: A Vision and A Strategy" by the U.S. National Academy of Sciences in 2007. This report reinforces the shift to move away from the reliance on toxicological outcome testing in laboratory animals towards the use of human-based *in vitro* (cell culture) assays and *in silico* (computational) methods mainly designed to detect perturbations in toxicity pathways at the mechanistic level.

In an effort to predict chemical toxicity, TATRC's BHSAI is working together with the Defense Threat Reduction Agency (DTRA) to develop a genomic approach for liver and kidney injury predictions. The team led by Dr. Wallqvist has identified sets of genes whose expression levels correlate with specific injury phenotypes (injury modules), by mining large data resources of rats exposed to hundreds of chemicals (Te et al., *J Appl Toxicol* 2016). The gene responses of these liver and kidney injury modules have been validated and shown to correlate both in live rats and rat cell cultures (Schyman et al., *Front Genet* 2019 and Schyman et al., *Toxicology* 2020). To address possible interspecies challenges between animal and human models, they validated the injury module approach by exposing chemicals in human cell cultures with known injury phenotypes (Schyman et al., *Int J Mol Sci* 2020). Based on these results, they have developed a publicly available Web tool for liver and kidney toxicity predictions: TOXPANEL. This tool allows users to evaluate a compound's potential for liver and kidney injury based on gene expression data from animal-free cell studies.

Telemedicine Goes to Cyber Quest 20

Almost 20 years of military conflict has led to our front line medical personnel being trained to a higher level of clinical skills in order to treat battle trauma. The experience gained through this conflict is that Tactical Combat Casualty Care guidelines have been developed that, along with air superiority to evacuate casualties within the golden hour, have resulted in our survivability rate increasing to greater than 95% when compared to similar injuries in previous conflicts. As we look toward the future, the Department of Defense's medical departments are evaluating peer and near-peer conflicts that will possibly deny our air superiority, thereby reducing the ability of the U.S. military to evacuate casualties during the golden hour.

When this occurs, the highly trained front line medical personnel will now have to treat a casualty for hours or possibly even days. The focus shifts from emergency lifesaving treatments to prolonged casualty care in hostile and austere environments. At this point, highly specialized surgical or definitive care may be required that go well beyond the training level of our first responders. Now these front line medical personnel are in a situation where they must provide ongoing advanced clinical care with limited medical supplies and equipment. As we have all learned through the recent COVID pandemic, this is a perfect scenario in which we can provide expert medical guidance and support to our first responders through the use of Virtual Health technologies to improve clinical outcomes.

In response to this, the U.S. Army Medical Research and Development Command's (MRDC) TATRC is studying Virtual Health capabilities to provide the front line medic the ability to reach out and touch a specialized physician through telemedicine. Members of TATRC attended and participated in the Cyber Quest 20, under U.S. Army Cyber Center of Excellence (CCOE) and U.S. Army Futures Command, and conducted simulated casualty scenarios with medical personnel alongside many talented organizations demonstrating emergent networking capabilities that leverage their strengths to close capability gaps to solve Army challenges. The medical scenarios at this yearly event drove an end user experience designed to obtain user feedback and recommendations on point of care patient monitoring capabilities that can provide knowledge-based telemedicine data through a tactical cloud to a medical provider in the rear.

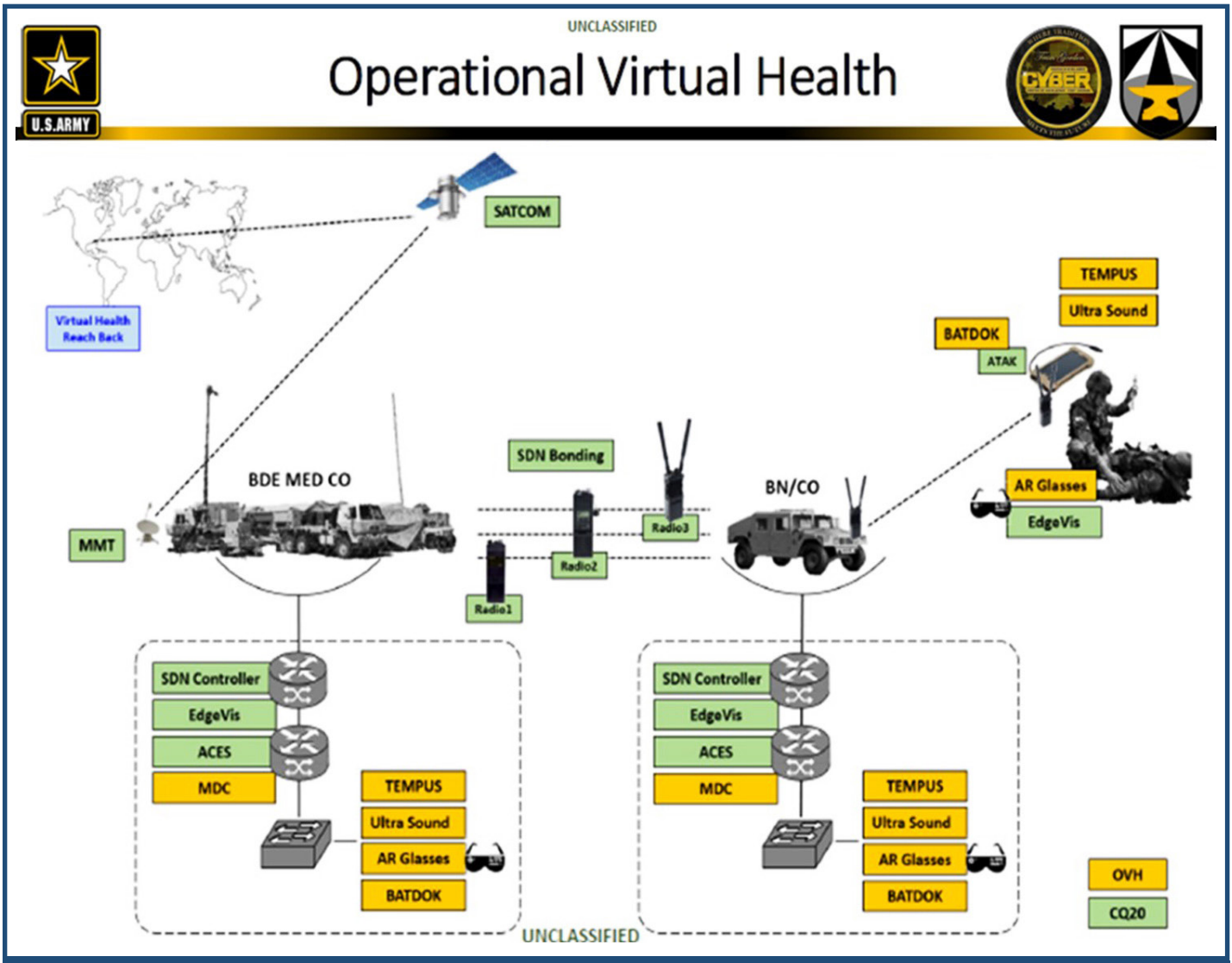
Mr. James Beach, Project Manager within TATRC's Medical Intelligent Systems Lab stated, "This was the first opportunity TATRC had to attend the Cyber

Members of TATRC attended and participated in the Cyber Quest 20, under U.S. Army Cyber Center of Excellence (CCOE) and U.S. Army Futures Command, and conducted simulated casualty scenarios with medical personnel alongside many talented organizations demonstrating emergent networking capabilities that leverage their strengths to close capability gaps to solve Army challenges.

Quest 20 event. The unique environment at Cyber Quest 20 allowed us to demonstrate research prototypes of telemedicine capabilities on a tactical network to address the lack of ability for bi-directional medical communications originating in the tactical environment." The technologies used to conceptually demonstrate tele-mentoring were the U.S. Air Force Research Laboratory's (AFRL) Battlefield Assisted Trauma Distributed Observation Kit (BATDOK), Remote Diagnostic Technologies' Tempus Pro and Corsium Suite, and Aviation and Missile Center S3I's Medical Data Cloud Dashboard (MDCD).

Data from a simulated medical casualty was transmitted from a simulated operational environment at the point of injury to a medical mentor at the Virtual Medical Center. Another objective was to collect data on the functionality, feasibility, and usability of the systems, and provide usable data to advanced developers and transition program managers on further development of the systems being researched.

During the Cyber Quest event, TATRC tested the technologies over different networks. The basic OV-1 concept, point of care patient monitoring devices; BATDOK and Tempus Pro, would make a call and transmit medical data, imagery, Voice over Internet Protocol (VoIP) over tactical radios to a mobile PacStar



The unique environment at Cyber Quest 20 allowed TATRC to demonstrate research prototypes of telemedicine capabilities on a tactical network to address the lack of ability for bi-directional medical communications originating in the tactical environment.

server with the MDCD installed. A medical provider would receive the call and use a web browser on the internet to view the medical data and imagery, and have a VoIP conversation with the front line medical person in order to provide medical guidance.

In collaborative partnership with the U.S. Army Special Operations Command, Naval Special Warfare, Virtual Medical Center, and Dwight D. Eisenhower Army Medical Center, TATRC was able to successfully connect the front line medical personnel at Fort Gordon, GA with surgeons at CONUS medical treatment facilities in San Diego, CA, Fort Detrick, MD, and San Antonio, TX during 36 different medical scenarios. Through the research and medical scenarios at Cyber Quest 20, the medical personnel provided human factors feedback and helped to identify and explore the processes and additional system functions to inform further refinement of these technologies. This information will be shared with the Program Management Office Special Operations Forces Tactical Combat Casualty Care that is accepting the research prototypes for advanced development under the Special Operations Forces Joint Medical Exchange of Documentation Information for Combat Casualty Care (JMEDIC-3) to fulfill the requirements identified in the J-MEDIC3 Capability Development Document.

Employee Spotlight

New Nurse Comes to the Aid of TATRC's Sim Team

Ms. Holly Ortman joins TATRC's Medical Modeling, Simulation, Informatics, and Visualization (MMSIV) team as a Critical Care Nurse. Her nursing experience will mainly be focused in the MMSIV lab, while also assisting in other TATRC capacities at Ft. Detrick, MD. She is tasked with contributing her nursing perspective for simulated combat casualty care scenarios and providing recommendations for research proposals and concepts. She will also assist with formulating training plans and field test assessments.

Holly first attended Michigan State University on a full-athletic gymnastics scholarship and graduated with a BS in Dietetics (Nutrition) in 2008 but realized she wanted to make a bigger impact at the bedside. She slowly but surely returned to school and graduated from York College of Pennsylvania in 2016 with a BSN. During her time at York College, she was introduced to the intensive care environment and knew she found her niche. She spent some time at a Level 1 Trauma Center in York, PA and quickly realized how humbling critical care can be and the remarkable resilience of the human body. She transitioned to a rural Pennsylvania ICU and began utilizing telemedicine for specialty and emergency consults. Due to a relocation, she continued her nursing career at Holy Cross Germantown ICU where she expanded her nursing knowledge, honed her nursing skills and discovered a desire for nursing process improvement. Her desire to "make things better" led her to the National Institutes of Health in Bethesda, MD as an ICU Clinical Research Nurse. There she participated in delivering alternative and unconventional treatment plans to rare genetic mutations and uncommon disease processes.

Holly grew up in Maryland and currently resides in Frederick, MD with her husband and two daughters. She has a deeply rooted respect for all branches of the military (particularly the Army) as her husband is retired active duty and currently an Army reservist. She and her husband originally met while in middle school and reconnected later in life over their love of Disney movies! They even had a Disney themed wedding followed by a Disneyworld honeymoon. Their love of all things Disney continues and is shared with their girls. She spends most of her time cheering at her daughter's soccer games, reading psychological thrillers, cooking, and planning the next trip to Disney!

Holly, welcome aboard and thank you for being here!

Ms. Holly Ortman, Critical Care Nurse, Medical Modeling, Simulation, Informatics & Visualization Lab.

MedSim Team Brings on New Administrative Assistant

Ms. Ann Trout is the newest addition to join the TATRC team. Ann will be supporting and assisting the ever growing Medical Modeling, Simulation, Informatics and Visualization team at TATRC headquarters as their Administrative Assistant. This group has never had an administrative assistant on board, but with the intensive requirements and growing functions of this critical lab, her presence is a welcomed addition.

A graduate of Frederick Community College, Ms. Trout has many years of experience in administrative tasks. During her tenured career in Frederick County, she has worked for the Veterans Affairs Acquisition Academy as well as Medical Counter systems (MCS) also located at Ft. Detrick.

A native of Frederick County, she currently resides in Thurmont, with her husband, Ron, and her cat, Chesterfield. Ms. Trout loves searching for buried treasures from antiques shops, to thrift shops. She also enjoys spending time with her family and friends.

Welcome to the team, Ann!

Ms. Ann Trout, Administrative Assistant, Medical Modeling, Simulation, Informatics and Visualization Lab.

Congratulations to TATRC's Q4 Employee of the Quarter

Congratulations are in order for Ms. Tabitha Waldrop of TATRC's Digital Health Innovation Center (DHIC) located in Fort Gordon, GA for being recognized as the organization's Employee of the Quarter for Quarter 4! Tabitha has been performing double duty for TATRC since the inception of the Technology in Disaster Environments (TiDE) efforts which commenced this past spring to support the COVID-19 response. The plan had been to immediately backfill her existing position at DHIC, to allow a new staff member to manage the day to day operations of all the active DHIC development and execution efforts, and redirect her to directly supporting TiDE work. However, due to intensive and short-fused timeframes, Tabitha was placed in a position of doubling her workload since the initiative kicked off in May. While the conditions that created this situation were unintentional, she never complained or allowed any workload items to drop. Instead, she was highly creative in terms of both multi-tasking and delegation of duties to ensure that nothing was missed in terms of routine TATRC project execution or special COVID-19 assignments. Tabitha performed her work with great enthusiasm, and always strived to improve our TATRC operations.

One of the major DHIC projects during this past quarter was Project Boom, which involved tedious work with the Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense (JPEO-CBRND) office and US Special Operations Command, and the initiative had extremely demanding standards. It is notable that the JPEO-CBRND staff have repeatedly reported their satisfaction and praise to the TATRC DHIC team, and Tabitha in particular for keeping them informed and engaged during the Project Boom mobile app and portal development process.

Tabitha is very deserving of being awarded employee of the quarter for her dedication and determination to the organization during a very challenging time when TATRC literally did not have enough staff to perform the mission, but did so anyway. She has effectively and efficiently grown into every role assigned to her. She is a TATRC rising star, and her future is bright.

Ms. Tabitha Waldrop,Telehealth/ Virtual Health Project Manager, Digital Health Innovation Center.

On behalf of the TATRC family, we want to congratulate Tabitha on this wonderful recognition. Her contributions day-in and day-out reflect great credit upon her and the value she brings to the TATRC Team!

TATRC Welcomes New Biomedical Engineer to the MEDRAS Team

Mr. Zachary "Zack" Buono has joined the TATRC team as a new Biomedical / Aeronautical Engineer. He has a background in Biomedical and Surgical Systems and will be supporting several exciting robotics projects in casualty evacuation and mission medical support. He will focus his efforts with the Medical Robotics and Autonomous Systems (MEDRAS) Lab at the TATRC headquarters in Ft. Detrick, MD.

Zack recently graduated with an MSE in Bioengineering Innovation and Design from the Johns Hopkins University, where he had also previously received his BS in Biomedical Engineering. While in pursuit of his Master's degree, Zack worked on two healthcare device design projects to improve surgical procedures in colorectal surgeries and advance malaria vector surveillance in sub-Saharan Africa. While this will be his first full time position, he assisted with the COVID-19 RADx Initiative throughout this past summer.

Zack grew up in the small town of Powhatan, VA, but has called Baltimore home for the last 5 years. He has recently moved to Frederick and is looking forward to exploring the area and meeting new people. Outside of work, Zack enjoys hiking, traveling, visiting breweries, playing music, and going on runs with his dog – a Staffy mix name Tortellini.

Mr. Zachary Buono, Biomedical / Aeronautical Engineer, Medical Robotics & Autonomous Systems

The TATRC team is very excited to have you join our growing organization!

AMTI
ADVANCED MEDICAL TECHNOLOGY INITIATIVE

PROJECT SPOTLIGHT

High-throughput Screening of Military-relevant Contaminants Using ECIS Technology

Soldiers encounter a wide range of potentially toxic chemicals throughout their military lifecycle; however, fast and inexpensive toxicity screening of chemicals found in and around military sites is not currently available. Funding support from AMTI has allowed a collaborative team of scientists at Tripler Army Medical Center in Honolulu, HI and the University of North Texas in Denton, TX to explore the use of off-the shelf technology called Electric Cell-substrate Impedance Sensing (ECIS) to test the toxicity of military-relevant pollutants on a large scale.

ECIS is based on the principle that a toxic chemical will cause damage to live cells cultured on a plate. This damage is detected by the ECIS system as a change in the resistance of an electrical current applied to the cells. A significant change in electric resistance of cells from baseline would mean that chemical being tested is toxic. The ECIS system allows for the simultaneous testing of up to 96 different chemicals and / or combinations of chemicals, with real-time results obtained within a matter of hours. This makes ECIS the ideal platform for quick, inexpensive screening of environmental chemicals and pollutants.

In this initial project, "Development of a High-throughput Screen of Neurotoxic Compounds Using Electric-Cell-substrate Impedance Sensing Technology: A Scientific Collaboration Between Military and Academic Institutions," the study team successfully showed that ECIS could be used to identify known toxicants, such as the single chemical benzo[a]pyrene (BaP), or the complex compound crude oil. Using ECIS, the team found that after only one hour of treatment with BaP or crude oil, significant changes in resistance of cells representing the blood-brain barrier could be detected. The team then validated the in vitro ECIS findings by using a well-established behavioral zebrafish model. They showed that the effects of BaP detected by ECIS was reflected in the disruption of behavior in zebrafish. These findings were presented at the 2019 Military Health System Research Symposium, and

Figure 1: The Electric Cell-substrate Impedance Sensing (ECIS) system is comprised of an array station that holds a 96-well test plate. The ECIS software allows for real-time tracking of electrical resistance detected in the test plate. (Image: Applied BioPhysics, Inc. (Troy, NY), www.biophysics.com)

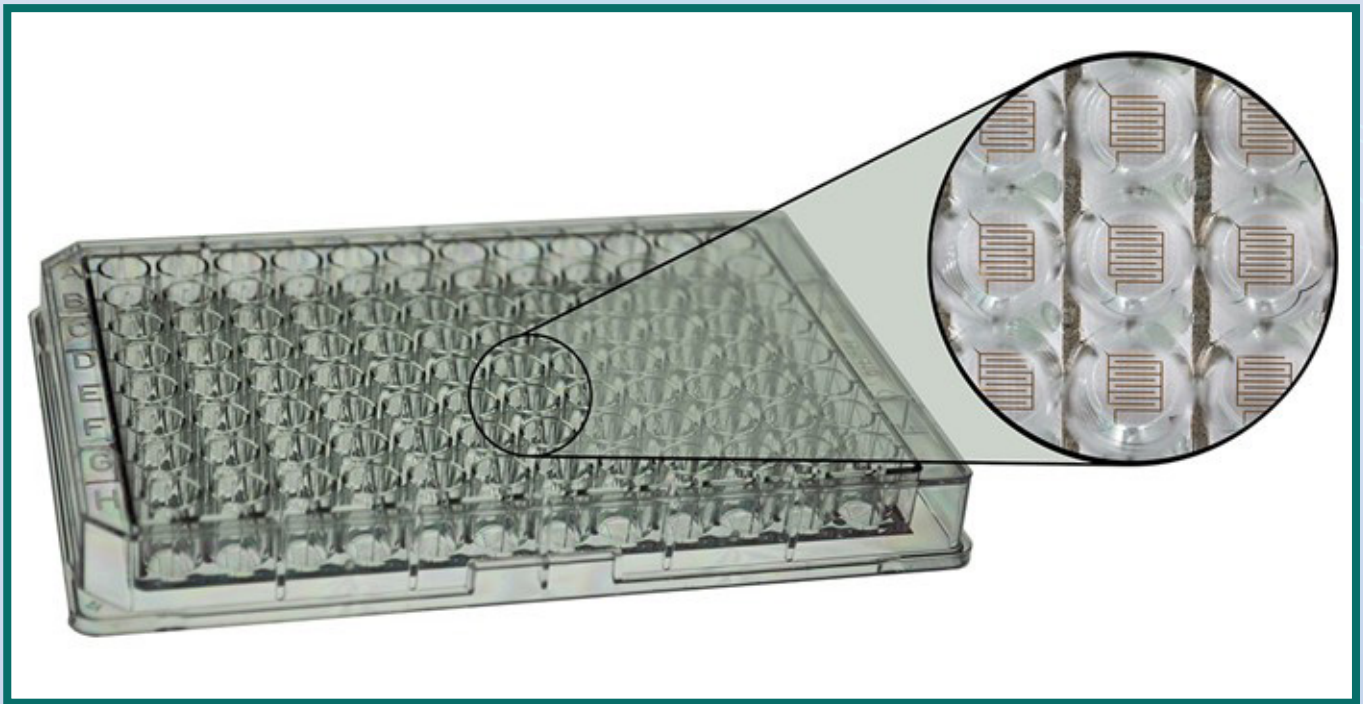


Figure 2: ECIS test plates allow for the screening of up to 96 different chemicals or compounds. Plates are outfitted with electrodes that enable the detection of a change in electrical resistance of live cells grown in the wells. A significant change in electrical resistance of cells indicates toxicity of the treatment applied (Image: Applied BioPhysics, Inc. (Troy, NY), www.biophysics.com).

subsequently published in the journal "Comparative Biochemistry and Physiology," (2019 Sep;223:96-105).

"We are excited to show that ECIS detected toxicity of BaP in cells that represent the blood-brain barrier. BaP is highly relevant to the military because it is found at high levels in burn pits, and has been implicated in neurological disorders. We also used ECIS to test complex compounds such as crude oil, and showed that this technology potentially could be used to test toxicity of complex environmental samples found at military sites. While we used cells of the blood-brain barrier in this demonstration, cells from lungs, kidneys, and heart also can be tested in this system. Without the support of the AMTI program, we would not have been able to jumpstart this project," said project team leader, Dr. Dao H. Ho, Biomedical Research Scientist and Chief of Physiology at Tripler Army Medical Center.

Reports show that after deployment, U.S. Soldiers come home with significantly higher serum levels of chemicals that are associated with burn pits, crude oil, improvised explosive devices, gunfire residue, and jet fuel combustion. Even in garrison, a Soldier may be exposed to toxic pollutants that are present at their assigned duty station. Many contaminants have been identified as contributing to health disorders faced by Warfighters, but there are many other chemicals whose toxicity remains unknown. Thus, it is vitally important to have the means by which to quickly test whether the chemicals that military personnel are exposed to may have detrimental effects on their health. Dr. Ho stated, "The development of a rapid, cost-effective method, such as ECIS, to screen the toxicity of particular chemicals used and produced by military operations will greatly enhance military readiness. Rapid identification of the environmental conditions most likely to constitute an exposure risk to military personnel can aid in the development of new standards for exposure."

For more information on this AMTI Project, the AMTI Program POC is Ms. Holly Pavliscsak who can be reached at holly.h.pavliscsak.ctr@mail.mil.

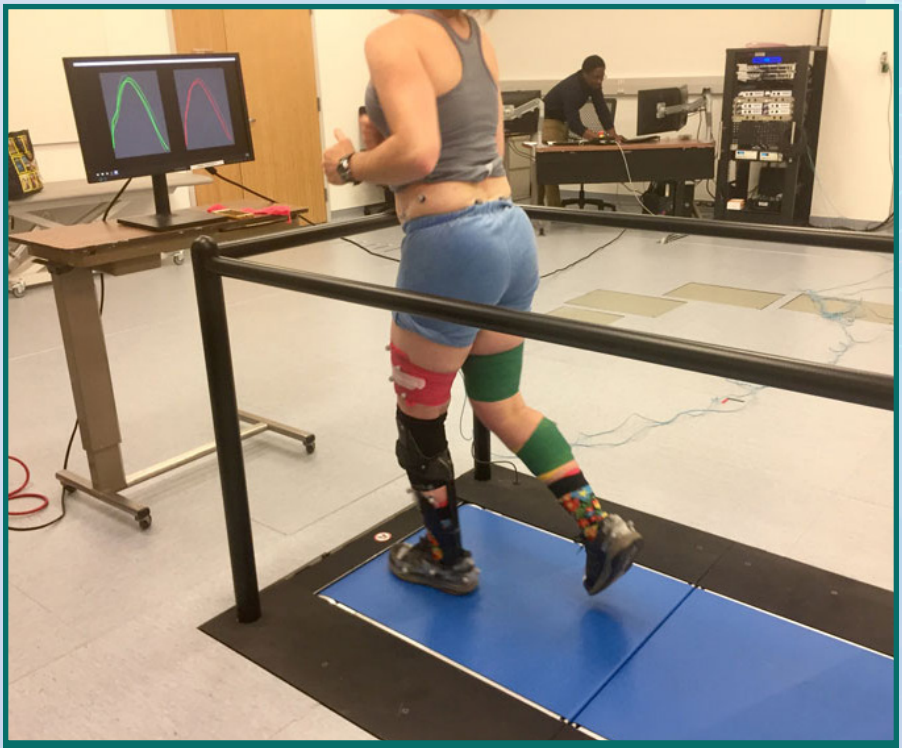
AMTI
ADVANCED MEDICAL TECHNOLOGY INITIATIVE

PROJECT SPOTLIGHT

Real Time Bio-Feedback During Running Rehabilitation

This project is the second in a line of AMTI-funded work using real-time bio-feedback to improve performance and rehabilitation outcomes for Service Members with severe lower extremity injuries. Ankle-foot orthoses are a type of bracing system often prescribed to support and stabilize the ankle and foot of individuals with lower extremity injuries. Recent custom carbon fiber ankle-foot orthoses have allowed individuals with lower extremity injuries to return to high impact activities, such as running. These devices bend to store and return energy during running. To take advantage of these mechanical properties, the way a person contacts the ground during running is important. Making forefoot contact with the ground, as opposed to a heel strike, offers the greatest mechanical advantage. Training proper footstrike on the injured limb using the ankle-foot orthosis is an important part of the rehabilitation received by Service Members using these devices. However, preliminary work found that they consequently overloaded their unaffected limb and still ran asymmetrically. With AMTI funding, the project team sought to address this issue by providing a training intervention on running mechanics in ankle-foot orthosis users with lower extremity trauma. The team, led by Dr. Elizabeth Russell Esposito, provided real-time bio-feedback on the force with which they contacted the ground. This variable gives them important information about not only the way they contact the ground and how hard they contact it as well. The team trained individuals over the course of up to six sessions. Intervention using

Training individuals with musculoskeletal injuries who use ankle-foot orthoses to shift from a heel strike pattern to a midfoot or forefoot strike pattern takes better advantage of the energy-storing-and-returning properties of the device.



Vertical ground reaction forces provide important information on the type of foot strike and the magnitude of the impact. Real time bio-feedback was provided on force to encourage patients to adopt a new running pattern. Overall, the training significantly improved energy expenditure. For some, this also reduced risk factors for overuse injuries.

real time bio-feedback significantly improved running economy such that the new mechanics were more efficient and used less metabolic energy, which can be interpreted as improved running performance. Some patients additionally reduced loading on their unaffected limb, which may reduce the risk of overuse running injuries. Results from this project were presented at the Military Health Systems Research Symposium and at the American Society of Biomechanics annual meeting.

Clinical application of this work may impact the quality of care provided to injured Service Members. As part of this project, the team improved patient outcomes from the existing standard of care by exploring an intervention designed to address a specific clinical need. The improvement some patients had in unaffected limb loading impacts the readiness of the force by reducing the risk for overuse running injuries that are widespread in the military. By showing patients ways to move that can reduce the risk of injury, we may expect improvements in performance, cost savings, and reduced lost duty days due to injury.

Preliminary data within new lines of inquiry can be challenging to generate without a source of funding. AMTI's support of early stage projects helps grow novel ideas and applications, such as this running training intervention, to address the needs of Service Members and their clinical care teams. Based on the success of this AMTI-supported project, the results can be leveraged to pursue a clinical trial to provide this program more broadly across the Defense Health Agency.

Dr. Elizabeth Russell Esposito, AMTI Innovator for this study stated, "Our line of AMTI-supported projects have resulted in paradigm shifts in the way the clinical community views outcomes after severe lower limb trauma. Through our prior and current AMTI-supported work, we have been given the necessary resources to take that critical first step in evaluating new tools to improve the care of Service Members with musculoskeletal trauma."

Dr. Elizabeth Russell Esposito is a Research Biomedical Engineer. From 2012 to 2018 she conducted research at the Center for the Intrepid at Brooke Army Medical Center and has since shifted her research to the Center for Limb Loss and Mobility at the VA Puget Sound in Seattle, WA. Her research in movement biomechanics and energetics of individuals with lower extremity musculoskeletal trauma aims to improve not only the assistive device put onto a person, but also the rehabilitation of the person put into the device.

For more information on this AMTI Project, the AMTI Program POC is Ms. Holly Pavliscsak who can be reached at holly.h.pavliscsak.ctr@mail.mil.

DHIC's Blast Exposure Monitoring Project Continues Development

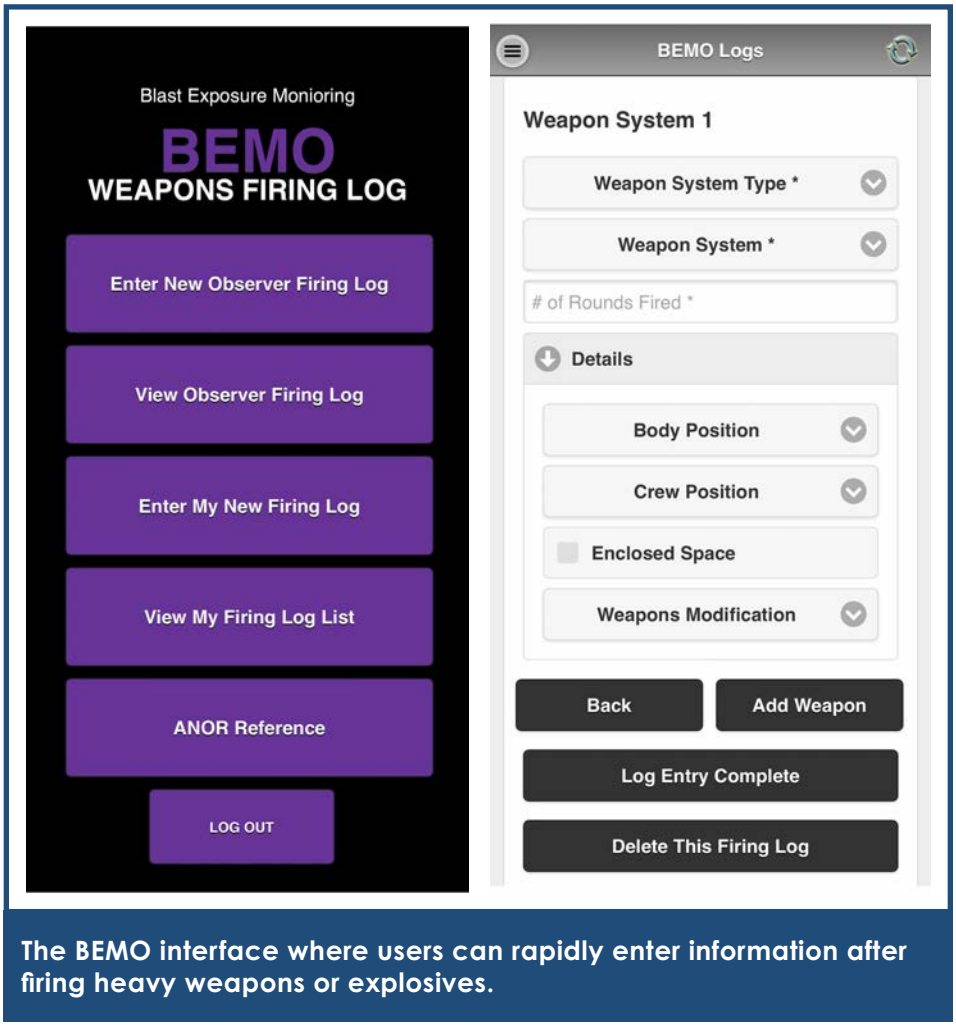
Work on the Blast Over-pressure Exposure Monitoring project continues as TATRC's Digital Health Innovation Center (DHIC) programmers are developing a weapons firing log mobile application and a web portal, known as BEMO, within the mCare / MHCE system in support of the Joint Health Risk Management Enhanced Capability Demonstration (JHRM ECD) program which is a research collaboration between Defense Health Agency (DHA), the Joint Program Executive Office for Chemical Biological Radiological and Nuclear Defense (JPEO CBRND) and U.S. Special Operations Command (USSOCOM).

The Weapons Firing Log tool, in both mobile app and web-based format, will conveniently enable operators and observers on training ranges to enter weapons firing log information into the app or the web portal, which will be matched by the MHCE BEMO web portal, with blast sensor data that is collected for those who are wearing the sensor. This data, will reside in the MHCE web portal, and can be used to assist environmental health professionals track longitudinal Warfighter exposures to blast overpressure during live fire weapons training. The data will also be transferred to and stored on Service Members' health records in Systems of Record, such as DOEHRS, or other electronic health records. In this way, the health data will follow the Service Members and can be used to inform health care providers throughout their lifetime.

The DHIC team has followed the Agile Software Development methodology throughout the duration of this effort, providing Sprint Reviews consisting of product demonstrations to the key stakeholders including end users, and have received developmental feedback which has resulted in early redesign, and enhanced features while delivering a more valuable product for those we serve. This lightweight mobile capability that can be accessed and used anywhere, and at any time aligns with recent FY18, FY19 and FY20 NDAA (sections 734, 253, 717 & 742, respectively) mandating study of the effects of blast overpressure on armed Services Members and longitudinal recording of exposures.

This project stretches the MHCE / mCare system beyond remote health monitoring, into the operational environment. It also stretches the capability into new use case scenarios resulting in feature development not implemented before.

DHIC is excited to work on this project with Adam Becker, JHRM ECD Demonstration Manager and the JHRM ECD team. Per Mr. Becker, "This project serves an important role in fulfilling our national obligation to our Warfighters by improving the documentation of individual environmental health hazard exposures, and we are glad to be working with TATRC to develop it."



The BEMO interface where users can rapidly enter information after firing heavy weapons or explosives.