



MP7: TATRC Participates in Highly Immersive Prolonged-Field Care Training Event



A Green Beret Medic assigned to 4th Battalion/3rd Special Forces Group (Airborne) utilizing BATDOK in support of a simulated burn victim during a prolonged field care training exercise July 18, 2019, in Greenville, N.C. (U.S. Army photo by Sgt. Steven Lewis)

From 16 - 19 July, COL Jeremy Pamplin, TATRC's Director led Mr. Ron Yeaw, Mobile Health Innovation Center Deputy Lab Manager, and Mr. Jimmy Gaudaen, Project Officer to the North Carolina mountains where they participated in the 7th Mountain Path (MP7) Prolonged Field Care (PFC) Training event with the 4th Battalion/3rd Special Forces Group (Airborne) at Ragged Edge Solutions (RES) Training Center in Tarboro, NC. Ragged Edge Solutions, LLC is a training and education company that provides comprehensive, realistic PFC training anchored on curriculums tailored for every level of provider based on Swedish Remedy, formerly the model of combined Special Operations Forces (SOF) field medical training. This field offers a flexible and adaptable training, testing, and research environment that allows military SOF to rapidly investigate new approaches, new educational materials, and new technology products to determine their value to other training environments and platforms.

Two SOF teams, each with one 18D medic and 4-6 operators, participated in the training. COL Jeremy Pamplin participated as an instructor and lane proctor while Mr. Ron Yeaw and Mr. Jimmy Gaudaen were observers. The training consisted of 2 days of didactic, hands-on education, a morning of mini-PFC scenarios (crush injury, burn resuscitation, and bullet wounds), and an 18 hour capstone PFC simulation exercise on two separate lanes. On each lane, teams managed 2-4 casualties at a point of injury and then needed to evacuate these casualties back to "friendly lines" by way of 1 or more safe houses. On one lane, the team also experienced a simulated MASCAL

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New Director, With a New Vision to Forge the Future

The tools and techniques that we create here over the next few years could change the way we do medicine; making it safer, more effective, and more available, especially in resource-limited environments.”

These rousing words were a fitting opening on 15 July when TATRC's newest Director, COL Jeremy Pamplin, brought the entire team together for its inaugural quarterly Town Hall meeting. The first of many planned Town Halls, the gathering provided both the team and COL Pamplin a great opportunity to engage in open dialogue regarding future courses of action for the organization.

COL Pamplin kicked things off with a personal introduction, and proceeded to outline his leadership philosophies, the strengths of the organization, the importance of working together as a team, and the direction in which we should be focusing our efforts and attention.

Summarizing his core ideals as Director, COL Pamplin said, “My big three are: Never be content with the status quo; create an environment that people want to be part of; and be honest with yourself and others.”

COL Pamplin also touched on how the Army Futures Command motto, “Forge the Future,” is greatly in-line with TATRC's own principles and goals, stating, “This might not be our motto, but we should embrace it wholeheartedly.”

Described as being “born for this role, and being at



COL Pamplin shared his core ideals at TATRC's Town Hall which are: Never be content with the status quo; create an environment that people want to be part of; and be honest with yourself and others.

the right place at the right time,” COL Pamplin rallied the troops with his thought-provoking and inspirational message. Following his opening address, the floor was opened to the team for questions, answers, and comments, resulting in productive and interactive dialogue.

Overall, the event was a resounding success and a motivating morale booster, and the team is greatly looking forward to proceeding under COL Pamplin's leadership! ■■■

TATRC Welcomes New Deputy Director, LTC Justin Stewart



**LTC Justin J. Stewart,
TATRC's Deputy Director**

Team TATRC is proud to announce the arrival of our newest addition to our leadership team, Deputy Director LTC Justin J. Stewart! Coming to us from the great state of Washington, specifically, from Joint Base Lewis McChord (JBLM), LTC Stewart is eager to join the team and roll up his sleeves and get started! No stranger to the field, some of his previous foreign assignments include OIC of the Level II

clinic at Camp Red Cloud in the Republic of Korea, Battalion Surgeon of the 1-75 CAV 2BCT 101 ABN in Iraq (OIF), and Staff Internist with the 14th CSH in Afghanistan (OEF).

LTC Stewart is a board-certified Internal Medicine Physician who completed his residency at Brooke Army Medical Center. His education includes a DO from the UNT Health Science Center--Texas College of Osteopathic Medicine and a MBA and MHA from Baylor University. His most recent operational assignment was as the Command Surgeon of the 593d Sustainment Command (Expeditionary) which ended in 2017. He just completed a fellowship in Clinical Informatics at JBLM, WA and is looking forward to joining the TATRC Team as the Deputy Director and supporting COL Pamplin in providing advanced technologies to the front-line medic.

We know LTC Stewart will be a great asset and leader here in support of our mission to help advance military medicine in support of the Warfighter! Welcome aboard, Sir! We look forward to working with you! ■■■

USAMRDC Passes the Flag During Symbolic Change of Command Ceremony



The Command stands at attention during the ceremony.



GEN Murray passes flag to incoming Commander, BG Talley.



From left to right: MG Holcomb, GEN Murray and BG Talley salute the Command Units.

On a hot, sunny July morning, another very symbolic milestone for the USAMRDC took place. MG Barbara Holcomb officially handed over the organizational reins to BG Michael J. Talley at 0900, during the MRDC Change of Command. This long-standing, traditional ceremony took place outdoors on the picturesque Blue & Gray Parade Field, in front of Bldg. 810 with Troops in formation.

Having commanded Fort Detrick / USAMRDC since July 2016, MG Holcomb left behind an impressive legacy! Not only was she the installation's first female commander, but some of her previous assignments include Commanding General – Regional Health Command – Central (Provisional), Fort Sam Houston, TX, and Deputy Commanding General for Operations, U.S. Army Medical Command, as well as deployment to Desert Shield / Desert Storm! MG Holcomb has proudly and dutifully guided the USAMRDC to become the organization we know and love today, and helped seamlessly navigate the Command through some rough seas during all the transitions over the last two years. Team TATRC was honored to have operated under her leadership these past few years and wish her a happy & well-deserved retirement!

Team TATRC would also like to extend a hearty welcome to BG Michael J. Talley! Coming to the MRDC from his appointment as the Deputy Commanding General, Regional Health Command

– Atlantic, BG Talley has been serving our great Nation for 36 years! His latest appointment as Commanding General leads an impressive list of career accomplishments!

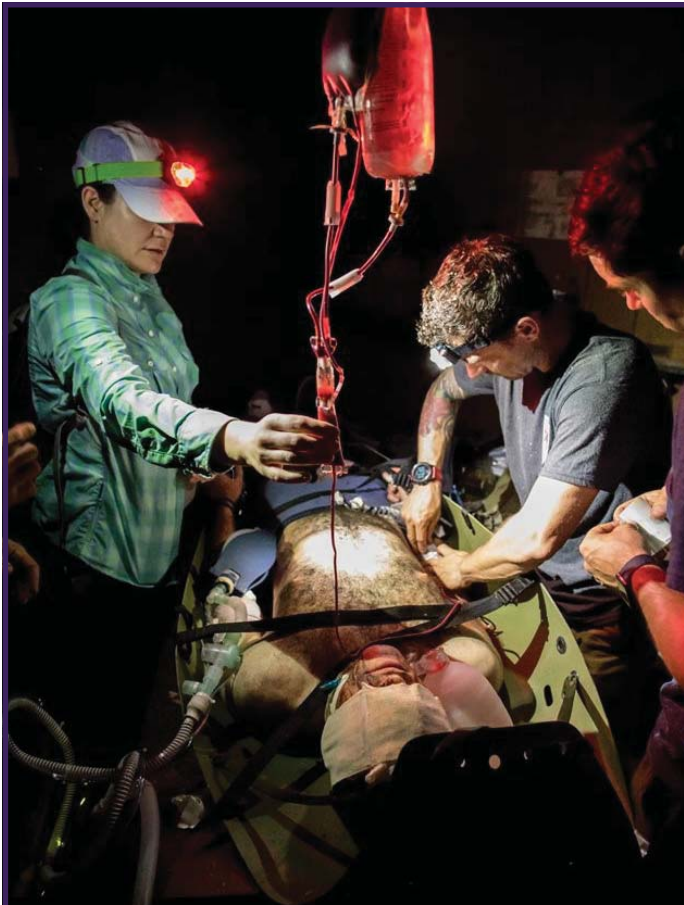
BG Talley is no stranger to MRDC or Fort Detrick as he served as the Commander of the 6th MLMC.

Volunteering for military service in 1983, BG Talley has assembled quite an impressive list of career achievements, including the United States Army Forces Command Surgeon and, most recently, the Deputy Commanding General, Regional Health Command – Atlantic, as well as awards and decorations including the Legion of Merit and the Bronze Star, among many others! Additionally, BG Talley served Operation Iraqi Freedom combat tours as the Executive Officer of 261st Medical Battalion (ABN) and S3, 507th Corps Support Group (ABN), as well as a deployment to Saudi Arabia as the Assistant Program Manager for Health Affairs, Office of the Program Manager, Saudi Arabian National Guard (OPM-SANG) Modernization Program.

His latest appointment as CG of Fort Detrick / USAMRDC is a fitting step forward, placing an organization that's proven to do great work under the guidance and direction of a proven leader!

Team TATRC is proud and excited to welcome BG Talley to Fort Detrick, and we look forward to the future! ■■■

Mountain Path *continued from page 1*



A simulated patient receives a blood transfusion by a Green Beret assigned to 4th Battalion/3rd Special Forces Group (Airborne) during the Mountain Path prolonged field care training exercise July 18, 2019, in Greenville, N.C. This prolonged field care training required Green Berets to treat a simulated casualty for over 15 hours in different environments. (U.S. Army photo by Sgt. Steven Lewis)

event (5 patients from CBRN explosion).

Overall, this training provided researchers' a better understanding of the constraints and challenges of medical care in austere and remote settings and helped them to better study and deliver more viable solutions. The RES Training Center may offer collaborative opportunities to study emerging technologies and prototype solutions using a reproducible model for casualty care in the context of interest.

According to COL Jeremy Pamplin, "This is currently the most realistic PFC training in existence and provides the best situational awareness of the context, constraints, and challenges that PFC poses to our medical force. Providing opportunities for researchers to witness this type of training



MP7 was supported by (left to right) TATRC Members Ron Yeaw, Jimmy Gaudaen, and Director COL Jeremy Pamplin, MD. COL Pamplin also assisted in the training and Telementoring modalities during the multi-day exercise.

and/or combining this type of training environment with a research model like the Tele PFC study, may offer unique and fruitful opportunities to better understand the care-context that needs solutions and to develop, study, and test these solutions effectively."

As TATRC continues to look ahead at the potential of staging similar research training capabilities on premise, experiences like Mountain Path and the recent TATRC Tele-PFC Demo with our partners from Madigan Army Medical Center, helps grow our own bench as well. COL Pamplin, did add the caveat though that, "not all lessons from these scenarios will translate to conventional force medical solutions, however the medical care and medical needs will be the same."

Mr. Ron Yeaw felt the training was a paradigm shifting event. "Personally, having not ever been deployed or been up close to medical training before participating in this event, allowed me to open my eyes. It's 4 am, you've been on your feet for 16 straight hours and you're thinking to yourself 'wow, this has to be over soon.' Then three guys kick open the door screaming about a chemical explosion of sorts, and you realize... no, we are just getting started. Understanding how medical technologies can fit in that environment is humbling to say the least."

For more information on Mountain Path, please visit www.raggededgesolutions.com. ■■■

TATRC Arrives at DHITS 2019 with a Bold Vision

“One Team, One Mission – Enabling MHS Transformation” was the powerful theme of this year’s 2019 Defense Health Information Technology Symposium (DHITS) Conference which took place from 29 July – 1 August. COL Jeremy Pamplin, TATRC’s Director, Mr. Ron Yeaw, mHIC’s Lab Deputy, and Mr. Edward Kensinger, mHIC Project Manager participated in this exciting event which took place in Orlando, FL. DHITS is a three-day annual DoD-sponsored symposium for leading health IT professionals to share ideas, lessons learned, and new developments. Over 2,000 military medicine providers and IT professionals came together at this year’s DHITS Conference. This conference, sponsored by the Defense Health Agency provides a unique venue for knowledge sharing, innovative ideas, discussion of lessons learned, and new developments.

Vice Adm. Raquel C. Bono, then Director of the DHA, stated, “It’s a great venue for MHS leadership to update the industry on our progress with MHS GENESIS, interoperability and cybersecurity. It was exciting to highlight with Mr. Pat Flanders, Maj Gen Lee Payne and Mr. Bill Tinston how powerful MHS GENESIS capabilities are in supporting the military medical enterprise’s prioritization of readiness, quality and safety in care, integration of services, and standardization.”

TATRC’s delegation was invited to present, not only in the exhibit hall within the DHA and MHS pavilion, but also in a breakout session presentation. TATRC strategically partnered their booth space to work with the Virtual Medical Center’s team to share a joint presentation entitled, “Virtual Medical Center & TATRC’s Operational Virtual Health Overview for Today and Tomorrow.” Mr. Michael Kile, Operational Readiness Program Manager for U.S. Army Virtual MEDCEN saw the value in partnering this year and stated, “DHITS was a tremendous opportunity to discuss, share and collaborate on virtual health capabilities with peers across the enterprise, both military and civilian. This forum helps to drive a shared TATRC vision and enhance relationships that are dedicated to deliver the best technology to the Warfighter and other DoD beneficiaries.”

TATRC’s breakout session presentation was entitled, “Enabling MHS Transition to Autonomous Combat Casualty Care,” and was attended by over sixty participants. This session allowed COL Jeremy Pamplin to outline TATRC’s vision for Autonomous Combat Casualty Care, as well as lay out a plan to get there. Notable audience members included CAPT Valerie J. Riege, Chief Innovation and Integration Officer BUMED, COL Scott McIntosh, Joint Project Manager for Medical Modeling and Simulation, and LTC Sean Hipp, Director Army Virtual Medical Center. Individual meetings were also held with the PEO STRI team, several emerging operational health vendors, as well as the Army Virtual Health Office.

Overall, this conference helped TATRC broaden the MHS communities’ awareness of our autonomous combat casualty care



COL Jeremy Pamplin (center) catches up with TATRC’s former-Director COL(R) Dan Kral (left) and Dr. Bob Walker from DHA (right).



Mr. Ron Yeaw (left) and COL Jeremy Pamplin (right) share the stage to discuss the future of Multi-Domain Operations (MDO).



COL Jeremy Pamplin (right) shares ideas on new initiatives in Medical Modeling and Simulation with COL Scott MacIntosh (left).

focus, further establish TATRC as thought leaders in this space, provide for tech-watch awareness, and enhance our relationships with our strategic and emerging partners.

According to Mr. Ed Kensinger, “Collaborating at DHITS allowed TATRC to work directly with the Virtual Medical Center to benefit from the lessons they are learning today in order to apply them to the solutions that we are developing for the future.”

TATRC Director, COL Jeremy Pamplin, shared this opinion, “DHITS is a great opportunity to interface and join forces with senior leaders in the MHS IT space to help advance digital capabilities for the medical mission in Multi-Domain Operations.”

The 2020 DHITS conference will be back in Orlando, 28 – 30 July and TATRC is looking forward to once again being involved in this exciting and thought-provoking IT event. ■■■

TATRC Research Shines at 2019 MHSRS

Team TATRC made their way to the sunshine state in Kissimmee, Florida from 19 – 23 August for the MHS Research Symposium (MHSRS). The Annual MHSRS, held at the Gaylord Palms Resort & Convention Center, is the Department of Defense's premier scientific meeting that focuses on Combat Casualty Care (CCC). It combines three previous conferences, including the former Advanced Technology Applications for Combat Casualty Care Conference (ATACCC); the Air Force Medical Service Medical Research Symposium; and the Navy Medicine Research Conference under one, main joint umbrella. The MHSRS conference is an ideal venue to assess other research efforts that are currently in progress and/or recently completed, that may assist TATRC in the focus for their future research efforts and initiatives. The networking opportunities alone to meet with current partners and future collaborators makes this an extremely valuable annual event.

Vice Adm. Raquel C. Bono, the Defense Health Agency (DHA) Director at the time stated, "The MHSRS has become one of the Military Health System's premier events, and each year that I've been the DHA Director, I've watched it grow and expand. It is always energizing and amazing to see how the representation at each MHSRS has become more global while the caliber of research presentations and breakout sessions have risen to a very high scientific level. MHSRS provides the opportunity to take stock of the many research and development contributions across the MHS that will keep us laser-focused on research for readiness and on innovations that will surpass our own historically high survival rates on the battlefield."

Ms. Amanda Schmeltz, Research Project Manager at TATRC's Mobile Health Innovation Center (mHIC) also sees the immense value. "The MHSRS is



The Team gathered for the annual photo at MHSRS 2019.



Dr. Gary Gilbert, MIST Lab Lead, speaks about the success of leveraging SBIR/STTR projects in support of Army research.

a truly dedicated and protected time to step out of daily task mode, connect with and learn the needs of our medic Warfighters on the battlefield where the only constant is change, and get a pulse check on the trends within the MHS, as well as amongst DoD industry partners. The renewed perspective when returning home refreshes

the purpose of mission, which can easily get buried in the day-to-day challenges of conducting research, regardless of one's role in the research."

mHIC Regulatory Compliance Nurse, Ms. Mabel Cooper appreciates

MHSRS 19 continued to page 7

DHA Looks Closely at mCare as a Possible Enterprise Wide Platform



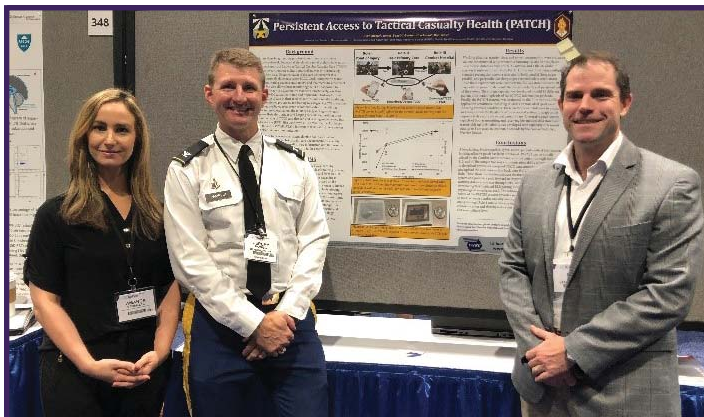
Mr. James West and Mr. Patrick Arida, both of the Defense Health

Agency's (DHA) Virtual Health (VH) Program Management Office visited TATRC's Mobile Health Innovation Center (mHIC) at Fort Gordon earlier this summer for an all-day information sharing session between both offices. As DHA VH evolves, many changes in strategies, staff, and capabilities are occurring which bring quite a lot of uncertainty and challenges. TATRC's mHIC Lab Leader, Ms. Jeanette Little, briefed the benefits and many successful use cases of the Mobile Health Care Environment (MHCE) web capability and mCare Remote Health Monitoring (RHM) mobile application. The mHIC team also demonstrated MHCE and mCare's robust security features and capabilities developed for TATRC research studies. Ms. Amanda Schmeltz and Ms. Tabitha

Waldrop, two Project Officers from mHIC, demonstrated the use cases, and provided a broad perspective of the ways MHCE could become a spring-board platform for both asynchronous and synchronous virtual health solutions in the Garrison environment, as well as in the deployed operational environment.

Mr. West and Mr. Arida met the entire mHIC team over lunch, during which time, they were able to attain a better understanding of the development and technical support environment which allows for the ease of tailoring this potential solution to various DHA needs. Ms. Jeanette Little stated, "While the future DHA Enterprise-wide decisions are still uncertain, TATRC's mHIC team presented a broad range of RHM and VH possibilities for consideration, and has positioned TATRC for future collaborative success in partnership with DHA." ■■■

MHSRS 19 *continued from page 6*



Ms. Amanda Schmeltz, COL Jeremy Pamplin, & Mr. Ron Yeaw representing one of the many TATRC posters during the scientific poster session.



Team TATRC takes a break from the MHSRS action and share ideas over a meal.

MHSRS for the chance to meet so many peers in her field. "At the end of the day it's about the potential for lives saved and the quality of life of Warfighters no matter what stage of their careers they're in. That is what makes this meeting of the minds so amazing and invigorating."

TATRC had representation from each of its key labs and was actively engaged across the four day event attending breakouts, defending and presenting posters, and performing podium presentations. In fact, TATRC could be found speaking at six different posters and five breakout sessions covering the gamut of Telehealth, Behavioral Health, Artificial Intelligence,

Autonomous Casualty Extraction in Multi Domain Operations, Medical Robotics, Blast Injury and Virtual Health.

This MHSRS was the first for LTC Justin Stewart in his new role as TATRC Deputy Director. "MHSRS provided TATRC an opportunity to showcase our great talents. I am humbled to be part of an organization so focused on improving Warfighter health by leveraging both present and future technology."

The TATRC team is already looking forward to the 2020 MHSRS and hopes to expand our presence even further. ■■■

TATRC & NATO Look at Autonomous Tactical Evacuation in Munich

Following an initial meeting in the National Capital Area in April of the NATO Human Factors in Medicine (HFM) Autonomous Tactical Evacuation Exploratory Team (ET) chaired by Dr. Gary Gilbert, TATRC's Lead for the Medical Intelligent Systems Lab, subject matter experts from multinational military departments of France, Germany, Netherlands, Sweden, United Kingdom and the United States came together again for a follow-up in Munich, Germany from 24 - 26 Sep 2019 to conclude the panel's initial work.

HFM-ET-167 was created by the NATO HFM Panel to look at the development of autonomous medical systems for tactical evacuation in future battlefield environments. This exploratory team addressed the following five key objectives:

1. Establish common NATO concepts for leveraging emerging general-purpose unmanned system (UMS) platforms for medical missions;
2. Establish a common NATO research and development roadmap for robotic, autonomous, and unmanned capabilities in support of combat casualty care and tactical evacuation;
3. Develop methods and approaches for implementing safe ride standards on emerging UMS platforms for tactical care evacuation;
4. Survey and select interoperability standards; and
5. Define mission planning capabilities required to effectively coordinate tactical care and evacuation in unmanned systems.

During the first workshop in April, it was determined that potential use of unmanned platforms could vary in different combat scenarios, so small teams of participants were created to develop combat scenarios evaluating the potential utility of Advanced Medical Technology, Robotics, and Unmanned Vehicles in providing medical support in such scenarios. The four scenarios chosen were: Combat in Dense Urban Terrain; Littoral Combat; Naval Combat; and Search and Rescue. The scenario-based team findings were briefed at the September meeting along



Multinational military departments of France, Germany, Netherlands, Sweden, United Kingdom and the United States came together in Munich Germany this past September for a follow-up on HFM-ET-167.

with an additional exchange of national information related to the topics and pre-established NATO policies. The panel concluded its work by recommending that NATO appoint a NATO Research Technology Group (RTG) to develop the objectives explored by the ET in more depth. Consensus was reached that in future conflicts, unmanned systems and autonomous medical care devices should and will be used to support casualty care and evacuation, and NATO must develop evidence-based guidance to assist commanders in making an informed decision on their use by creating concepts of operations, standards, and mission planning capabilities to effectively coordinate tactical care and evacuation. The group proposed the use of the term 'RASEVAC' (Robotic & Autonomous Evacuation), to limit the scope of its work to casualty evacuation onboard autonomous platforms that maneuver without onboard manned guidance (driver, navigator) across the range of military operations within the air, ground, afloat and submerged domains. This does not exclude the presence of onboard medical personnel providing care to the casualty.

The formal recommendation to establish an RTG will be made by the U.S. representative to the NATO Human Factors in Medicine Panel in April. According to Dr. Gilbert, "the opportunity to lead a NATO-appointed research panel, especially in an area of your own passion, is a true honor as well as a once-in-a-lifetime cherished opportunity, especially when down-the-road outcomes may save the lives of our soldiers, sailors, airmen, and marines and those of our allies." ■■■

BHSAI Crosses the Pond for the Annual Blast Injury Conference



Dr. Reifman presented 'Effects of animal orientation on brain responses to primary blast' & 'Potential cause of primary, blast-induced brain injury: direct vs. indirect mechanisms' at the 2019 Blast Injury Conference. (Photo credit: www.blastinjury.org.uk)

The 2019 Blast Injury Conference, held from 11 – 12 July at the Imperial College of London welcomed 220 delegates from ten countries, as well as His Royal Highness Prince Harry the Duke of Sussex. The conference was hosted by the Imperial's Centre for Blast Injury Studies.

The 2019 Blast Injury Conference included an invigorating multidisciplinary program of presentations that delved into a broad range of topics related to military and civilian blast injury. The intention of the conference was to provide a stimulating environment where international and UK Researchers, Clinicians and Specialists from across the research pipeline could showcase their discoveries, reinforce existing but also spark new collaborations, and share knowledge and awareness in topics associated with blast injury.

Dr. Jaques Reifman, Director of TATRC's Biotechnology High Performance Computing Software Applications Institute (BHSAI), was among the top researchers invited to share his work in the field and presented two abstracts on primary (non-contact), blast-induced brain injury in rats.

The first presentation was on the 'Effects of animal orientation on brain responses to primary blast.' For this important project, BHSAI scientists, together with

collaborators at the U.S. Army's Walter Reed Army Institute of Research (WRAIR), showed that the same blast wave affected the intracranial brain pressure in peripheral regions and maximum principal strains throughout the brain differently depending on whether the rat was positioned prone or vertically relative to the blast wave.

Dr. Reifman's second presentation at the Conference dealt with the 'Potential cause of primary, blast-induced brain injury: direct vs. indirect mechanisms.' In collaboration with scientists at WRAIR and the New Jersey Institute of Technology BHSAI researchers characterized the changes in the rat brain due to direct and indirect mechanisms of primary blast-induced injury at a blast overpressure of 130 kPa, and found that the direct mechanism was the major contributor to brain changes due to blast exposure.

Professor Anthony Bull, Director of the Centre and Head of the Department of Bioengineering, stated, "The Centre focuses on improving treatments and recovery through medicine, prosthetics and rehabilitation, and develops better ways of protecting those serving in current and future conflicts. The research discussed at this year's Blast Injury Conference is a shining example of how bringing together scientists, engineers, medical professionals and military personnel for preventing and treating blast injuries can really change lives." ■■■

On the Horizon...

Upcoming Events:

3-5 May: American Telemedicine Association (ATA) Annual Meeting - Phoenix, AZ

11-15 May: Special Operations Medical Association Scientific Assembly (SOMSA) Conference - Raleigh, NC

TATRC's PHR Project Looks Ahead to Phase 2



Patient-directed health information is increasingly becoming an important component of patient care between patients and their health care providers. As part of this critical component in patient care, TATRC is working with the Defense Health Agency (DHA) and Department of Veterans Affairs (VA) to research current definitions of patient-directed health information terminologies, build consensus for acceptable definitions where they vary or might vary, research current functionalities, develop functionalities where current functionalities may not meet the needs of Department of Defense (DoD) unique patient populations that include, active duty service members, separated and or retired service members and their beneficiaries. To make this possible, TATRC is working together with the DoD and Veterans Health Administration to develop an interoperable personal health record (PHR) which would replace organization-specific and often disjointed service-specific PHRs already in existence.

According to Ms. Ollie Gray, TATRC's PHR Project Manager, "The ability of Service Members to manage their health information while in and out of the service, to include information exchange with their civilian providers, and the addition of other personal health related information to their self-directed personal health record is the core of our work with DHA and VA partners." TATRC participates in several workgroups at the DHA and VA levels, assisting in developing and reviewing deliverables including road map for implementation of patient personal health record focusing on current Phase 1 project deliverables.

Ms. Gray went on to say, "Our involvement and participation in these workgroups is increasingly being recognized and depended on by other players with whom we work, and are required to work with as we implement this project."

TATRC participated in developing core capabilities of the proposed DoD / DHA personal health record that should improve how health care is provided to members, and the way information from such care is used and disclosed by the Service Members, retirees and their beneficiaries. TATRC has developed a research paper that addressed current definitions of PHR, definitions of patient portal, the differences between patient portal and personal health record, and the need to separate the two for proper patient control in DoD and VA health facilities. The goal is to ensure that patient information is available at the point of care, and that beneficiaries control their information and determine with whom they wish to share their information. TATRC is a core member of the Joint DoD / VA personal health record strategy planning committee. The goals of the group are to:

- **Leverage interoperability between DoD and VA**
- **Expand personal health record functionalities**
- **Expand patient portal functionalities**
- **Leverage the Cerner functionalities in both departments**
- **Improve the use of patient-generated data in health care**
- **Develop strategies for integration of personal health record and patient portal with MHS Genesis**

TATRC expects to help shape the new patient directed health information to ensure the PHR meets the requirements of the Office of National Coordinator for Health Information Technology standards, DoD and VA standards, as well as the ability to exchange information with all providers. In doing so, TATRC is reviewing patient-directed application commercial vendors, literature reviews, and consultations with military and other government services, to come up with a product unique to our Service Members and their beneficiaries while allowing for communication with civilian medical providers. TATRC has also submitted a research paper that addressed current definitions and functionalities of PHR and suggested many of the capabilities that should form the core parts of personal health record system.

"I am excited to be part of TATRC's core team working on this project. TATRC's leadership role in the project is well recognized," said Dr. Godwin Odia who represents TATRC on the project. Next steps for the project include a trip to Joint Base Lewis McCord for Dr. Odia and Ms. Gray to participate in a joint DoD / VA requirements session to lay out a potential Phase 2 for the PHR Project. ■■■



AAMTI PROJECT SPOTLIGHT

A Mobile Web-Based Application for Personalized Cancer Survivorship

According to military statistics, approximately 1,000 active duty service members are diagnosed with cancer on an annual basis with nearly \$250 million per year spent on their treatment. After completion of initial cancer care, patients then transition to survivorship. One definition of cancer survivorship includes, “living with, through, and beyond cancer.” While most cancers can be treated when initially discovered, the sobering reality is that some cancers can and will recur for up to five years after their initial diagnosis. Therefore, after enduring the emotional and physical recovery after surgery, chemotherapy, and/or radiation treatment, patients and their families must be prepared for an intense follow-up period which includes frequent appointments, scans, and lab work. This period of survivorship is often marked with uncertainty, fear of cancer recurrence, and in the military population, the added concern to ensure that care can rapidly be re-established at the new duty station. These types of cancer surveillance visits are difficult in any circumstance, as the frequency and composition of visits varies depending on the cancer type, the stage, and national guidelines. Particularly in the military, where cancer care is often fragmented between military and civilian healthcare systems, where primary care managers who are champions for successful adherence to survivorship change, and where patient duty station changes, cancer survivorship can be challenging.

In 2016, recognizing the difficulties that a migratory patient population diagnosed with cancer faced in adhering to cancer survivorship, LTC Vance Sohn, MD, Surgical Oncologist at Madigan

Army Medical Center, Joint Base Lewis-McChord, WA, teamed up with TATRC’s Mobile Health Innovation Center (mHIC) and utilized the AMEDD Advanced Medical Technology Initiative (AAMTI) funds to leverage technology to enhance survivorship. The goal was simple, use automated programming following national guidelines to send reminders via text and email to the survivor and their families about upcoming appointments. Traditionally, when patients completed their initial episode of cancer care, they were provided a written summary of their follow-up and required visits for the following five years. “Technology has advanced to a point where consumers can sign up for mobile alerts for almost anything,” stated LTC Sohn. “And so it didn’t make sense that we were asking patients to remember all of their appointments and CT scans, and labs, when we have the technology to automate these reminders.”

Incorporating a multidisciplinary approach, LTC Sohn and the mHIC team, along with AAMTI support, used the National Comprehensive Cancer Network (NCCN) survivorship guidelines for breast and colon cancer to create a website that patients and their cancer provider could populate after completion of their initial cancer care. mHIC members included nurses, computer programmers, and project managers to help transform guidelines into code, and ultimately, into texts and emails.

Once pertinent information was entered, the reminders would be automated for the next upcoming five years at pre-determined intervals per the guidelines. Patients could choose whether they wanted automated reminder texts, emails, or both, and who else they wanted

to get these reminders. These reminders were detailed and allowed any healthcare provider to get a snapshot into the important dates, names, treatments that the patient received, and most importantly, what tests needed to be completed for that particular visit. “The ability for any healthcare provider to see an email and get all the information they needed is critically important in the military healthcare delivery model,” stated LTC Sohn. “If a Soldier is diagnosed with a colon cancer on the east coast, but then PCS’s to the west coast, he can go to any healthcare provider, show the email or text, and that provider knows exactly what to order and why they are ordering it.”

LTC Sohn added, “The hope is that this technology can help patients as they complete their cancer journey. Our patients, who want to continue to serve in uniform even after their cancer diagnosis, deserve every opportunity of beating cancer.”

Ms. Mabel Cooper, an mHIC Project Officer said, “In this project we were able to address the unique survivorship planning needs of a specific group of survivors who are in a transient state while remaining compliant with American Society of Clinical Oncology, NCCN and Commission on Cancer standards. The potential applications for a broader list of cancers and other diseases requiring follow-up care are endless now that a basic structure has been put in place.”

“Dr. Sohn’s project represents the AAMTI program’s capability to fund small investments in great ideas that have the potential to make a much larger impact on cost, quality, safety, access and readiness,” said Ms. Holly Pavliscsak, TATRC’s AAMTI Program Manager. ■■■

AAMTI

PROJECT SPOTLIGHT

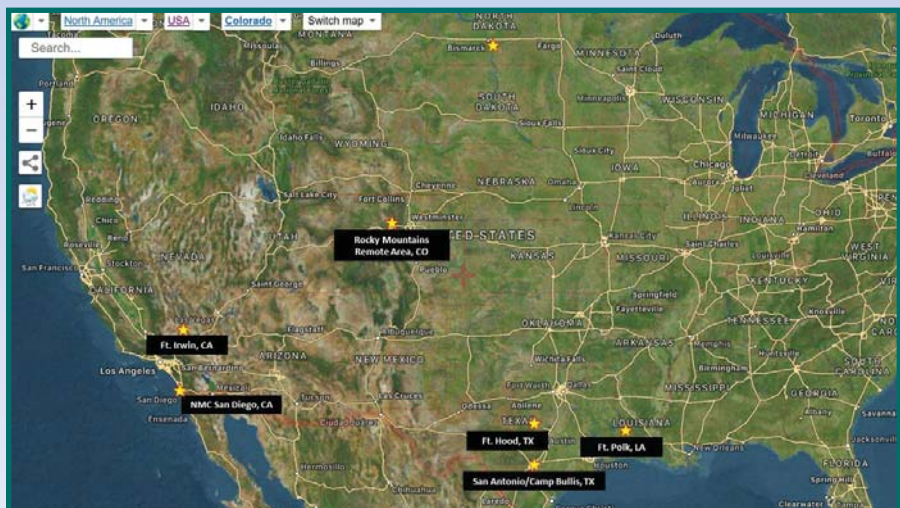
The Agile Network Connectivity for Mobile Medics

The Agile Network Connectivity for Mobile Medics was an AMEDD Advanced Medical Technology Initiative (AAMTI) Rapid Innovation Fund (RIF) project that tested the use of a commercial off-the-shelf mobile broadband kit (MBK) by 4K Solutions to leverage both T-Mobile and AT&T cellular networks in the continental United States (CONUS) and four commercial “pay as you go” SIM cards in Europe and outside the continental U.S. to support synchronous virtual health and the mobile medic mission.

The mobile medic is a process to develop the 68W skill set and increase far-forward primary care. The technology leveraged is only an enabler to bridge time and distance factors and act as a provider extender to allow provider coverage across a geographically dispersed population to maximize combat power forward. The utilization of the technology and process will increase the clinical skills and abilities of the medic. The skills developed and learned through training and utilization of this process will be a medical force multiplier, even when connectivity is not available, ensuring a ready medical force. The ability to provide primary care at the point of need mitigates some of the requirements to transport patients to higher levels of care, thus maximizing combat power forward. The mobile medics use the Algorithm Directed Troop Medical Care (ADTMC) manual when appropriate. When the requirement for medical support goes beyond ADTMC, medics connect to a higher level provider using digital medical device capabilities and Video



OCONUS Testing site in Bulgaria and Romania.



Current testing sites in the Continental United States.

Teleconferencing (VTC) software. The MBK plays an extremely important role in our ability to properly execute the mobile medic mission. The MBK provides the medics with dedicated cellular data that allows them to conduct synchronous virtual health

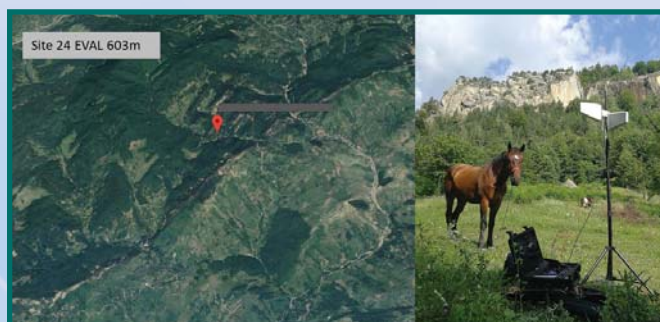
encounters. Without the MBK, the mobile medic mission would be limited to only areas of operation with excellent cellular coverage. The MBK allows the medics to operate in Garrison areas of operation that have limited to no cellular network coverage

with traditional WiFi pucks. The four SIM cards used in Europe were specific to the geographic locations where the MBK was tested. The OCONUS locations were selected in much the same way as the CONUS locations and to test the MBK capability in European countries with limited cellular infrastructure.

The AAMTI RIF was instrumental in successfully testing the MBK in both CONUS and Garrison areas of operation and to successfully identify the MBK as a low-cost, efficient and easy way to establish dedicated communications to support operational virtual health efforts. The MBK was greater than 95% successful in Garrison areas of operation and 22% successful in OCONUS locations. The main issue with OCONUS locations was not the technology, but rather the SIM cards available to use. Further testing in FY19 / 20 will validate the use of Global SIM cards that will make the MBK useful in almost any country in the world. The MBK has proven to be an incredible asset to the mobile medic mission in San Antonio, providing the medics with dedicated cellular data that is much cheaper and easier to set up when compared to satellite communications. The MBK only takes five minutes to set up (and can be easily set up after five minutes of training) and costs approximately \$150 per month for 50 GB of data. This is compared to the manpack satellite system that costs in excess of \$40,000 for the equipment and then, more than \$40,000 per month to receive unlimited data and upload / download speeds sufficient to support synchronous virtual health. The two main issues with satellite communications is the cost and the latency that cause video distortion. The MBK did not experience any latency and worked greater than expected in areas with no cellular data signal on traditional WiFi pucks and cell phone hot spots. The MBK is an outstanding capability that is cost-effective, easy to use and provides excellent cellular data upload and download speeds to support almost any virtual health encounter.

MAJ Daniel Yourk, one of the researchers on this project stated, "This technology allows medics, nurses, independent duty corpsman, independent medical technicians and providers to bring virtual health both synchronous and asynchronous support to the point of need with easy to use, cost-effective, solutions. This project has the potential to decrease our dependence on satellite communications in the operational environment, improve the communications capabilities using available cellular networks and event leveraging future 5G technology to surpass what is currently possible in the virtual health world."

This project was conducted in collaboration with SFC Todd Hall, Regional Health Command – Europe Virtual Health Non-Commissioned Officer in Charge & TATRC. The project started in April 2018 and ended in December 2019. The Virtual Medical Center (VMC) is continuing to



MBK setup in Romania



Testing further flexibility in Torun Poland, a personal SIM (on a DE data plan) was transferred to the MBK immediately providing Virtual Health reach-back capability to the Army Virtual Medical Center in San Antonio, TX. (Left to right, LTC Robert Cornfeld – RHCE VH Medical Director; SFC Todd Hall – RHCE VH NCOIC; LTC (P) Sean Hipp – V-MEDCEN Director)

expand the use of this technology to support mobile medic missions around the world in FY20.

The future vision of this project is to find cost-effective, agile capabilities to support virtual health in operational environments where organic communication support is not available. This project enabled the VMC to identify ways to provide this type of connectivity that allows for the integration of virtual health in operational environments. In FY20, the VMC will leverage this technology, along with Global SIM cards to support the mobile medic mission in CONUS locations along with potential support in EUCOM, AFRICOM, INDOPACOM and CENTCOM. In the end, this project led to product adaption to support synchronous virtual health across the DoD.

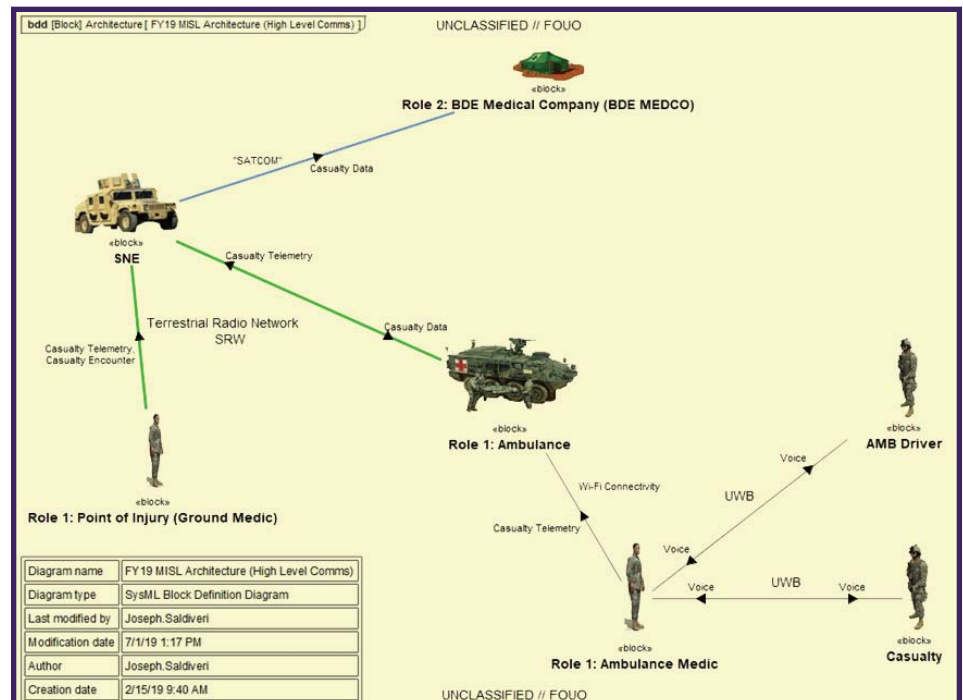
According to SFC Hall, "The Agile Network Connectivity for Mobile Medics project is just one more example of how the AAMTI program provides an opportunity for our best and brightest to have an avenue and opportunity to explore their best ideas and solve the real world problems they face day-to-day!" ■■■

TATRC's MISL Lab Hits the Range at Ft. Dix for their Annual Research Event

TATRC's Medical Intelligent Systems Laboratory (MISL) has been at it again. Last summer the MISL team conducted another research event at Joint Base McGuire-Dix-Lakehurst (JB MDL) ranges in New Jersey. This year's event concentrated on collecting data on the latest research project that is focused on cloud capability on a military tactical radio network. In Multi-Domain Operations, with a near-peer adversary capability, commanders need near real-time situational awareness on the battlefield. A mobile cloud system can provide needed casualty information to the commander and the receiving higher level medical treatment facility.

The research event was hosted by the Army Futures Command (AFC) and Combat Capabilities Development Command (CCDC), Command, Control, Computers, Communications, Cyber, Intelligence, Surveillance and Reconnaissance (C5ISR) Center at JB MDL. The C5ISR provided the necessary vehicles required and established the closed-loop military tactical network. The focus of the event was centered on research of medical technologies performing specific and discrete types of interactions to obtain medic feedback and collect data related to the performance and network characteristics of the technologies.

The research concept and objective was to integrate cloud servers on a mobile Soldier Network Extension vehicle to simulate a Battalion communication point. Medical personnel in the field and medics in the ambulance would transmit medical data to the Medical Data Cloud Dashboard, which is being developed by the AFC CCDC Aviation & Missile Center Systems Simulation, Software and Integration Directorate. The medical device and sensors used by the medical personnel, collected the simulated casualty data while the medics were performing Tactical Combat Casualty Care on the mannequins with a variety of casualty wounds. The medical devices used during this research event to capture



FY 19 MISL Architecture (High Level Comms) diagram.

and collect data were the U.S. Air Force Research Laboratory's (AFRL) Battlefield Assisted Trauma Distributed Observation Kit (BATDOK) and Philips Remote Diagnostic Technology's Tempus Pro™ physiological monitor.

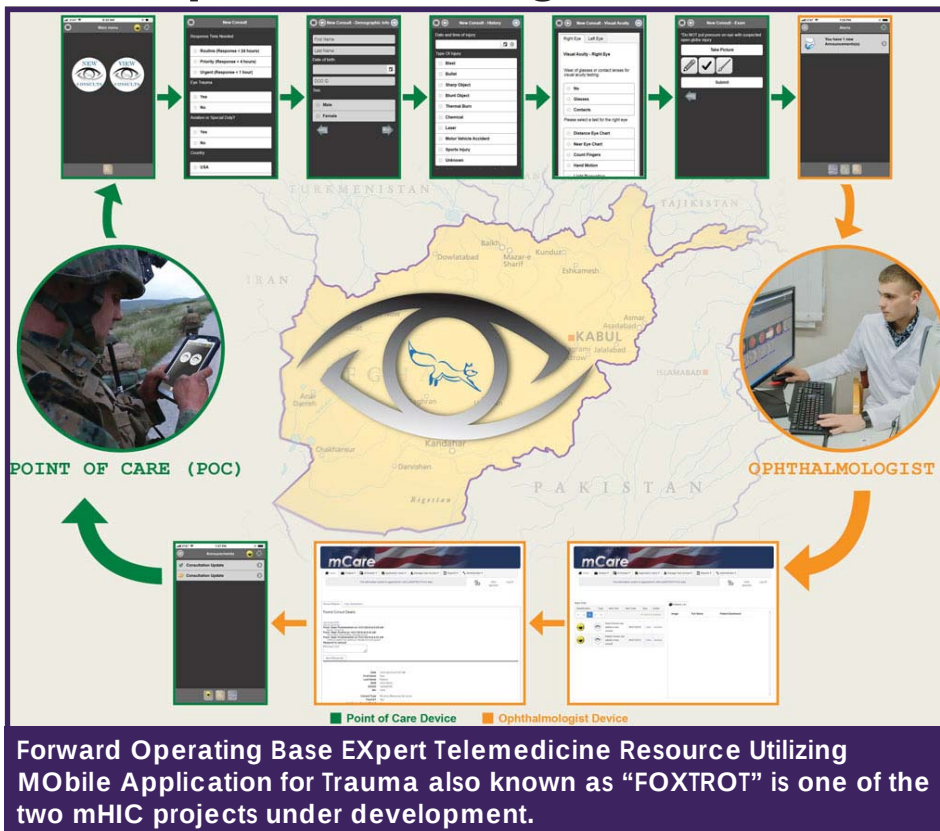
As the medics pushed the simulated medical data to the Medical Data Cloud Dashboard, a medical provider back at the simulated Brigade Medical Company, used a laptop browser connected via a SATCOM LAN to view the medical data on the Medical Data Cloud dashboard; streaming vital signs telemetry and the Tactical Combat Casualty Care card. Even though the data was only one directional, future research is underway to create two-way voice communication, texting capability, and transmission of video and still imagery.

The other cloud capability being researched was the Naval Surface Warfare Center Dahlgren Division's Medical Common Operation Picture (MedCOP). This research capability utilizes Radio Frequency Identification (RFID) to track

patient movement. The proof of concept worked very well as the casualty moved from the casualty collection point onto the ambulance, where an RFID reader collected the data and transmitted it to the MedCOP server which alerted the Medical Regulator. Then, when the ambulance arrived at a medical treatment facility and was off loaded, the RFID reader registered the casualty arriving. Additional research in tracking medical logistics and resupply via RFID is being explored and if additional RFID readers were available, the casualty could have been tracked from the point of care through the medical treatment facility's wards.

Mr. Carl Manemeit, TATRC's Deputy Lab Manager for MISL stated, "Our annual research event allows us to obtain critical feedback directly from the medics in the field. Only from Soldier-user feedback and direct observation of performance on real, tactical networks, can you effectively assess the potential of new medical information technologies for operational use." ■■■

Two New Projects Under Development Utilizing mHIC's MHCE



TATRC's Mobile Health Innovation Center (mHIC) successfully utilizes its Mobile Health Care Environment (MHCE) platform for the implementation of research and pilot evaluations to determine the clinical impact on care coordination between patients and providers utilizing an encrypted, bi-directional mobile messaging system. The system conveys information directly to a HIPAA compliant application installed on the patient's personal cell phone. The MHCE system allows for synchronous and asynchronous communication with patients beyond the limitation of traditional communication mechanisms.

mHIC has two new projects that are under development using the MHCE. Those projects are Forward Operating Base EXpert Telemedicine Resource Utilizing MOBILE Application for Trauma also known as "FOXTROT" and the Enhanced Capability Demonstration (ECD) for the Joint Health Risk Management (JHRM).

FOXTROT:

For project FOXTROT, the vision is to improve and extend ophthalmic trauma care in remote deployed environments. The Principle Investigator (PI) of this new initiative is Maj William Gensheimer, of the 455th Expeditionary Medical Group Craig Joint Theater Hospital, Bagram Airfield, in Afghanistan and is complimented by TATRC's own mHIC Lab Director, Ms. Jeanette Little, who serves as the Co-PI. The FOXTROT mobile capability incorporates the ability to perform teleophthalmology using the mCare app and clinical peripherals tailored to the ophthalmologic needs of the patient and provider. These features include triage surveys, image capture, chat, secure messaging, video chat, reports, remote health monitoring, and user management. The design will provide complete and comprehensive teleophthalmology capabilities to downrange Service Members, and will include a comprehensive review of current

ophthalmology mApps including the Wills Eye Manual, Eye Handbook (EHB), EyesHaveIt, Ullman Indirect, and EyeTube. Testing will occur in CONUS settings, as well as within the CENTCOM Area of Responsibility. This is particularly exciting for TATRC's mHIC team as it is the first ever Air Force Ocular Trauma project that we have collaborated on.

Enhanced Capability Demonstration (ECD) for the Joint Health Risk Management (JHRM):

The second project that utilizes MHCE, is in support of the Joint Program Executive Office for Chemical, Biological, Radiological and Nuclear Defense (JPEO-CBRN), TATRC's mHIC lab is supporting an experimental Joint Health Risk Management (JHRM) initiative to integrate monitoring devices, collect, visualize, and longitudinally record individual blast overpressure exposure data in training and combat environments using the MHCE / mCare product. The potential operational impacts include recording data to inform exposure reduction measures, medical surveillance and on-going health effects research. The partners on this project include JPEO-CBRN Defense, Joint Operational Medicine Information Systems, Defense Occupational Environmental Health Readiness System, and the Defense Health Agency's Virtual Health office. This project kicked off with the initial meeting occurring in August.

The operational concept of this capability follows a process by which a wearable blast gauge device transmits data through the blast gauge web application, and is passed to the MHCE where it is then displayed according to the user's role and needs. It is then parsed out to other systems of record, such as the Electronic Health Record, Global Biosurveillance Portal, and other health data repositories.

TATRC's Ms. Jeanette Little stated, "We are excited to see TATRC's mHIC work expand beyond the traditional use cases for mobile devices, and into the environment sensors in a very novel partnership that could lead to more robust collaborations in the future." ■■■

Employee Spotlight

TATRC Hires Long Awaited Loggie to the Team



Ms. Tanya Rexrode, Logistics & Resource Management Support Officer

Tanya Rexrode, affectionately referred to as “T-Rex,” is the latest hire to join the TATRC team. Tanya will be dual hatted and supporting both TATRC Logistics, as well as assisting in the Resource Management group.

She comes to us from Letterkenny Army Depot located in Chambersburg, PA. During her three-year tenure, she used her eight years of prior learning and experience in logistics

to help drive the Depot’s SOP standards for the two shops she maintained to success. The mission for the Depot is to support the Soldier with “Just-in-time” deliveries. In order to maintain the multiple RECAP & RESET PATRIOT Programs Tanya used a variety of SAP Programs to include LMP and CAMs to keep a 90% standard.

Tanya was born and raised in Wisconsin (a proud “Cheesehead”) and calls the City of Fond du Lac (First on the Lake Winnebago) home. After many struggles in her early years, she decided to join the Army in 2008 to

make a better life for her and her two beautiful daughters. Her first MOS was a 63J (Quartermaster and Chemical Equipment Repairer); however as there were going to be no requirements for her MOS down range, her CW3 found that Tanya’s vast knowledge with organizational skills (and a little OCD) could go a long way in the Motor Pool! This was where Tanya became a 92A (Automated Logistics Specialist). Being deployed in 2009-2010 in Afghanistan, Tanya learned the true meaning of Brotherhood, Loyalty and Honor; three codes she lives by daily. By 2013, she earned her SGT Stripes, and if it wasn’t for her mentor from her “first Army Family” who was always instilling the “NCO Creed,” Tanya would not be where she is today, nor so humbled or honored. In 2016, Tanya decided to hang up her uniform, but not her codes.

Tanya took her drive and ambitions to her civilian work and college. In 2016, she earned her Bachelors in Business Administration, Specializing in Operations Management, along with her Master’s in Business Administration, Specializing in Human Resource Management in 2017. Tanya is currently in college for a third time trying to earn another Bachelor’s in Cyber-security; both degrees were earned through American InterContinental University. Tanya loves walks in the woods, music, The Chicago Cubs, Green Bay Packers, and softball.

TATRC warmly welcomes “T-Rex” to the team! ■■■

TATRC Welcomes Marvin Cole to the mHIC team at Fort Gordon

The TATRC team is proud to welcome Mr. Marvin Cole as the new Systems Integrator down at our Ft. Gordon Office in Augusta, GA. Marvin is recently retired after serving 22 years and 6 months in the Army, with his last assignment being at the U.S. Army Signal School, Cyber Center Of Excellence at Ft. Gordon as a 25B Information Technology Specialist.

Marvin currently holds an Associates of General Studies Degree from Central Texas College and is currently pursuing a Bachelor’s Degree in Technology Management from Excelsior College. He was deployed multiple times in both Afghanistan (OEF) and Iraq (OIF).

Among his many achievements are the Adolphus Greely Signal Corps Bronze Order of Mercury Recipient (Lifetime, 2015), and Sergeant Audie Murphy Club Inductee (2012).

Marvin is married and has three children. His hobbies include spending time with family, working with charity organizations, relaxing while watching a good movie or comedy, and manicuring lawns. He is a Prince Hall Freemason and a Shriner.

Marvin states that he is “eager to take on this challenging new position within the TATRC team. This organization seems to be firmly committed to the highest standards of integrity, competence, and leadership. I look forward to going the extra mile to inspire excellence in others with my unparalleled work ethic and keen sensibility to the issues that arise. I vow to perform well individually and collectively with a team, combining excellent interpersonal, communication, and technical skills with the ability to multi-task and adapt easily to changing environments.”

We are so glad to have Marvin on our team! ■■■



Mr. Marvin Cole, mHIC's New Systems Integrator

Mr. Ray Samonte is TATRC's Q4 Employee of the Quarter!



Mr. Ray Samonte, Graphic Designer & Webmaster is the Employee of Quarter 4.

Congratulations are in order for TATRC's Q4 Employee of the Quarter, Mr. Raymond Samonte, from the Marketing & Public Affairs group.

Ray Samonte, who serves as the Graphic Designer & Webmaster for TATRC, won this award because he continuously models and effortlessly exemplifies the characteristics and qualities as stated in the Employee of the Quarter Charter Memo:

"The Employee of the Quarter should model behaviors of a good employee including a positive, professional attitude, respectful of institutional policies, helpful to co-workers, exhibiting good customer service and people skills, and a record of good attendance." He not only meets this, but exceeds it regularly! Ray is an exemplary employee, whose "can do" spirit is evident in everything

he tackles. His commitment to TATRC's many and evolving missions has been unwavering, and the execution of his tasks and responsibilities has been flawless.

Often times, Ray is left with the numerous, repetitive daily duties of making the graphics functions run successfully, one of which is preparing and creating graphics and PowerPoint slides, often with no notice and not a lot of guidance. People do not realize what all goes into that and he does it happily, with a smile. He is an A +, stellar performer, who always provides a high level of support to all the TATRC labs and staff, that is often unrecognized. He is a quiet strength, a true, unsung hero, who is always behind the scenes, "making good stuff happen" without a lot of fanfare.

His additional duties and accomplishments include: Assisting in the development and execution of all visual graphics at TATRC's very successful Open House, which is a high visibility, herculean effort that comes off without a hitch. Additionally, Ray plays a key and critical role in the development of the TATRC Times, which is TATRC's Quarterly newsletter that goes out to just under 2,000 essential personnel throughout the MEDCOM / DHA / MHS and other federal agencies, which is significant, because it is through this vital mechanism, that our strategic messaging is distributed and communicated.

The bottom line is that Ray is creating a vision and branding the organization with his exceptional artistic visuals that impacts TATRC every day.

Congratulations Ray Samonte on this well deserved honor! ■■■

This Quarter's TATRC TRIVIA...



Question: TATRC can be found in two geographic locations in the United States. What are they?

Answer to Last Issue's TATRC TRIVIA...



Question: Who is the only TATRC Director to attend the Army's prestigious military academy, West Point?

A: COL Jeremy C. Pamplin is the only Director to have attended the Army's prestigious military academy, West Point.

BHSAI's Research of Finite-Element Models Help Us Understand Blast-Induced Brain Injuries

Exposure to improvised explosive devices (IEDs) can result in various types of traumatic brain injury (TBI), ranging from mild concussions to severe penetrating injuries. Of the more than 350,000 Service members diagnosed with TBI since 2000, 82% are classified as mild TBI [1], which shows normal structural brain imaging but can lead to lasting behavioral and cognitive deficits. Many factors can contribute to mild TBI, such as blunt trauma to the head. What is unclear, however, is whether the mere interaction of blast waves from IEDs with the body can also contribute to brain injury, leading to non-impact, primary blast-induced TBI. In the absence of human studies of blast-induced TBI, which are unfeasible, animal models can advance our understanding of this injury by clarifying whether blast waves damage brain tissues and, if so, how. To address the latter issue in detail, however, we also need to complement this approach with accurate high-fidelity computational models of animal brains. To inform the development of such models, we performed high-strain-rate testing of brain tissues and cerebral vasculature tissues from rats [2]. Using this new information, along with an explicit representation of the cerebral vasculature, we recently developed a three-dimensional (3-D) high-fidelity finite-element (FE) rat-head model and validated its predictions with data from rats exposed to a blast wave in a shock tube [3]. The model, whose blast-induced brain responses are sensitive to the properties of brain tissues and cerebral vasculature, will ultimately help us understand the potential injuries that underlie non-impact, primary blast-induced TBI.

Relevance of Work to DoD

Animal studies have advanced our understanding of blast-induced TBI. However, we cannot directly apply the results of such studies to humans,

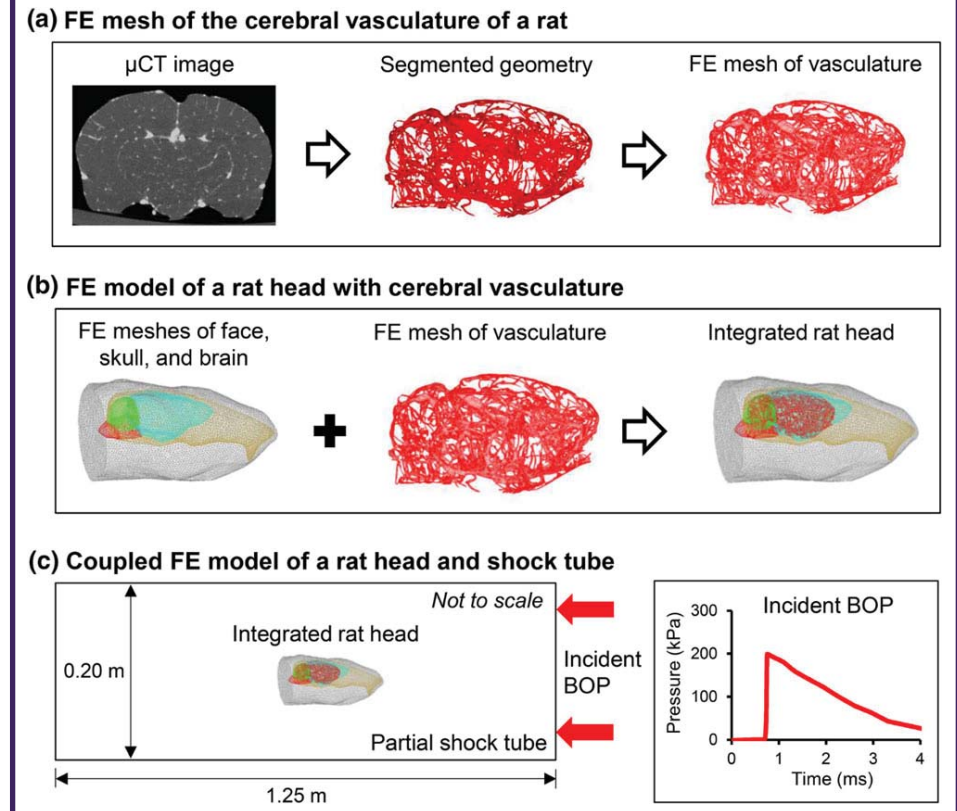


Figure 1: Sequence of steps involved in the development of the high-fidelity three-dimensional finite-element model of the rat head.

given the lack of validated scaling laws to translate the injuries observed in animals to those in humans. Accurate high-fidelity FE models of animal brains could serve as a means to predict how blast waves affect the brain, and extrapolate what would happen in humans from injuries induced in animals. This capability will help us identify the changes underlying non-contact blast-induced TBI and, in turn, specific countermeasures to mitigate the injury.

Computational Approach

We collected micro-computed tomography (μCT) images from Sprague-Dawley rats to obtain the geometry of the cerebral vasculature. We then used the Centennial High Performance Computing (HPC) Machine at the Army Research

Laboratory (ARL) to develop a 3-D high-fidelity FE rat-head model that incorporated this geometry, along with the high-strain-rate properties of the face, skull, brain tissues (brainstem, cerebellum, and cerebrum), and cerebral vasculature. To this end, we generated a 3-D FE mesh of the cerebral vasculature from the μCT images (Figures 1a, 2), integrated this with FE meshes of the face, skull, facial bones, and brain (Figure 1b), and coupled the integrated rat-head model with a 3-D FE model of a partial shock tube. We then validated the complete model using data from rats exposed to blast overpressure (BOP) in a shock tube (Figure 1c).

We hypothesized that incorporation

Finite-Element Models
continued to page 19

Finite-Element Models *continued from page 18*

Figure 2: Three-dimensional geometry of the cerebral vasculature of a male Sprague-Dawley rat developed from microcomputed tomography images.

of the cerebral vasculature and high-strain-rate material properties of the rat brain into the model would influence the biomechanical response of the brain to blast waves. To test this conjecture, we compared how BOPs influenced brain pressure, brain strain, and cerebral vasculature strain in three models: one with vasculature (RHwCV), one without vasculature (RHw/oCV), and one without vasculature but using human high-strain-rate material properties (Legacy), as has been previously used [4]. As each model had over one million finite elements, we employed ARL HPC Modernization Program resources to perform the computationally intensive simulations.

Results

The cerebral vasculature and material properties of the rat brain did not influence predictions of brain pressure. However, they affected predictions of the magnitude of the maximum principal strain. Strains predicted by the Legacy model (Figure 3, right), which lacked vasculature and used the stiffer material properties of human brain tissue (relative to rats), were as much as 3 times lower than those predicted by the RHw/oCV model, which used the material properties of rat brain tissue (Figure 3, center).

Incorporation of cerebral vasculature also affected the distribution of maximum principal strain. Strains at the bottom of the brain did not differ between the RHwCV and RHw/oCV models (Figure 3, left and center; Figure 4), likely because vasculature is absent in this area. Strains in other regions were lower for models with vasculature (Figure 3, left and center; Figure 4: RHwCV vs. RHw/oCV). These reductions were greater for thicker vasculatures (Figure 4, center and right). The pattern of average peak maximum principal strains across brain regions (cerebrum, cerebellum, and brainstem) differed between the RHw/oCV (6.2, 6.8, and 6.6%, respectively) and

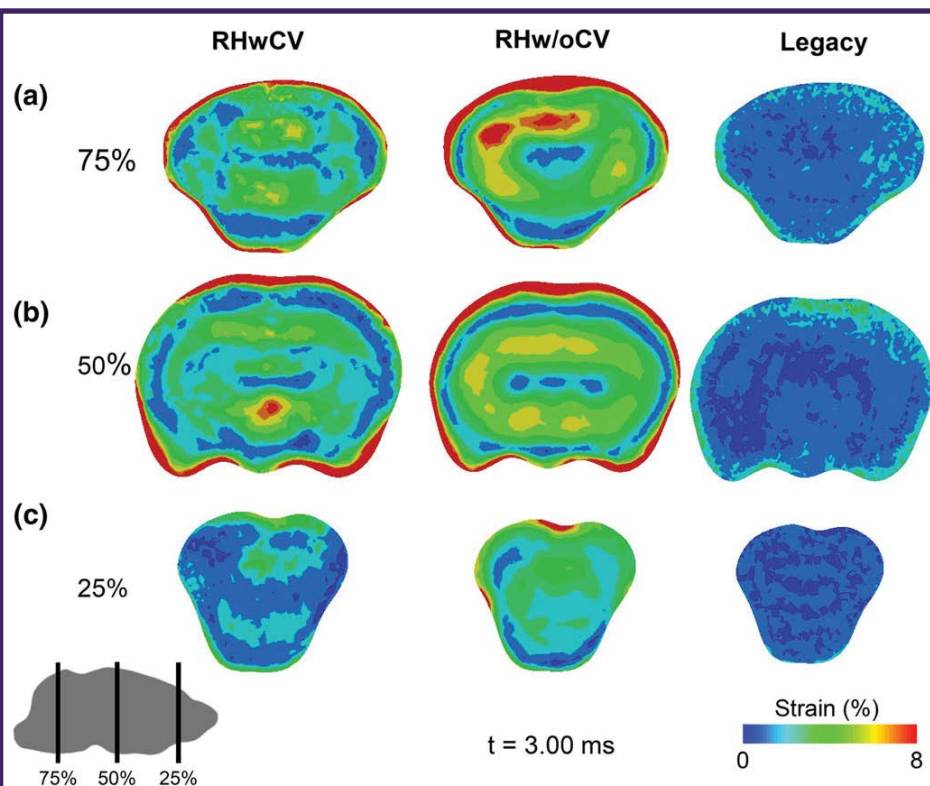


Figure 3: Comparison of maximum principal strains in the coronal plane at the back, center, and front (75, 50, and 25%, respectively, from the anterior end) of the brain predicted by models with cerebral vasculature (RHwCV), without vasculature (RHw/oCV), and without vasculature but with human material properties (Legacy).

Finite-Element Models *continued to page 20*

Finite-Element Models *continued from page 19*

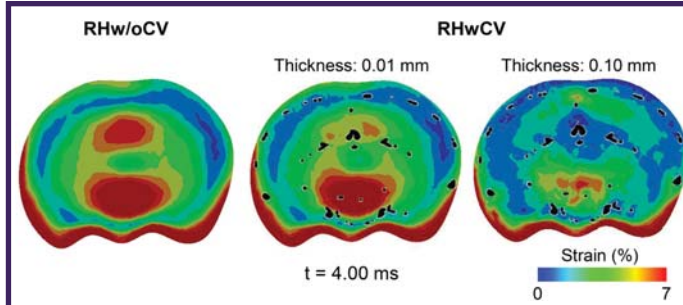


Figure 4: Comparison of maximum principal strain in the mid-coronal plane predicted by rat head models with (RHwCV) and without cerebral vasculature (RHw/oCV). For the RHwCV models, the cerebral vasculature (thickness of 0.01 or 0.10 mm; represented as black dots) is superimposed on the brain.

RHwCV (0.01 mm) models (6.1, 5.7, and 6.3%, respectively).

Our findings highlight the importance of species-specific material properties and cerebral vasculature in a 3-D FE model of a rat head for assessing the effects of blast exposure. In addition, the strain distributions predicted by high-fidelity models will help us localize the key sites of injury in the rat brain and, thereby, identify the underlying mechanisms of primary blast-induced mild TBI.

Future

In ongoing collaborations with the Walter Reed Army Institute of Research (WRAIR) and New Jersey Institute of Technology (NJIT), we are examining the brain regions affected by blast exposure and the mechanisms underlying blast-induced

changes at these sites. Our next challenge will be to develop high-fidelity FE models of a Göttingen minipig and a human to determine the scaling laws to translate the results in animals to those in humans.

Co-Investigators

Professor Kenneth Monson (The University of Utah); Dr. Joseph B. Long, Dr. Sujith Sajja, and Mr. Stephen van Albert (WRAIR); Professor Namas Chandra (NJIT)

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