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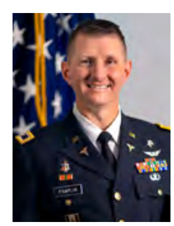
FEATURED SPOTLIGHT:

ALSO INSIDE:



Commander's Corner: A Message from COL Jeremy Pamplin & Team TATRC

COL Jeremy C. Pamplin, TATRC Commantder

We are off to the races! Since our last update, TATRC has been a whirlwind of activity. Never have I witnessed the organization humming along like such a finely-tuned engine – we have transformed. For most of its history, TATRC's primary function was execution management: receiving proposals, awarding funds to external entities and ensuring the completion of that research. Now we are an organizational team focused on a mission and we are all working together to accomplish it through programmatic research (**Figure 1**). It has been remarkable to watch this team do such incredible things! We are truly blessed to have phenomenal individuals working at TATRC – from our science teams to our science support and command staff, our contractors, civilians, and military – everyone is invested and focused on delivering new capabilities to help modernize military medicine. I'm immensely proud of the work TEAM TATRC has accomplished over the past six months and excited to see what the future holds!

More on Automating Casualty Care:

The last two Commander's Corners have highlighted the importance of automating casualty care to increase capability and capacity on the future battlefield and how this could be done following examples from industry, specifically the automotive industry's climb to summit Mount Autonomy. We've introduced many concepts around passive data collection and why we are working to automate tactical combat casualty care (TC3) documentation as our first material product solution, a project we affectionately call "AutoDoc."

This quarter I'd like to share more details about how TATRC intends to move from a paradigm in which casualty care is exclusively in the human domain to one of increasing human-technology teaming and automation (**Figure 2**) to meet the anticipated challenges of all-domain operations against near-peer adversaries: massive numbers of casualties and the need to care for them for prolonged periods. We will also cover some of the key concerns regarding our approach. Hopefully, by the end, there will be more clarity about how TATRC intends to grow the automation portfolio in an ambitious but expeditious and thoughtful manner.

First, training artificial intelligence (AI) models to automate complex tasks like driving or documenting casualty care is dependent upon having data that is sufficiently representative of the task. This data must be accurate, reliably available, collected at a frequency that enables machine performance to be comparable to a human's, and be inclusive of the contextual variations of the task we wish to automate. For example, the computer may not interpret data it "sees" from driving on a sunny day in the same way it "sees" driving on a rainy day. The same holds true for interpreting medical tasks under different conditions.

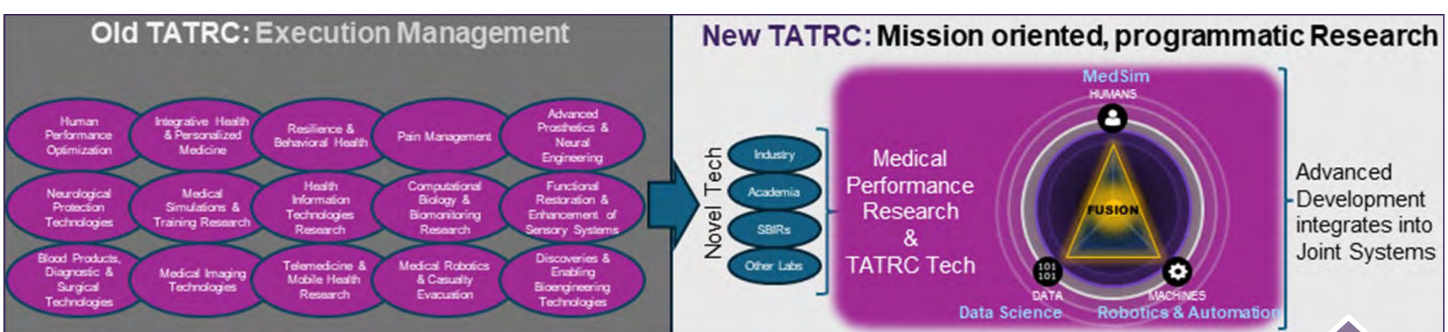


Figure 1. The old TATRC was primarily an execution management agency with numerous portfolios like the Congressionally Directed Medical Research Programs. The "new" TATRC, has been evolving since about 2012 into a mission oriented, programmatic research lab, now focused on automating casualty care and understanding the Military Healthcare Systems Medical Performance of Casualty Care.

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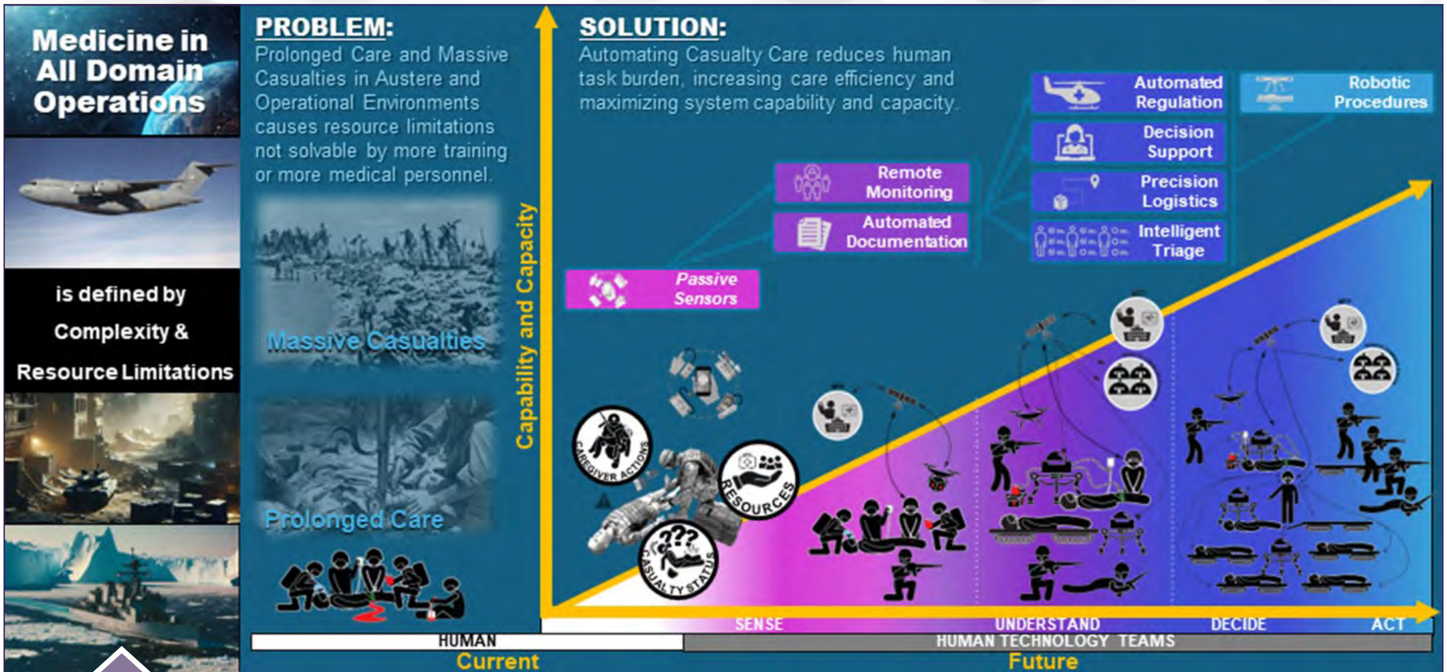

Figure 2. Large Scale Combat Operations against peer adversaries in all domain operations challenges the military health systems to deliver sufficient medical capability at scale. To address this challenge, we must transition from casualty care delivered entirely by humans to casualty care delivered increasingly by human-technology teams.

Data that we build our ecosystem around must be reliably collected and useful in contexts: the light and the dark, the loud and the silent, the clean and the muddy (or bloody), the hot and the dry and the cold and the wet. We assume that one data source (like video) will be insufficient and that we can identify a set of SWaPC3[1] compliant, caregiver worn sensors that will be unobtrusive to TC3 performance. We start from the premise that is it better to build a system around data that is reliably collectable and accurate across all care environments. We must rigorously test these assumptions, recalibrate our approach, and invest in new sensors or sensor configurations. We must do this until we have a dataset that is sufficiently reliable, accurate, and robust enough to create our system around.

In the context of AutoDoc, we need data from real-combat casualty care that represents the ground truth about what casualties look like, what caregivers do, and what resources they use to care for casualties during TC3 in all combat environments. Historical data is not available, as it was not recorded, and there is limited combat casualty care conducted at present. So, where can we get this data from?

TATRC proposes the Data Nexus (**Figure 3**) as a model for collecting data about TC3 and, in the future, from all echelons of care. In this model, a core data set from unobtrusive, reliable, SWaPC3 compliant ground truth sensors are collected from the laboratory environment, casualty care training (specifically student or team validation testing), and real-world patient care (primarily civilian or garrison based until a fieldable sensor suite is identified and made available during real combat casualty care). We acknowledge that datasets collected from each of these environments – lab, training, and civilian or garrison care – will have inherent biases that could affect future AI models. For example, data collected from the lab may not represent C3 contexts of dirt, snow, or complexity; data collected from training may not represent the experience of treating a real human, or the time pressures from mission or enemy threat; and data collected from civilian or garrison based patient care may not represent the same sequence of C3 expected in military context and that it is provided by caregivers without the same knowledge, skills, abilities, experience, sets, kits, and outfits (KSAs and SKOs) as military pre-hospital caregivers. One example of a key difference between the care delivered during real C3 on a battlefield and all other domains available to collect data from, is the probability that a caregiver is delivering C3 to a friend or colleague – a rarity in training, civilian, or garrison healthcare, but a 99% probability for a military pre-hospital provider during combat. It is important to note that these differences in context will produce data that has differences from

[1]Size (smaller is better), weight (lighter is better), and power (longer battery life, hot-swappable batteries, etc. are better), cost (least cost, ideally "throw away" components), connection (functions in a networked, degraded, intermittent, limited and non-networked capacity), and cyber secure.

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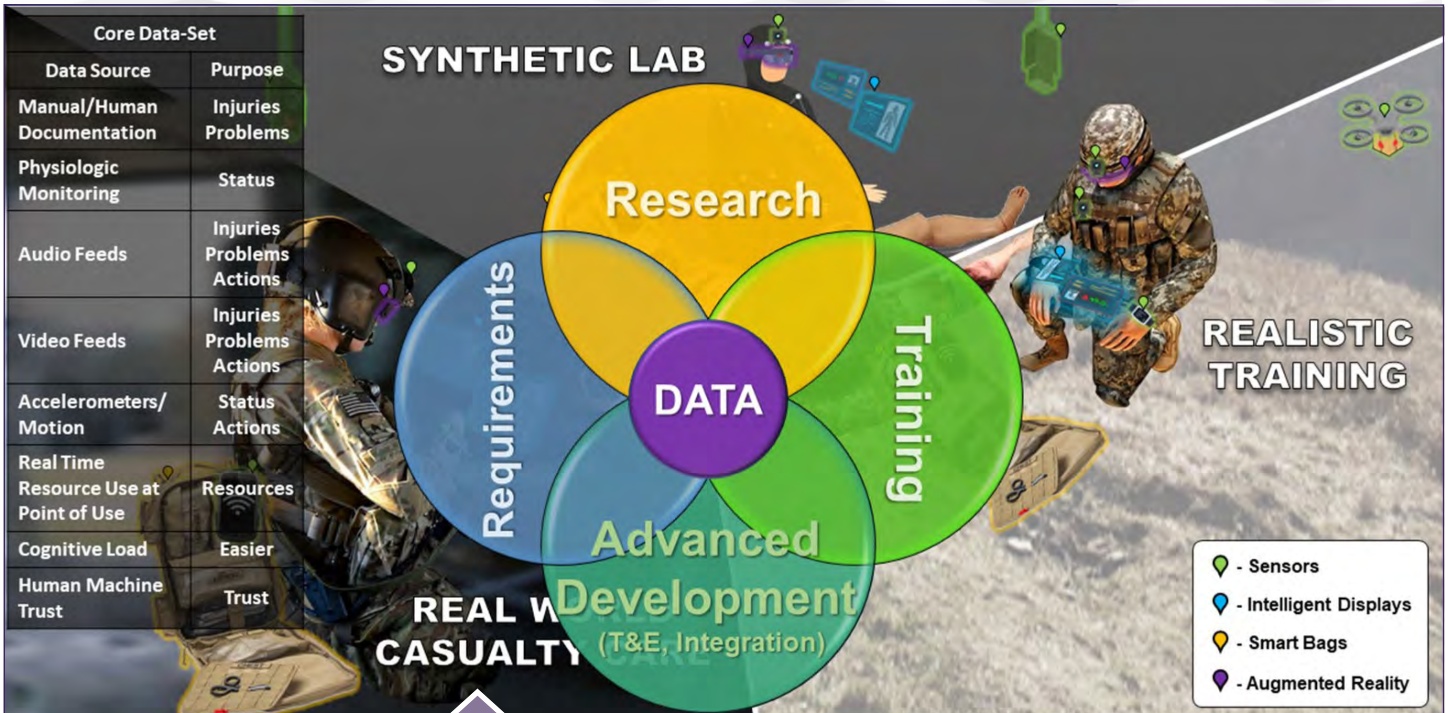

Figure 3. The Data Nexus. A core data set that represents casualty care can be collected using unobtrusive ground truth (passive, real-time data not interpreted by humans) sensors from research, testing/training, and real-world civilian and military environments. Using this data, we can learn to improve care delivery, training, and requirements generation. We can also model the data to produce material products like autonomous documentation, intelligent decision support, and advanced triage solutions.

real C3 in combat. Models produced from this data will therefore be biased. We must be intentional about identifying solutions that will minimize these biases, or be able to correct for them, when we transition the models to real C3 applications.

How much data do we really need and how much can we actually collect? These are unknowns at present. Preliminary experience published by the Trauma THOMPSON1 group suggests that even with a relatively small dataset, AI can learn to recognize TC3 tasks. In collaboration with these investigators, and others working in this domain, developing a large dataset with thousands of TC3 tasks and scenarios (tasks for machine recognition, scenarios for task sequencing) is necessary, but may be insufficient. In addition to data collected from the physical world, we must also augment our datasets – introducing variations and complexity to it like shadows, rain, obstructions, different shapes and sizes of casualties and caregivers, signal loss, etc. We anticipate harnessing gaming applications and generative AI in the future to help produce additional data for training algorithms, but these applications and the generative AI need baseline data from the care context of interest to compare against, or else we risk introducing significant bias to algorithms from the larger volume of synthetic data we create. In other words, we need the ground truth data from the real-world to avoid biasing models produced from synthetic data. Collecting data from the Data Nexus is no small undertaking – stakeholders in each of these domains have different perspectives, priorities, and motivations. Policies for data collection, storage, and usage vary within each domain and across military Services as well as in the Defense Health Agency (DHA). The resources needed to store, annotate, curate, and analyze this type of data is not fully available. To tackle these challenges, we have initiated a quarterly Data Nexus Symposium. Information Papers from the first two events, and invitations to participate in future events, are available upon request. Please send your inquiry to: lori.a.debernardis.ctr@health.mil and anna.k.applegate.ctr@health.mil).

Sprint 2:

This first phase of our approach is nearly complete. Over the past six months we have:

- Internally reorganized our teams to most efficiently accomplish work;
- Internally developed a sensor suite and are finalizing a data-aggregation solution (Figure 4) that can be worn by a medic during TC3;
- Nearly completed an external competition to select a partner sensor suite team that will similarly deliver a medic worn sensor suite and data-aggregation solution;

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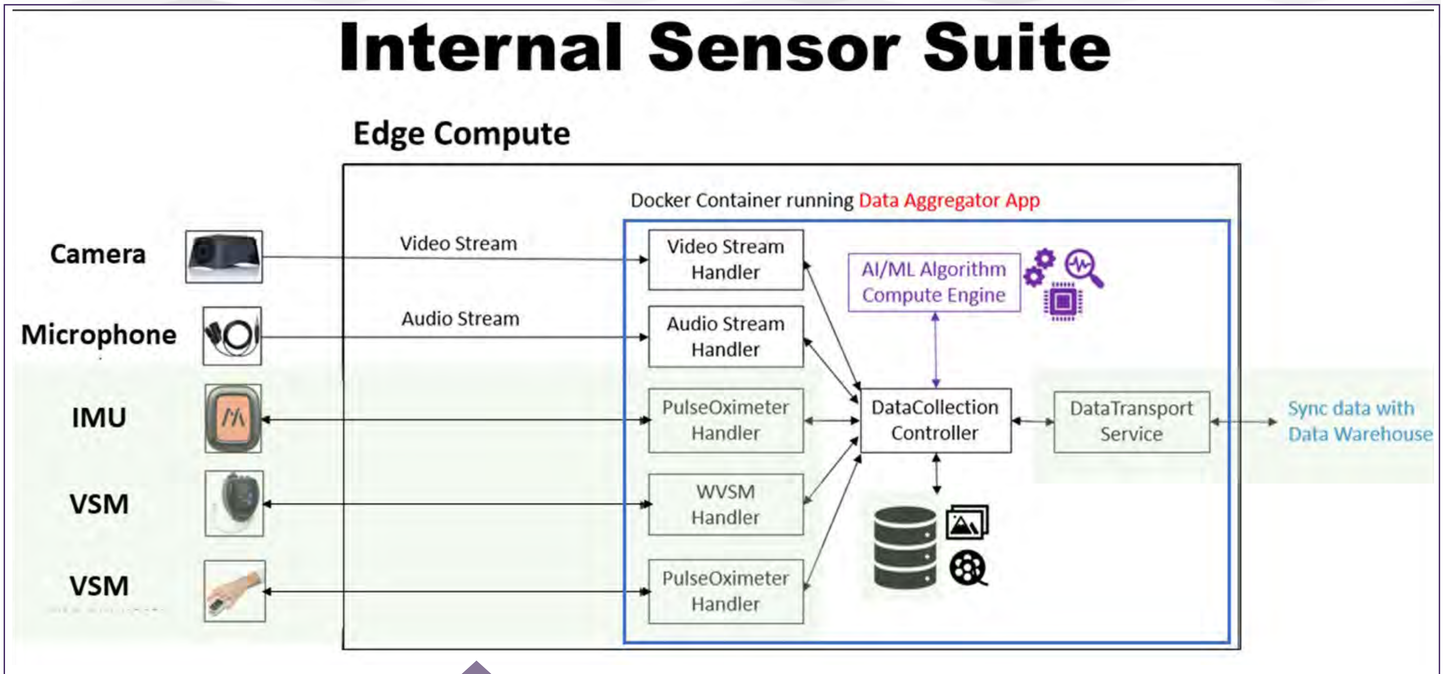

Figure 4. The intramural sensor suite consists of sensors and the "Point of Treatment Aggregation" (POTAG) Software. This software is composed of data handlers for sensor input (Audio, Video, inertial measurement unit and vital signs monitors), a controller interface with compute engine (algorithm), a controller interface with local files storage, and a database interface. Acronyms: inertial measurement unit (IMU); vital signs monitor (VSM); wearable vital signs monitor (WVSM); artificial intelligence (AI); and machine learning (ML).

- Nearly completed a contract with an industry partner to collect data about combat casualty care from hyper-realistic training environments;
- Established contracts with partners to help coordinate data standards and interoperability amongst all components and to manage a "data commons" – a data infrastructure available to TATRC and partners for data storage, analysis and model/AI development;
- Collected over 65 GB of data from 35 high fidelity medical simulation scenarios and dozens of task trainers representing over 250 TC3 tasks and covering information from nearly 50% of the TC3 documentation card (DD Form 1380);
- Obtained approval for core research protocols involving human subjects;
- Prototyped data synchronization and annotation software; and,
- Conducted two Data Nexus Symposiums to gather perspectives, partners, and momentum in scaling data collection efforts.

We are now at the cusp of scaling our data collection within TATRC's research lab and at partner sites. Over the next six months, we will obtain research and organizational approvals for data collection at our partner sites; ship sensor suites for their use; and collect, annotate, and store data. Simultaneously, we will work with the Medical Technology Enterprise Consortium (MTEC) to identify external algorithm teams through a competitive contracting process allowing us to share data with the selected teams for algorithm development. And, in parallel to the data collection and algorithm development efforts, we will work closely with DoD stakeholders and leverage FFRDC partners at MITRE and MIT Lincoln Labs to evolve data standards, interoperability framework, and data management infrastructure necessary to be successful across the Data Nexus.

Other Important Items to Note:

While I have spent considerable time and effort conveying the importance of the AutoDoc Project, AutoDoc is not TATRC's only project and it is only the beginning of our Automating Casualty Care Portfolio. In our August 2023 TATRC Times, we introduced the concept of the Automation Stack. AutoDoc is the foundation of the "sense and understand" components of the stack: through passive data collection and modeling of data to produce discrete data necessary to document, AutoDoc makes important information available for other projects. Clinical decision support is essential to maximize capability at the point of need and capacity across the care continuum. With our partners at the Institute of Surgical Research, we continue

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to revise the Medic Clinical Decision Support System (Medic CDSS) to take advantage of a future where data is made available to it passively and in real-time. We anticipate that an early by-product of the AutoDoc effort will be a Medic CDSS that functions to passively monitor medic actions during TC3 to ensure that necessary interventions are not missed and a version that functions actively to coach a non-medical provider through the steps of TC3; similar to how an automated external defibrillator prompts a lay person to save the life of someone in cardiac arrest.

In parallel to our passive data collection and algorithm development efforts at the "bedside," we continue to evolve sensing capabilities "at a distance" in collaboration with the Defense Advanced Projects Agency (DARPA) Triage Challenge (DTC) and our Vision and Intelligence Systems for Medical Teaming Applications (VISTA) Project. This project has generated significant interest at multiple exercises for its ability to identify potential casualties at a distance and to determine their general condition by monitoring vital signs remotely. We anticipate that this technology – incorporated into drones, robotic agents, fixed cameras, etc. – will help to prioritize medical responses to mass casualty events and to help monitor casualties waiting for medical care to arrive. There are multiple efforts in the DoD – like DTC - seeking to automate "sensing" across the care continuum. This demonstrates the foundational importance of our work both to amass data about care to build AI models and to leverage the data from sensors to enable future medical concepts. Through collaboration and sharing best practices, we hope to help field trusted solutions faster.

Similarly, the Remote Patient Management System (RPMS), a software solution that we developed during COVID under FDA Emergency Use Authorization (EUA) that enables remote control of multiple commercial life-support medical devices like mechanical ventilators, monitors, and IV pump, represents another foundational component of an ecosystem that can help manage large numbers of casualties with fewer trained humans. In the future, many of the functions of the RPMS device will likely be automated (e.g., autonomous mechanical ventilation, autonomous resuscitation with IV fluids/medications), but, at least in the foreseeable future, these autonomous algorithms will reach limits of execution. In these situations, where the context of care dictates there are few or no trained providers, but a trained medical provider is needed to help the machine decide, that remote control of the medical devices will be necessary. Consequently, reach-back to a remote expert using telemedicine, at least for a long while, will always be a necessary component of any autonomous medical system – we are, and will remain, the Telemedicine AND Advanced Technology Research Center.

As TATRC's portfolio of work continues to evolve we anticipate a convergence of technologies like AutoDoc, Medic CDSS, VISTA, and RPMS into an ecosystem of solutions to help manage single casualties for inexperienced or untrained caregivers, or massive casualty volumes within the care continuum using fewer human agents. The data collected, analyzed, and modeled at the right location within the echelons of care, will help to optimize the efficiency of the system to deliver the right care with the right resources to the greatest number of casualties. This will offer battlefield commanders a great deal of agility in responding to dynamic battlefield conditions – optimally managing casualties within the fight and maximally returning the ill or injured to duty, rapidly evacuating casualties when possible and necessary, and ideally matching resources to casualty needs (i.e., triage). This will be the key challenge for TATRC and its' partners over the next decade: bringing together the essential, real-time, reliably collected, and meaningful data across the care continuum in such a way that we can optimize the entire system of care… and that's a topic for the next edition.

Conclusion:

As I opened this narrative, I will close it by praising the people who work at TATRC; our family of renegades, innovators, disruptors, and visionaries; the hard working-behind-the-scenes team that ensures progress at every step; our partners, friends, and supporters who show up, provide critical perspective, and knock-down barriers on our behalf. THANK YOU ALL for what you do. For continuing to fight for delivery of better solutions that increase our collective capability and capacity to heal and protect our Nation's most valuable asset: our Service Members.

References:

1. Birch E, Couperus K, Gorbatkin C, Kirkpatrick AW, Wachs J, Candelore R, Jiang N, Tran O, Beck J, Couperus C, McKee J, Curlett T, DeVane D, Colombo C. Trauma THOMPSON: Clinical Decision Support for the Frontline Medic. Mil Med. 2023 Nov 8;188(Suppl 6):208-214. doi: 10.1093/milmed/usad087. PMID: 37948255.

From the Desk of the Science Director

As you may have heard, TATRC is well underway in re-focusing its efforts on the Automating Casualty Care (AC2) portfolio. Its first project known as 'AutoDoc,' focuses around establishing a viable set of sensors, algorithms and infrastructure needed to collect data passively and reliably in casualty care environments and to use that data to document care.

The AC2 portfolio and AutoDoc project, which we have described in more detail in previous editions of the TATRC Times, represent a foundational capability for automating casualty care. They provide the "sensing" base of the "Artificial Intelligence (AI) Stack" (Sense, Understand, Decide, Act). Having the ability to passively source data about casualty care – actions of the medic, state of the patient and resources used – in real time has the promise of enabling AI solutions that assist caregivers and leaders at the point of care and across the continuum to understand, decide and act better and more rapidly to increase the capability and capacity of the entire military medical system.

On 8 February, TATRC's leadership team briefed MRDC's senior leaders and key staff from the Principal Assistant for Research and Technology (PART) and Combat Casualty Care Research Portfolio (CCCRP) on the progress on the AC2 portfolio and AutoDoc project. This was the first quarterly In-Progress Review (IPR) since the project received official approval from MRDC's Commanding General to move forward in November 2023. TATRC briefed a long list of accomplishments reflecting the strong work of each of TATRC's functional teams and staff.

Here is a sample of some of the highlights from the first half of the first "sprint" of the AutoDoc project:

Mr. Matt Quinn,
Science Director, TATRC

More important than the actions of the teams across TATRC working together to accomplish these activities, was the progress of the team in delivering value for our sponsors and, ultimately, our customers – the combat medics and others in the military health system: 25 Tactical Combat Casualty Care (TCCC) simulations were conducted, 120 TCCC procedures were recorded, 25GB of scenario data was recorded, representing 20% of the DD1380 covered in recorded scenarios.

Also important in the advancement of TATRC's work in automating casualty care is awareness, engagement and input from those who could incorporate these technologies into their plans. A key partner for TATRC in this portfolio of work is Joint Operational Medicine Information Systems (JOMIS). TATRC hosted Ms. Sandy McIntyre, Program Manager, JOMIS Program Executive Office, and other key leaders from JOMIS' Future Requirements and Emerging Technology (FRET) group at Fort Detrick in early February to share TATRC's work, JOMIS' needs, and opportunities for collaboration.

The rest of the first sprint of the AutoDoc project will prepare TATRC for scaled data collection in the subsequent sprints. Data is our currency, and this project will build the data set that TATRC and others will use to model and automate casualty care.

We look forward to continuing to share progress on this important work!

Programmatic & Organizational	• Project and Staff Realignment Complete • Project approval to start/ funded (9 Nov 23) • Prioritized partnerships identified & agreements initiated
Infrastructure	• Course of analysis conducted and selected • Contract with MIT Lincoln Lab (RAPIDS) • RAPIDS accounts established • Tested RAPIDS infrastructure + data curation & annotation
Sensor Suite	• Intramural Sensor Suite Identification & Acquisition • Extramural Sensor Suite Prize Competition • Extramural Sensor Suite OTA announced
Data Collection	• Non-Determination Letters established with HRPO • Protocol for data collection approved by HRPO • Data collection events for intramural sensor suite & sensor suite prize competition
Algorithms	• Intramural algorithm Identification & Acquisition

Working Towards Interoperable Medical Device Systems, a Key Component of Military Medical Modernization

The complex intelligent systems that create the interconnected digital world of today rely on effective data integration. Quick and reliable transmission and storage of data between devices is just one part of this equation. The shared data must also be written and stored in a standard data format such that it is understandable across a system. Imagine attempting to read a book written in a different language. The original writer may have written an amazing piece of literature (such as the TATRC Times FY24Q2 Newsletter!), but to you, it just appears to be nonsense. Although the same information has technically been shared and recorded, its utility is greatly diminished when other devices cannot comprehend the shared data. Est-ce que tu comprehends? Capisci?

In much the same way, medical data can suffer from similar limitations. Currently, medical devices from different manufacturers often store patient medical data in different formats. For patient data recorded from one device to be used by another device in the system, it must then be translated into a common data format. A critical aspect of medical data interoperability that is often overlooked is Where and When the data is translated into a common language (data model), which can have a large impact on the functionality of the overall system. In

Figure 1: Proof of Concept Remote Patient Management System (RPMS). The RPMS is a medical device platform composed of mechanical ventilator, infusion pump, and patient vitals monitor devices designed to augment casualty care capability and capacity during evacuation and pre-hospital environments.

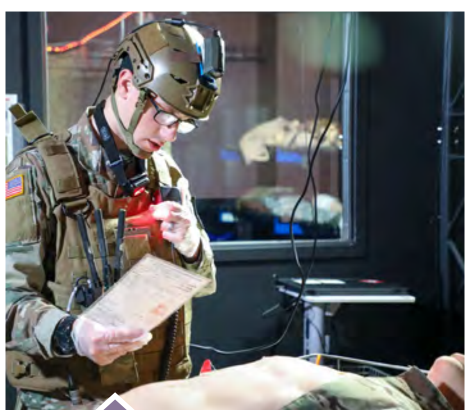

Figure 2: Automating the DD 1380, or Tactical Combat Casualty Care Card, allows the combat medic to have greater capability and capacity to deliver care by giving the medic time for more physical tasks by reducing their task burden.

TATRC's Remote Patient Management System (RPMS) (see **Figure 1**) and Automating Casualty Documentation Projects (see **Figure 2**), prototype concept systems are being developed that translate medical data from various devices into a common data standard in real time at the point of care.

Figure 3 compares two data integration approaches in which medical data from multiple devices is collected from a battlefield care encounter and then transmitted into

Interoperable Medical Device Systems
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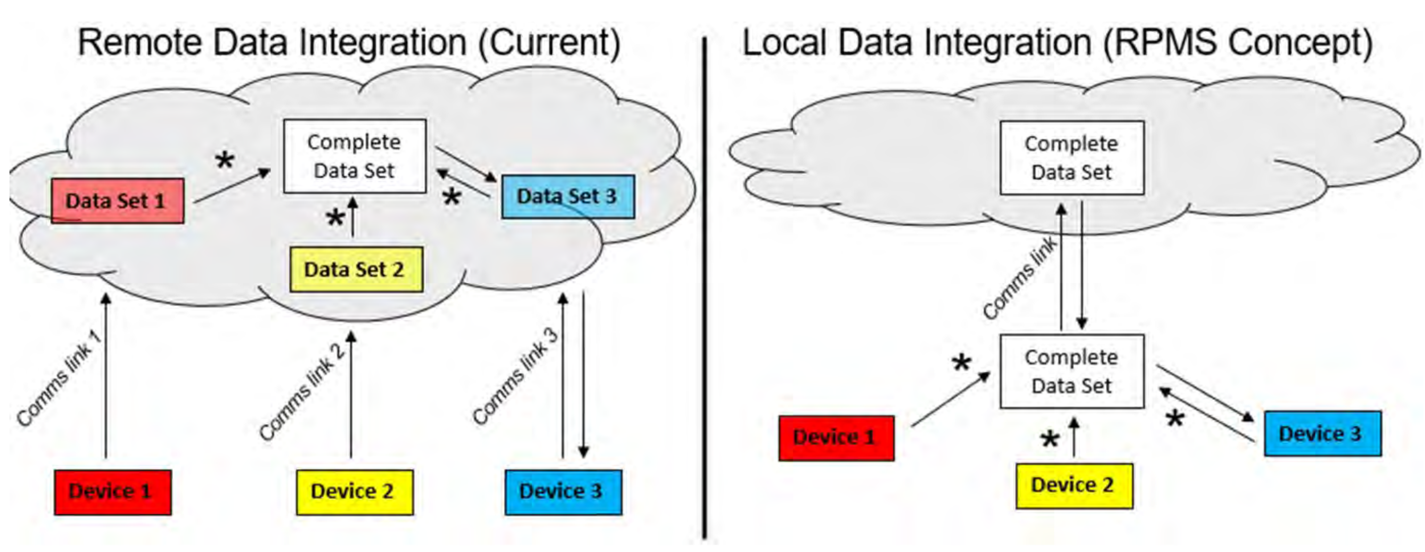

Figure 3: This figure compares two data integration approaches in which medical data from multiple devices is collected from a battlefield care encounter and then transmitted into the cloud to be accessed at a remote site.

the cloud to be accessed at a remote site. In the current process (left), medical data is typically integrated together only after patient care has ended and the recorded medical data is being entered into an EHR. However, in the RPMS approach (right), data is integrated locally and in real time into a single shared data set.

This updated approach has a variety of system-level benefits for patient care. For example, it can streamline telemedicine and allow a remote care provider to better support local care. In the system on the left, the data transmitted from each separate device would have to be remotely viewed on a separate software package, webpage, or physical device entirely. With the novel approach on the right, the remote care provider can view all patient data and control device settings with the same standard user interface. With better visualization of all patient information, a remote expert is empowered to provide effective and timely care in time critical and medically complex care situations. In addition, they can more simply view patient data and provide care assistance to multiple patients in various locations.

The RPMS approach for telemedicine can also allow for more efficient use of bandwidth over tactical networks. A locally integrated data set can be transmitted from a single communications link and can be optimized to send patient data based on situational need. For example, a remote expert may require real-time access to bandwidth-heavy data to care for a critical patient. However, they may only require low-bandwidth transmission of essential vitals signs for basic monitoring for a stable patient, thus freeing up bandwidth for other operational uses. Finally, the local data integration approach enables the introduction of autonomous control of medical care, in which AI or a closed loop control algorithms can use patient data from multiple devices to manage resuscitation or provide intelligent alerts to providers. TATRC is exploring the variety of potential benefits for this care model in which patient management tasks are shared between local providers, remote experts, and intelligent algorithms operating at the edge. A common data model must be introduced at the point of care to realize these potential benefits, and is a key enabler to TATRC's Autonomous Casualty Care portfolio in our aim to modernize military medicine to meet the demands imposed by our future operating concepts.

For more information on this initiative, contact Mr. Nate Fisher at: nathan.t.fisher3.civ@health.mil.

BHSAI Works to Establish an Evidence-Based Injury Threshold for Blast-Wave Exposure

Exposure to blast-pressure waves from explosive devices poses a serious threat to Warfighter health and well-being, potentially leading to brain injury and cognitive deficits. Even a mild traumatic brain injury (mTBI) can affect an individual's physical functioning and mental health. Despite advances in our understanding of the detrimental effects of blast exposure on brain health, we still lack criteria that allow us to screen Service Members for brain injury after a blast exposure and establish procedures to ensure safe operational and training environments. To address this knowledge gap, Dr. Jaques Reifman, Director of the Biotechnology High Performance Computing Software Applications Institute (BHSAI) here at TATRC, leads an inter-disciplinary, multi-organizational effort to use experimentation, computations, and clinical data to establish, for the first time, evidence-based injury criteria for mTBI caused by blast exposure.

Dr. Reifman and the team at the Henry M. Jackson Foundation (HJF) in support of BHSAI, previously developed a unique, validated computational human-head model that predicts the human-brain response to a blast exposure. Although this computational model can accurately predict intracranial pressure (within 7%), the team could not link a Service Member's blast exposure to a brain injury diagnosis due to the lack of curated data directly associating a specific blast exposure, including the exact characteristics of the pressure wave loading the head, with the resulting clinical outcome. However, data now exist linking a well-documented blast-exposure event (the ballistic missile attack of the Al Asad Airbase in Iraq in January 2020) to the subsequent clinical diagnoses of mTBI reported by 109 Service members. In addition, in 2021, Dr. Jason Roth and his team at U.S. Army Engineer Research and Development Center (ERDC) completed a preliminary field study at Ft. Johnson, LA, to reconstruct the Al Asad Airbase attack and found that they were able to determine the pressure fields experienced by Service Members inside of their protective bunkers during the attack. Furthermore, the Joint Trauma Analysis and Prevention of Injury in Combat (JTAPIC) office at Ft. Detrick will provide clinical outcome data. Therefore, in response to the Congressionally Directed Medical Research Program's Joint Warfighter Medical Research Program, Dr. Reifman proposed a collaboration between BHSAI, HJF, ERDC, and JTAPIC to enable the development of quantitative, evidence-based guidelines for establishing injury criteria for blast exposure in humans, and his was the only project selected for funding (out of 26) in Operational Medicine and Readiness.

This Joint Warfighter project will identify blast-insult thresholds that induce mTBI in humans and develop dose-response curves linking blast exposure to brain injury using an experimental/computational approach. First, BHSAI will collaborate with ERDC to perform field studies at Ft. Johnson, LA, to reproduce the blast-pressure waves experienced by our Service Members sheltered at multiple locations inside protective bunkers during the 2020 Al Asad Airbase attack. Next, using the data from these studies, the BHSAI team will develop and validate computational models that allow them to simulate and expand the field studies in order to characterize the load to the head of bunker occupants at multiple locations inside the bunker for a range of blast-pressure exposures (see **Figure 1**). Then, using their previously developed human-head model, they will predict the mechanical responses of the human brain (e.g., pressure, stress, and strain) in response to the range of blast-pressure waves. Finally, in collaboration with JTAPIC, the BHSAI team will use de-identified medical records and diagnostic data for Service Members stationed at the Al Asad Airbase during the attack to link *actual* blast-pressure exposures to *documented* brain injuries, enabling the determination of an evidence-based lower-limit pressure threshold linked to brain injury and the development of dose-response curves that relate blast-wave exposure to the likelihood of brain injury.

During the course of the study, the BHSAI team will also assess commercial wearable pressure sensors for their ability to accurately monitor blast exposures. The identification of accurate wearable pressure sensors represents an important step in establishing the ability to monitor Service-Member exposure. When combined with the developed

Blast-Wave Exposure
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Blast-Wave Exposure *continued from page 10*

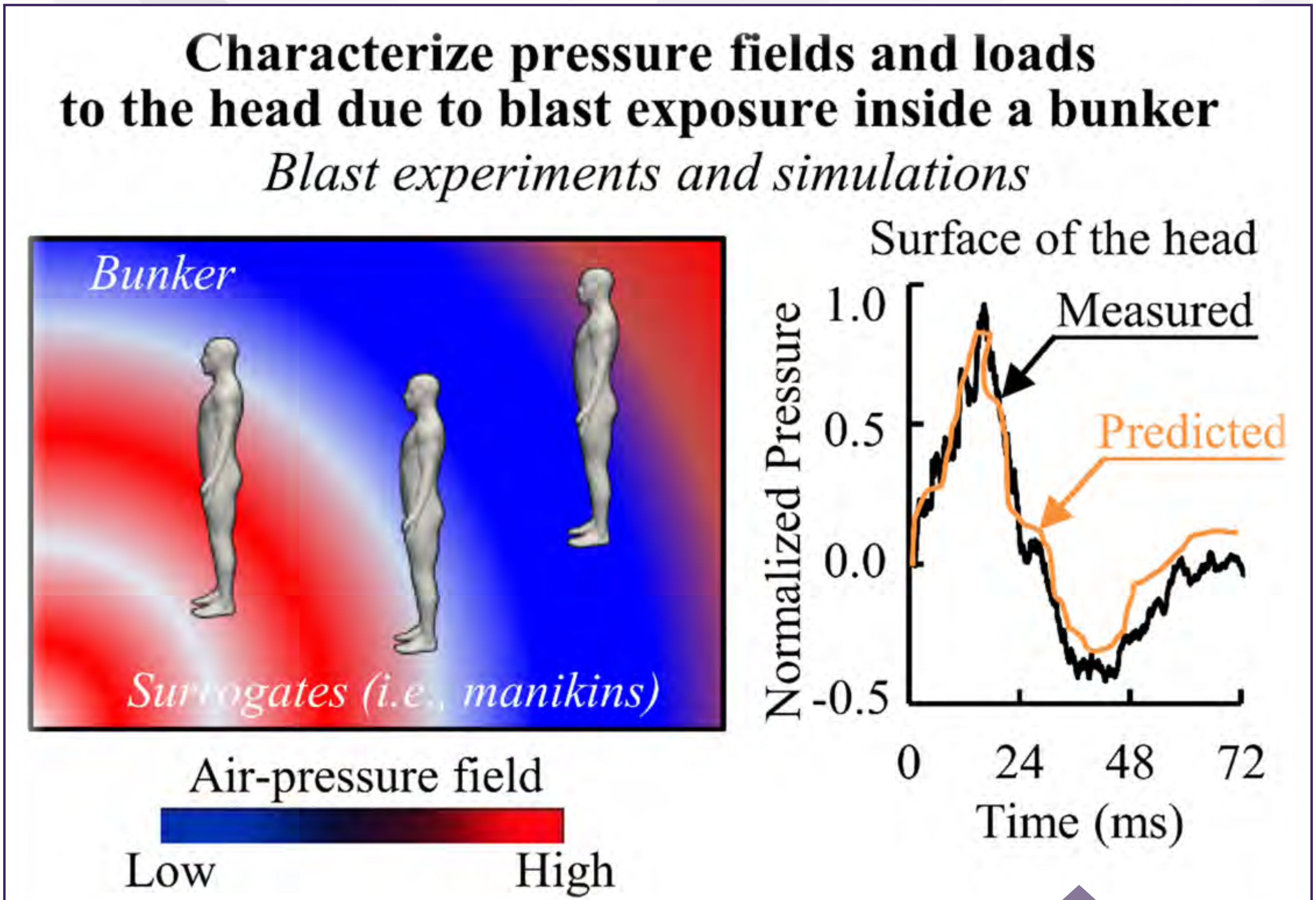

Figure 1. BHSAI's inter-disciplinary, multi-organizational effort will identify blast-insult thresholds that induce mild traumatic brain injury (mTBI) in humans and develop dose-response curves linking blast exposure to brain injury. First, the team will reproduce blast exposures equivalent to those experienced by our Service Members inside a bunker during the Al Asad Airbase attack in January 2020. Then, they will quantify the resulting blast-flow fields and load to the head, and use validated computations to extend blast insult predictions to other blast-exposure levels.

guidelines for blast exposure and dose-response curves, this will allow for real-time assessment of whether a blast exposure is likely to result in mTBI.

In the short term, this research will provide evidence-based blast-exposure pressure thresholds for mTBI and critical knowledge to inform the establishment of Force Health Protection injury criteria. In addition, this knowledge will guide the evaluation and revision, as necessary, of training and operational doctrine that defines blast exposure limits to minimize mTBI risk. In the long term, Dr. Reifman anticipates that this work will lead to the ability to screen Warfighters for brain injury in the field immediately after a blast exposure, enabling the quick evacuation of Service Members at risk for mTBI who require immediate medical care and leading to early interventions and improved clinical outcomes.

"We are excited for the opportunity to make a tangible contribution to blast research, with the potential to help enhance Force Health Protection," stated Dr. Reifman with regard to the Joint Warfighter project. This effort offers the potential to mitigate the effects of blast exposure and enhance Warfighter Brain Health, a key directive of the U.S. Department of Defense Office of Health Affairs.

For more information on this initiative, contact Dr. Jaques Reifman at: jaques.reifman.civ@health.mil.

MTEC Sponsored Prize Competition for Passive Data Collection for TATRC's AutoDoc Initiative

Last Fall, TATRC commenced a new Autonomous Casualty Care (AC2) research portfolio with an initial objective of creating an innovative, trustworthy, reliable solution to passively collect data for autonomous care, also known as AutoDoc. Determined to aid, and not distract the combat medic in high-stakes environments, TATRC intends to create a combined sensor suite capable of collecting DD Form 1380 data fields to replace the historical methods of manually collecting tactical combat casualty care (TCCC) data.

TATRC intends to create a combined sensor suite capable of collecting DD Form 1380 data fields to replace the historical methods of manually collecting tactical combat casualty care (TCCC) data.

To jump start this effort prior to receiving formal funding, TATRC has collaborated with the Medical Technology Enterprise Consortium (MTEC) in coordination with U.S. Army Medical Research Acquisition Activity (USAMRAA) to conduct a novel prize competition to ascertain combinations of commercial off-the-shelf technologies (COTS) sensors necessary for passive data collection. This government, not-for-profit collaboration was the first of its kind, as the prize funding source came from the consortium, rather than the government.

MTEC's sensor suite prize competition solicitation included requirements for three discrete assessment phases, all to be evaluated by TATRC.

• ***Phase 1*** was a Solution Brief, where proposals were evaluated based on Programmatic Relevance and Technical Merit; Personnel and Team.

• ***Phase 2*** involved a Virtual Pitch Session, including a summary of each proposed sensor suite solution and Q & A session, which was evaluated against Technical Feasibility; Scalability and Sustainability.

• ***Phase 3*** was a Live Demonstration and Assessment of the prototype sensor suite sets, which was assessed by Face Validity; Simulated Use; and Data Quality.

All the prize competition phase criteria were evaluated by MTEC and TATRC government personnel and were scaled on a 10-point Likert scale, ranging from 0 (lowest score) to 10 (highest score). Eight total submissions were assessed by MTEC and TATRC in *Phase 1*. Assessment scores for both Phase 1 criteria were totaled, and the top scoring teams (n=2) were recommended to advance to the *Phase 2* assessment. These two teams, Applied Research Associates and Ejenta, were assessed and evaluated in a similar manner against the Phase 2 criteria, and as a result, both were recommended to advance to *Phase 3*, the final stage.

Phase 3 evaluations are currently ongoing, but are scheduled to be completed by spring of 2024 in the TATRC NEXUS simulation lab. Only one prize winner will be selected by MTEC. This phase will include additional evaluation metrics based on their prototypes, including user surveys and an evaluation of the suitability, accuracy, and completeness of the data. The top scoring team within this phase will be nominated as the winners of the prize competition, and ultimately, it will be their combination of sensor suites that will be utilized to continue TATRC's overall effort of automating TCCC data collection.

The significance of this event is that this collaboration between MTEC and TATRC is the first of its kind. Offering a monetary prize from the not-for-profit consortium to commence the AC2 research portfolio efforts has provided a feasible solution to mitigate the challenges of expediting and advancing government research and development (R&D) by leveraging extramural partnerships in a more timely fashion.

For more information on this competition, please contact Ms. Jeanette Little at: jeanette.r.little.civ@health.mil.

EMPLOYEE SPOTLIGHT

TATRC Adds Data Science Expertise with New Hire!

Omar Badawi, PharmD, MPH, FCCM is the latest new hire to join TATRC, serving as the Data Scientist for the newly established Data Science section! As our Data Scientist, he will be working cross functionally to support the rest of TATRC and develop a data strategy that will improve our ability to achieve our mission of fusing Data, Humans, and Machines into trustworthy solutions that optimize medical performance and casualty outcomes.

Dr. Omar Badawi, Data Scientist, Data Sciences Area

Dr. Badawi recently led the design to launch a national system for active surveillance of medical devices for post-market safety signals at the National Evaluation System for Health Technology Coordinating Center. He has expertise in clinical product innovation by leveraging research from real world data and spent over a decade leading research for developing product-related predictive algorithms, benchmarking process and risk-adjusted outcomes, and decision support tools for tele-critical care systems. He also helped launch and manage the Philips eICU Research Institute which leveraged granular clinical data from over 6 million ICU patients to support collaborative research between industry, academia and clinicians.

Dr. Badawi is also a Section Editor in Implementation Science for PLOS Digital Health, an Adjunct Assistant Professor with the University of Maryland School of Pharmacy and Research Affiliate at the Massachusetts Institute of Technology. He earned a BS in Biological Sciences from the University of California, Irvine and a Doctor of Pharmacy degree from the University of the Pacific. After pharmacy school, he completed a PGY1 Pharmacy Practice Residency at UC Irvine Medical Center followed by a PGY2 Critical Care Residency at the Mayo Clinic in Rochester, MN. He then moved to Maryland to become a Clinical Assistant Professor at the University of Maryland School of Pharmacy where his practice site was the Cardiac ICU at the University of Maryland Medical Center. He then joined a health-tech startup (VISICU, later acquired by Philips) developing telemedicine systems for the critically ill. During that time, he earned a Master in Public Health degree with a focus in Epidemiology and Biostatistics from The Johns Hopkins Bloomberg School of Public Health and also became a Fellow of the American College of Critical Care Medicine.

He grew up in Southern California and currently lives in Baltimore County with his wife and two kids. He is a big soccer fan and played much of his life, including briefly in college. He loves to attend the FIFA World Cup whenever possible and has attended games and watched the United States play at 4 different World Cups and is very excited for the United States to once again host the World Cup in 2026, though he's disappointed Baltimore and DC did not get selected as host cities! Fun fact – although he started working around age 12 to help his parents with the deli / sandwich shop they owned, his first paying job was at Disneyland during high school and college covering summer vacations and peak season periods. He worked across the various restaurants on Main Street USA and on lucky days, he was serving frozen yogurt and baked goods at the Blue Ribbon Bakery but more often than not, he could be found bussing tables at the Carnation Restaurant!

Welcome to the team, Omar! We're delighted to have your expertise.

EMPLOYEE SPOTLIGHT

MedRAS Continues to Grow with New Software Developer & Researcher

Mr. Peter Chung joins team TATRC as a Software Developer & Researcher working within the Medical Robotics & Autonomous Systems (MedRAS) group. Mr. Chung will specifically be supporting our AutoDoc initiative which collects data from sensor suites for automating the process of filling out a tactical care combat casualty card, and Medic CDSS (Clinical Decision Support System), which provides real-time care guidelines to assist in trauma casualty assessment, management and disposition assistance.

Peter has extensive experience working as a software developer for federal agencies, such as DOJ (FBI, ATF), DOD (Army, Navy) and the Federal Reserve Board. Prior to coming to TATRC, he worked 9 years at DHS in the Customs and Border Protection agency as the lead developer supporting operations and maintenance on all in-house software systems.

Peter has lived in Montgomery County, Maryland since he was four. He received a bachelor's degree in Chemical Engineering from Carnegie Mellon University, and a master's degree in Environmental Engineering from the University of Maryland. So how did he end up doing software development despite the seemingly unrelated education? When he was younger, Peter always thought he would be working in the IT field. It helped that the analytical thinking and problem-solving skills developed during his education were applicable to IT, and thus he started down this path and has never looked back.

In his spare time, Peter enjoys being active outdoors, especially hiking and backpacking. He has backpacked in many locations across the United States and Canada, with the most notable trek being a 7-day, 93-mile circumnavigation of Mt. Rainier on just his second-ever backpacking trip! He is a usually casual, but occasionally serious runner, having run in a myriad of races from 5Ks, all the way up to marathons. Peter enjoys watching his sons play soccer and has become the videographer for his sons' teams. When not outdoors, he likes playing with the kids, watching movies and attending sporting events.

Mr. Peter Chung, Software Developer & Researcher
Medical Robotics & Autonomous Systems (MedRAS)

Team TATRC is thrilled to have this accomplished Software Developer & researcher join the team to help further our cause in automating casualty care. Welcome to the team, Peter!

New P.O. Joins our MedRAS Team

Mr. Keo Pich is the latest addition to TATRC's mighty Medical Robotics & Autonomous Systems (MedRAS) group. Keo is a seasoned professional with strong and extensive experience in project management. Originating from Cambodia, he relocated to the United States 15 years ago to pursue broader opportunities.

Keo earned his degree in Public Health with a specialization in Pre-Physical Therapy from George Mason University. During his academic tenure, he served as a Learning Assistant, providing instruction in Physics and demonstrating a commitment to education and mentorship.

Following graduation, Keo transitioned into project management, accumulating eight years of expertise across various sectors. He initiated his career in a non-profit organization dedicated to Physical Medicine and Rehabilitation research, significantly contributing to the advancement of healthcare practices.

Subsequently, Keo embraced the challenges of the technology industry by joining a Financial-software start-up. In this fast-paced environment, he demonstrated proficiency in project management and navigating the complexities of the tech sector with finesse.

Continuing his trajectory, Keo entered the realm of government medical research, solidifying his commitment to advancing medical knowledge and improving public health outcomes.

Beyond his professional endeavors, Keo is known for his diverse interests that complement his technical acumen. He takes pride in building computers, engaging in competitive gaming on 'League of Legends' and Chess, mastering the art of pulling espresso shots, maintaining an extensive knowledge of automobiles, and showcasing his culinary skills through a love for cooking.

Mr. Keo Pich, Project Officer Medical Robotics & Autonomous Systems (MedRAS)

Additionally, Keo is deeply passionate about discussing matters of faith, particularly his love for Jesus Christ. This aspect of his life adds a dimension of spiritual depth to his character, enriching his interactions with colleagues and peers.

We are so excited to have Keo as part of this dynamic team and appreciate his positive and energetic spirit! Welcome, Keo!

Pack Your Bags – TATRC Brings Aboard New Travel Coordinator!

Ms. Taylor Somers has joined team TATRC as our new Travel Coordinator & Budget Analyst. She is no stranger to government travel and has been here on base for the last 3 and ½ years as a contractor in an Executive Assistant role. Taylor has over 10 years of experience arranging travel for Government personnel in the Defense Travel System.

Taylor joined the Navy right out of high school and served four years. Her assigned rate was Air Traffic Controller, but ironically didn't do much air traffic control after graduating her A-school in Pensacola. She was assigned a role in the administrative department and

Ms. Taylor Somers, Travel Coordinator & Budget Analyst

exceled, hence her continuous years in an administrative role within the DoD. However, Air Traffic Control is still very present in her life! Her husband, Joe, just happens to be an Air Traffic Controller at the FAA Washington Air Route Traffic Center.

Taylor lives with her husband, her four-year-old son, Calum, her mother, Dawn, and her two dogs and two cats! When not coordinating the chaos, she enjoys interior design, going to wineries and breweries and spending time with friends.

TATRC warmly welcomes its newest member & Travel Coordinator, Taylor Somers!

EMPLOYEE SPOTLIGHT

MMSIV Welcomes New Human Factors Engineer to their Dynamic Team

Ms. Tiffany Quach is the latest new hire to join TATRC's Medical Modeling, Simulation, Information and Visualization (MMSIV) team! As a Human Factors Engineer, she is working in our NEXUS lab to collect data, run simulations, and provide user experience design recommendations for various projects. She has recently graduated from the George Mason University with a master's degree in psychology concentrating in Human Factors and Applied Cognition. Last summer, Tiffany presented an out brief and completed her internship with the DEVCOM C5ISR involving quarterly perception testing with Army Soldiers onsite and offsite traveling to collect user experience data as part of their perception team and second authored the Greening Course 2023 executive summary.

During her time at graduate school, Tiffany worked as a teaching assistant for Cognitive Psychology and Forensic Psychology courses. She participated in data collection for Human-AI Agent teaming dynamics using the gaming platform 'Overcooked! 2' while managing other research assistants within the HeART and ALPHAS labs. Tiffany has also competed in a 12-hour hackathon stylized competition called Usabilithon and received first place with her team sponsored by HelloFresh to redesign their onboarding and Marketplace system.

Before earning her master's, Tiffany received her bachelor's degree in biology also at George Mason University. There, she studied basic human anatomy, and biochemistry then began briefly working as a clinical technician at Mount Vernon Hospital post-graduation. During this time, Tiffany decided to pursue learning and researching more about human factors in psychology, leading her to return to school as a post-undergraduate researcher where she conducted research on social robotics, embodiment, and human computer interaction.

Tiffany is local to the DMV region and enjoys traveling and trying out new foods with friends. In her free time, she enjoys experimenting with new cooking dishes and baking sweets. She especially enjoys being an introvert playing long hours of console games and napping, however, she has recently made successful attempts to become more social by working out, joining local sewing and crafts communities, and meeting new people with similar interests.

Ms. Tiffany Quach, Human Factors Engineer, Medical Modeling, Simulation, Information and Visualization (MMSIV)

TATRC warmly welcomes its newest MMSIV member, Tiffany!

MedRAS & MMSIV Team Up at the DARPA Triage Challenge

Representatives from TATRC's Medical Modeling, Simulation, Information and Visualization (MMSIV) team along with the Medical Robotics and Autonomous Systems (MedRAS) group participated in the DARPA Triage Challenge (DTC) Kickoff Meeting in November of 2023 that took place at the Defense Advanced Research Projects Agency (DARPA) conference center in Arlington, Virginia. The TATRC team attended this kickoff event as one of the independent verification and validation (IV&V) teams supporting the challenge effort, primarily with scenario design, simulation, and data collection support.

Unmanned Aerial System (UAS) was used to collect data during a demonstration at the DARPA Triage Challenge.

The DTC is an effort for participating challenge performing teams to develop novel solutions for the identification of physiological signatures that will help medical responders perform scalable, timely, and accurate triage in both civilian and military mass casualty events. The kickoff for this effort brought together the challenge performing teams, IV&V and support staff, and DARPA leadership for a 2-day event to discuss the initial plans for execution, including scenario design, scene layout, test and evaluation processes, timelines, broader ideas, and datasets for development.

At the kickoff event, MedRAS Lead, Mr. Nathan Fisher and MMSIV Lead, Dr. Ericka Stoor-Burning, presented an overview of TATRC's scenario design, simulation strategy, and data collection plans for the first year, and a general strategy for how these aspects of the challenge will evolve over the entire DTC effort. This presentation described the initial training dataset that the TATRC team collected leading up to the kickoff event. Team members Ms. Moriah Newman, Mr. Zach Lattimore, Mr. Wesley Huff, Mr. Ethan Quist, and Ms. Alix Gondringer also represented TATRC and hosted a simulation demonstration for all attendees to interact with during the meeting. This consisted of displaying high-fidelity manikins and discussing the features that they could portray in both the training datasets and challenge events, and displaying examples of moulage or simulation props used on simulated live casualties. Additionally, TATRC also displayed example footage of the initial training dataset and the Unmanned Aerial System (UAS) used to collect the data, along with the physiological monitoring devices used to record and track the live actor ground truth vitals.

This kickoff event marks the official start of the three-year challenge effort for the performing teams which will consist of a workshop and a challenge event each year where the teams will test their prototype solutions live against predefined metrics. "While this event marks the starting line for the challenge performers, it marks a significant interim milestone for DARPA, TATRC, and the other IV&V teams," said Nathan Fisher. "The government team has worked hard to get to this point, and I think that showed at the event. It's been a privilege to be part of this dynamic and hard charging team."

The TATRC team will continue to support the DARPA and other IV&V teams throughout the DTC. If successful, this program will lead to new capabilities for rapid medical triage and assessment in complex settings, including the development of physiological signatures from standoff sensors that will help medical responders deliver timely, appropriate care and optimize resource allocation in mass casualty events. This objective is well aligned with TATRC's new mission of fusing data, humans and machines into trustworthy solutions that optimize medical performance and casualty outcomes.

A high-fidelity manikin was on display during the simulation demonstration.

For more information on the DARPA Triage Challenge, please contact Mr. Nate Fisher at: nathan.t.fisher3.civ@health.mil.

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