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14. ABSTRACT

U.S. military units are increasingly organized into smaller elements and operating in remote areas leading to longer evacuation times. This necessitates increased medical care by inexperienced clinical providers beyond doctrinal timelines, a concept coined "prolonged field care" (PFC). Early entry medical operations planning anticipate similar challenges during future engagements. Our research project proposes to use an off-the-shelf device that is capable of two-way audio/video streaming that can be used for expert medical consultation. We will develop PFC scenarios that are realistic along with a training program for novice physicians and medics to test. We will then evaluate the clinicians on what decisions were made, the timing of those decisions, their mental workload, confidence in their performance, and evaluation of the impact of their daily clinical practice on PFC performance. In this research study, we will determine if virtual critical care consultation (VC3) is beneficial in a PFC. Our research aligns with focus area 3 in which we will provide scientific knowledge on optimizing management of critically ill patients during PFC, the impact of virtual critical care consultation and how to provide it during PFC, and how to optimize tele-medical support technology.

15. SUBJECT TERMS
Trauma, simulation training, telemedicine, prehospital emergency care

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1. **INTRODUCTION:** *Narrative that briefly (one paragraph) describes the subject, purpose and scope of the research.*

The purpose of this study was to measure military caregiver performance related to critical care management in prolonged field care (PFC). We created a PFC testing platform, developed and validated simulation scenarios, and recruited subjects to measure their performance during PFC simulation scenarios both with and without support from a telementor. The telementor groups used synchronous and asynchronous communication technologies and were divided into partial and comprehensive telemedicine support to better approximate current military telemedicine capabilities supporting operational environments. Partial support uses phone and e-mail; comprehensive support uses phone, e-mail, and videoteleconferencing (VTC) during procedural telementoring (i.e. placement of tube thoracostomy).

2. **KEYWORDS:** *Provide a brief list of keywords (limit to 20 words).*

Telemedicine; Critical Care; Simulation; Technology; Virtual Health; Prolonged Field Care (PFC); Telecritical Care; Tactical Combat Casualty Care (TCCC); Telementoring

3. **ACCOMPLISHMENTS:** *The PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency grants official whenever there are significant changes in the project or its direction.*

What were the major goals of the project?

List the major goals of the project as stated in the approved SOW. If the application listed milestones/target dates for important activities or phases of the project, identify these dates and show actual completion dates or the percentage of completion.

1) Major Task 1: Identify a commercial off the shelf product that is sustainable and deployable (Complete)
2) Major Task 2: Install telemedicine workstations at collaborating sites. (Complete)
3) Major Task 3: Identify ideal, critical care clinical scenarios for testing. (Complete)
4) Major Task 4: Write PFC scenarios (Complete)
5) Major Task 5: Pilot test and validate scenarios with subject matter experts. (Complete)
6) Major Task 6: Recruit and conduct just in time training. (Complete)
7) Major Task 7: Test subject performance in PFC scenarios at MAMC & ISR. (Complete)
8) Major Task 8: Test telementor performance in PFC scenarios at MAMC during FY21. (Not Started)
9) Major Task 9: Determine transitional space for laboratory and equipment. (Complete)
10) Major Task 10: Determine director for PFC simulation lab upon transition to new location. (Complete)

What was accomplished under these goals?

For this reporting period describe: 1) major activities; 2) specific objectives; 3) significant results or key outcomes, including major findings, developments, or conclusions (both positive and negative); and/or 4) other achievements. Include a discussion of stated goals not met. Description shall include pertinent data and graphs in sufficient detail to explain any significant results achieved. A succinct description of the methodology used shall be provided. As the project progresses to completion, the emphasis in reporting in this section should shift from reporting activities to reporting accomplishments.

Major Task 1: Identify a commercial off the shelf (COTS) product that is sustainable and deployable. (Complete)

- Following further testing of COTS products on low bandwidth networks, none of the original solutions (Global Med or HoloSkype) were reliable enough for high quality research and data collection. Facetime, WhatsApp, Google Hangout, and Skype all functioned sufficiently on low bandwidth communication networks (cell signal) for this project and we chose to use a combination of Facetime and Google Hangout. We continued to pursue other first-person/heads-up-display (HUD) type technologies in year two as the augmented reality HUD technologies are evolving rapidly.

2) Major Task 2: Install telemedicine workstations at collaborating sites (Complete)

- Subtask 2.1: Laboratory Use Protocol approved locally
  - *Milestone A:* All necessary core and local protocols were approved.
- Subtask 2.2: Verification of telemedicine equipment platform and workstation connectivity.
  - MAMC & BAMC telemedicine workstations were installed and functioning.
  - *Milestone B:* We conducted ongoing connectivity tests with each scenario to ensure optimal telemedicine consults. We found that despite high bandwidth cellular signals and wi-fi connectivity, video-teleconferencing (VTC) applications will often fail (i.e. lose video signal). Without dedicated network analysis, it is difficult to determine what causes these failures, however it was a MAJOR finding. Namely, that COTS VTC solutions used by the "average" customer fail to maintain continuous video signal without interruption during all encounters. This has implications for military planning. A list of our VTC technologies are listed below.
  -

VTC Technology	Near Connection	Far Connection	Result
HoloLens	Cellular Hotspot (3G & LTE)	Cellular Connection on Smartphone or Laptop	Not functional
HoloLens	Hospital "Guest" WiFi	Cellular Connection on Smartphone or Laptop	Intermittent function
ODG R7	Cellular Hotspot (3G & LTE)	N/A	Not functional

VTC Technology	Near Connection	Far Connection	Result
HoloLens	Hospital "Guest" WiFi	Hospital "Guest" WiFi	Functional 100% (or near to)
FaceTime	Cellular Hotspot (3G & LTE)	Cellular Connection on Smartphone or Laptop	Function >90%
Google Hangouts	Cellular Hotspot (3G & LTE)	Cellular Connection on Smartphone or Laptop	Function >90%
Skype	Cellular Hotspot (3G & LTE)	Cellular Connection on Smartphone or Laptop	Function >90%

- Back-up for VTC (i.e. comprehensive telemonitoring) is first to re-start the VTC (effective >90% of the time) and then to switch the subject to partial telementoring. Voice calls (phone and/or voice over internet protocol [VOIP]) also have occasional problems with dropped calls and/or poor signal quality, but this problem is much less common than with VTC technology. We made these observations during our pilot testing. Data regarding frequency of these problems was obtained as part of subject testing.

3) Major Task 3: Identify ideal, critical care clinical scenarios for testing (Complete)

- Subtask 3.1: USAISR/MAMC develops and submits protocol to train and test subjects.
  - USAISR submitted a CORE protocol and a site-specific addendum to MRMC IRB. MAMC's RHC-P IRB deferred to MRMC IRB and a site-specific addendum for MAMC was subsequently submitted to the MRMC IRB.
  - The CORE protocol and USAISR site specific addendum were approved by the MRMC IRB on 6 June 2018.
  - The MAMC site specific addendum was approved by the MRMC IRB on 18 June 2018.
  - *Milestone C:* Is complete. A human use protocol and site-specific addendums were submitted to and approved by the MRMC IRB.

- Subtask 3.2: MAMC and USAISR will work with subject matter experts (SME) to identify appropriate number of scenarios and type of scenarios for study.
  - Four scenarios were initially identified to develop as representative of some of the most difficult challenges that could be faced by caregivers in PFC. While hemorrhage is a major cause of death on the battlefield, it is NOT in PFC; casualties must survive the initial insult to reach a PFC scenario.

- Consequently, caregivers in PFC manage the consequence of major trauma or life-threatening Disease Non-battle Injury. Some of the most difficult issues faced by caregivers in PFC are problems that they rarely experience, have only received limited exposure to during training, and are usually evacuated rapidly in recent conflicts. Some of these challenges are: non-hemorrhagic fluid resuscitation, management of sepsis/septic shock, management of organ dysfunction (pulmonary, renal, cardiac), and management of life-threatening electrolyte abnormalities. Given this context, the study team selected the following scenarios to further develop as cases that illustrate these challenges, and were likely to be *unfamiliar* to most subjects: large (40%) thermal injury, severe pneumonia with hypoxia and respiratory distress, crush injury, and closed head injury.

4) Major Task 4: Write PFC scenarios (Complete)

- Subtask 4.1: Write PFC description including situation, mission, training, execution, and data collection systems. Improve scenarios with SME.
  - The team created the overall case backgrounds and general case progression for each of the scenarios above (burns, pneumonia, crush, head injury). We quickly realized that each scenario took a tremendous amount of time to script and practice so that subjects at both sites would receive nearly identical case scenarios. The burn and pneumonia scenarios have each undergone over 200 hours of development, refinement, and practicing administering. Due to this extensive time and our desire for the two research sites to administer nearly identical scenarios, we elected to only administer the severe pneumonia case during the first year of testing. We selected the pneumonia scenario because it had the most clearly identifiable and differentiated tasks that subjects should complete thus providing more data elements for comparison between groups and it is a *medical* case, a scenario that few warfighters consider during training but equally as important to trauma in PFC. **We revisited the idea of adding additional scenarios to data collection in subsequent years, but opted to maintain homogeneity in the scenarios by only testing subjects on the ARDS scenario.**

5) Major Task 5: Pilot test and validate scenarios with subject matter experts. (Complete)

- Subtask 5.1: APTIMA will train research teams on how to use the ACLAMATE systems and data collection platform.
  - Two members of the APTIMA team visited MAMC to install software and instruct the research team on how to apply and use the ACLAMATE system in late April 2018.
- Subtask 5.2: MAMC and ISR team will travel between each other's respective site to pilot test the scenarios. Will conduct iterative improvements on the scenario testing with subject matter experts.
  - In late February 2018, the MAMC team traveled to ISR for one week for initial testing and development of Scenario 1.

- In late April 2018, the ISR team traveled to MAMC for one week of pilot testing of both scenarios.
- In June 2018, the MAMC team traveled to ISR for one week of final testing for both scenarios.
- *Milestone D:* Both teams ran through and tested the SME validated pneumonia scenario. Minor changes to scenario administration were addressed by the sites during regularly scheduled synchronization calls to ensure the scenarios ran smoothly, realistically, and remained consistent between sites.

6) Major Task 6: Recruit and Conduct just in time training (Complete)

- Fundamentals of Critical Care Support (FCCS) courses were conducted at both MAMC and BAMC sites in June 2018.
- Following the FCCS course, the ISR recruited and consented 14 individuals to participate in the study. MAMC recruited and consented 2 individuals.
- FCCS was an unsuccessful recruiting platform. Both sites worked to mitigate this problem by changing inclusion criteria for the protocols. These protocol amendments were approved by the MRMC IRB 25 March 2019. Protocol changes were needed to broaden the subject population by including physician trainees from non-surgical specialties and medics at large to better represent the majority of caregivers who provide PFC.
  - At the MAMC site, efforts were organized to recruit from Delayed Evacuation Casualty Management Course (DECM), and other Medical Sustainment Training Center (MSTC) courses in order to mimic similar "just-in-time" training as was intended from the FCCS course. In order to recruit from the DECM course, letters of support were obtained at MAMC from the 1SFG and the 7ID. These recruiting efforts allowed for a large and steady number of potential subjects to be recruited from these recurring courses.
  - Additionally, connections were made at the USAISR to recruit subjects in a similar manner.

7) Major Task 7: Test subject performance in PFC scenarios at MAMC and ISR. (Complete)

- In total, the MAMC site recruited and consented 23 subjects, 21 of which participated in simulations; 20 of these completed their full scenario and one dropped out mid-way through the simulation due to an emergency. The ISR had four subjects complete a simulation scenario.
- All 23 of the completed scenarios have been fully coded and adjudicated. Using this information, MAMC and the USAISR were able to refine the CRFs to more effectively capture the data pertinent to the simulation and primary outcomes of the study while simultaneously defining standard for running simulations and coding.
- The IRB protocol is closed to further subject enrollment. Validation testing of the Burn and TBI scenarios was completed by the study team and subject matter experts.
- A single-site protocol was submitted and approved with the MAMC IRB to allow for continued testing of an expanded subject role to include telementor performance.
  - *Milestone E:* Is Complete. The protocol is closed to subject enrollment. Validation and development were completed by the study team and subject matter experts. Development and approval of additional protocols will allow for broadened future data collection opportunities.

8) Major Task 8: Test Telementor performance in PFC scenarios at MAMC during FY21 (5%)

- IRB Protocol was reviewed and approved by MAMC IRB allowing the establishment of a Simulation Registry/Repository and the continued testing of the additional telementor focused AIMs, as well as additional scenario development validation and testing.
- **Additional research is taking place under AMTI sponsored work, Simulation Precision Enhancement Active Registry (SPEAR), in which we may continue to evaluate the performance of learners and telementors utilizing the TelePFC simulation cases.**
- **This task was unable to be completed due to COVID-19 restrictions, State and Federal, preventing the conduct of simulations and subject availability during the period of performance.**

9) Major Task 9: Determine transitional space for laboratory and equipment **(Complete)**

- **Lab space will continue to remain available at the IDES building on JBLM, as well as within the MSTC.**

10) Major Task 10: Determine Director for PFC simulation lab upon transition to new location. **(Complete)**

- **The director of the PFC simulation lab position will remain with LTC Colombo until the IDES lab space has been transitioned or closed. MSTC PFC simulation will be led by the current Director Tom Pingel and may be appointed at his discretion.**

11) Major Task 11: Statistical analysis, publications, and final report. **(Complete)**

- Enhancements were made to the escharotomy task trainer to increase fidelity and realism for users; enhancements include additional visual and tactile feedback for the learner while interacting with the trainer.
- CRFs were created and refined for compiling data collection elements, including scenario information and end-points for inter-rater reliability.
- Hexoskin data was collected for all simulations.
- A digitized database was created for coded data as a means to store both survey and coding data from all subjects.
- A COVID specific manuscript was drafted to disseminate guidance on how to Telementor or instruct patient care regarding ventilator and Acute Respiratory Distress Syndrome management, based on scripting used in the development of the TelePFC project.
- **Statistical analysis has been completed, a publication on the project results and methods has been submitted, and the final report complete and submitted with this report. Once manuscripts have been published an update will be sent with citations and copies for record retention.**

What opportunities for training and professional development has the project provided?
If the project was not intended to provide training and professional development opportunities or there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe opportunities for training and professional development provided to anyone who worked on the project or anyone who was involved in the activities supported by the project. "Training" activities are those in which individuals with advanced professional skills and experience assist others in attaining greater proficiency. Training activities may include, for example, courses or one-on-one work with a mentor. "Professional development" activities result in increased knowledge or skill in one's area of expertise and may include workshops, conferences, seminars, study groups, and individual study. Include participation in conferences, workshops, and seminars not listed under major activities.

Date	Conference	Attendees
29-30 Aug 2017	2017 Military Health System Research Symposium (MHSRS) Kissimmee, FL	Principal Investigator* Project Manager Research Coordinator
25-28 Feb 2018	Society of Critical Care Medicine's (SCCM) 47th Critical Care Congress San Antonio, TX	Principal Investigator Research Nurse
13-17 May 2018	2018 Special Operations Medical Association Scientific Assembly (SOMSA) Charlotte, NC	Principal Investigator* Research Nurse
15-20 July 2018	Human-Computer Interaction International (HCII) 20th International Conference Las Vegas, NV	Principal Investigator*
20-23 August 2018	2018 Military Health System Research Symposium (MHSRS) Kissimmee, FL	Research Nurse
26-30 January 2019	2019 International Meeting for Simulation in Healthcare San Antonio, TX	Research Nurse
19-22 August 2019	2019 Military Health System Research Symposium (MHSRS) Kissimmee, FL	Research Coordinator Medical Informatics Fellow
16-19 February 2020	Society of Critical Care Medicine's (SCCM) 49th Critical Care Congress Orlando, FL	Medical Informatics Fellow

*****Denotes presentation

Additionally, scenario development and pilot testing offered advanced medical training to 16 medics and physician trainees. Feedback from these individuals was that the scenarios and telementoring helped them grow as medical providers and better prepared them for future patient care.

How were the results disseminated to communities of interest?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe how the results were disseminated to communities of interest. Include any outreach activities that were undertaken to reach members of communities who are not usually aware of these project activities, for the purpose of enhancing public understanding and increasing interest in learning and careers in science, technology, and the humanities.

- Results have been disseminated through various updates presented during the conduct of the research project, along with the methods and results publications that have been accepted and published in peer reviewed journals.

What do you plan to do during the next reporting period to accomplish the goals?
If this is the final report, state "Nothing to Report."
Describe briefly what you plan to do during the next reporting period to accomplish the goals and objectives.

- Nothing to report following this reporting period/final report submission.

4. **IMPACT:** D*escribe distinctive contributions, major accomplishments, innovations, successes, or any change in practice or behavior that has come about as a result of the project relative to:*

What was the impact on the development of the principal discipline(s) of the project?
Describe how findings, results, techniques that were developed or extended, or other products from the project made an impact or are likely to make an impact on the base of knowledge, theory, and research in the principal disciplinary field(s) of the project. Summarize using language that an intelligent lay audience can understand (Scientific American style).

This is the first PFC simulation scenario published in the medical literature. Extended simulations in medicine are still a nascent area of research/development and require a great deal of work and success to reach the level of fidelity and utility that exists in other simulation disciplines (wargames and flight for example). This is particularly vital in the area of PFC for military medics, as much simulation development has been focused on the graduate medical education (GME), level. Publishing the simulation scenario and supplemental material for others to be able to run the sim, as well as the development method we used to create the scenario will serve as a starting point for others in the field to continue. Additionally, achieving consistency of the simulation at this level of complexity is a first step to creating automated versions of this type of simulation which will be essential for scaling the effort.

What was the impact on other disciplines?

Describe how the findings, results, or techniques that were developed or improved, or other products from the project made an impact or are likely to make an impact on other disciplines.

The project developed several tools that are likely to support military operational medical training and technology development and testing:

- Methodology for developing, validating and sharing through documentation high fidelity *military relevant* prolonged field care simulation scenarios.
- Methodology for time compressing prolonged field care scenarios so that subjects or trainees could, when appropriate/desired, complete the scenarios in less time. This included a new software application that manages simulation vs. real time.
- Methodology for standardizing groups so that it is possible to compare differences between caregiver performance with and without use of different technologies. Performance in key decisions and tasks is a surrogate marker for patient outcome.
- Low cost task trainers for tube thoracostomy, escharotomy, and tracheostomy.
- Pilot database of annotated audio, video, and "casualty" physiology that could be used for machine learning purposes.

What was the impact on technology transfer?

Describe ways in which the project made an impact, or is likely to make an impact, on commercial technology or public use, including:

- *transfer of results to entities in government or industry;*
- *instances where the research has led to the initiation of a start-up company; or*
- *adoption of new practices.*

Our team has made attempts to standardize certain video capture methods and settings during this project to create a more homogenous video and data repository but was unsuccessful in completing and securing adoption of the standards. This will continue to be an issue when attempting to piece together disparate data sets to find useful means of interpretation. Our goal through other funded work is to establish a data set that can be mined in the future and expanded to include video data and relevant technology transfer standards for Artificial Intelligence/Machine Learning/Natural Language Processing usage.

It is possible that the Dragon Skin and low-cost task trainers could be "transitioned" to industry. These tools would be beneficial for the simulation community and could be developed more fully

What was the impact on society beyond science and technology?
Describe how results from the project made an impact, or are likely to make an impact, beyond the bounds of science, engineering, and the academic world on areas such as:

- *improving public knowledge, attitudes, skills, and abilities;*
- *changing behavior, practices, decision making, policies (including regulatory policies), or social actions; or*
- *improving social, economic, civic, or environmental conditions.*

The impact of this work could lead to improvements in the efficacy and usage of scripting for procedural Telementoring. The results of this work have provided a simulation and lab space within JBLM that aided in the testing and development of Dr. Colombo and team's DISTRESS application in response to the NETCCN award during the pandemic, as well as augmented multiple training exercises using these scenarios. The awareness these efforts have brought have lead to a shift in perception with those we've interacted with by providing evidence that low bandwidth telemedicine is efficacious and of benefit to medics both at POI and the bedside.

5. CHANGES/PROBLEMS: *The PD/PI is reminded that the recipient organization is required to obtain prior written approval from the awarding agency grants official whenever there are significant changes in the project or its direction. If not previously reported in writing, provide the following additional information or state, "Nothing to Report," if applicable:*

Changes in approach and reasons for change
Describe any changes in approach during the reporting period and reasons for these changes. Remember that significant changes in objectives and scope require prior approval of the agency.

Challenges that affected approach over the project lifecycle:

- Recruitment
    - One of the biggest challenges for this study was subject recruitment. Recruitment challenges were overcome with 23 subjects completed after broadening the recruitment pool through local site relationships and protocol amendments.
    - We attempted to change our approach to recruitment and conduct of the research but were unable to begin evaluating telementors due to the problems addressed below. In response, a project was submitted and approved to establish a simulation registry so that we may continue to evaluate the simulations and aims of telementor performance elsewhere. The project has received AMTI funding and has an approved protocol at this time.
- Workload between sites
    - The distribution of workload between sites was adjusted to accommodate personnel and resource availability. The MAMC site became the primary site for recruitment and data collection.
    - Additional time was required to strengthen communication channels and team development strategies between sites.

- Staffing
    - The simulation tech position at MAMC was replaced by a research assistant who assumed the duties of the simulation technician as well as administrative duties in Year 1. Learning to program the complex scenarios for the sim manikin took longer than anticipated, but challenges were troubleshooted with the support of Laerdal and the Anderson Simulation Center.
    - Staff turnover in the fall of 2019 and the loss of the research nurse required the team invest considerable time to train to run simulation without that position. To help compensate, the team contracted with a simulation expert to provide medical expertise that other team members did not possess.
    - PI changeover between Dr. Pamplin and Dr. Colombo required additional time for Dr. Colombo to become familiar with the scenarios and train to be the primary telementor for the MAMC site.
- COVID-19
    - Delays incurred due to COVID-19 restrictions resulted in additional time being required to for Major Task 7 and 8 and a subsequent NCE. The NCE allowed for completion of Major Task 7 and initial work on Major Task 8 which laid the framework for further study.

Actual or anticipated problems or delays and actions or plans to resolve them

Describe problems or delays encountered during the reporting period and actions or plans to resolve resolve them.

Problems during this reporting period included the State and Federal restrictions that initially prevented us from conducting simulations to evaluate the Telementor performance during the PFC simulations. This was compounded by the lack of subject availability as our pool of Telementors was unavailable due to the medical demands of caring for patients during COVID-19 peak caseloads, to include the investigator team/PI.

Additional issued that affected this study over the project lifecycle:

- Telementors
    - Telementors face a large time commitment during simulations. Given the availability of medical professionals, this did result in a resource constraint. To mitigate this concern, we scheduled telementors in advance so that they were able to leave the day available for mentoring activities.
    - All telementors are different as they all have varying life experiences and may react to unexpected simulation events differently. We decided to use a restricted list of telementors and by using a core group of mentors, we increased the simulation standardization and eliminated as much variability as possible.

- Devices
    - Initial delays were experienced in acquiring both Hexoskin and Aptima devices due to manufacturing delays. All equipment was received by end of Year 1.
- Data Transfer Limitations
    - Connectivity and bandwidth issues for remote technologies caused significant issues in data transfer. To alleviate the video data transfer requirement, coding was assigned to local study team members. Site visits were also conducted to ensure inter-rater reliability between sites.
- Bandwidth and Connectivity
    - The study team experienced major limitations as a result of limited bandwidth and connectivity. To accommodate this limitation, the team developed internal protocols to step down subjects to less bandwidth intensive telementor options when needed while still maintaining scenario integrity.
    - Connectivity issues also affected devices with software that required higher bandwidth. The decision was made to remove augmented reality devices and retain only mobile video conferencing software that's easily accessible by mobile phone or tablet.
- Location
    - Location and infrastructure challenges contributed to scheduling delays at MAMC. The team gained room in the local simulation center and worked to resolve remaining network constraints. The MAMC team later gained office space at the IDES building and built a dedicated simulation room; this mitigated scheduling conflicts as the study team had dedicated exclusive of the space.

Changes that had a significant impact on expenditures

Describe changes during the reporting period that may have had a significant impact on expenditures, for example, delays in hiring staff or favorable developments that enable meeting objectives at less cost than anticipated.

It was identified in Year 1 that the original negotiated budget underestimated travel requirements necessary for developing and training seamless scenarios between sites. Funds were repurposed from personnel and equipment allocations for these increased travel costs.

Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Describe significant deviations, unexpected outcomes, or changes in approved protocols for the use or care of human subjects, vertebrate animals, biohazards, and/or select agents during the reporting period. If required, were these changes approved by the applicable institution committee (or equivalent) and reported to the agency? Also specify the applicable Institutional Review Board/Institutional Animal Care and Use Committee approval dates.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use of biohazards and/or select agents

Nothing to report.

6. PRODUCTS: *List any products resulting from the project during the reporting period. If there is nothing to report under a particular item, state "Nothing to Report."*

- **Publications, conference papers, and presentations**
  Report only the major publication(s) resulting from the work under this award.

  Journal publications. *List peer-reviewed articles or papers appearing in scientific, technical, or professional journals. Identify for each publication: Author(s); title; journal; volume: year; page numbers; status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

- 299: Telemedicine Affects Decision-Making And Cognitive Workload During A Prolonged Field Care Simulation December 2019 Critical Care Medicine 48:132. DOI: 10.1097/01.ccm.0000619552.85323.04
- Pamplin JC, Veazey SR, De Howitt J, Cohen K, Barczak S, Espinoza M, Luellen D, Ross K, Serio-Melvin M, McCarthy M, Colombo CJ. Prolonged, High-Fidelity Simulation for Study of Patient Care in Resource-Limited Medical Contexts and for Technology Comparative Effectiveness Testing. Crit Care Explor. 2021 Jul 6;3(7):e0477. doi: 10.1097/CCE.0000000000000477. PMID: 34250500; PMCID: PMC8263321.

Books or other non-periodical, one-time publications. *Report any book, monograph, dissertation, abstract, or the like published as or in a separate publication, rather than a periodical or series. Include any significant publication in the proceedings of a one-time conference or in the report of a one-time study, commission, or the like. Identify for each one-time publication: author(s); title; editor; title of collection, if applicable; bibliographic information; year; type of publication (e.g., book, thesis or dissertation); status of publication (published; accepted, awaiting publication; submitted, under review; other); acknowledgement of federal support (yes/no).*

Nothing to report.

Other publications, conference papers and presentations. *Identify any other publications, conference papers and/or presentations not reported above. Specify the status of the publication as noted above. List presentations made during the last year (international, national, local societies, military meetings, etc.). Use an asterisk (*) if presentation produced a manuscript.*

- Telemedicine Affects Decision-Making And Cognitive Workload During a Prolonged Field Care Simulation Sena Veazey, **Christopher Colombo**, Stacie Barczak, Katy Cohen, Mark Espinoza, Joanne Kunze, David Luellen, Kevin Ross, Drew Thomas, Maria Serio-Melvin, Jeremy Pamplin. Critical Care Medicine volume 48 number 1(supplement) January 2020 presented at SCCM Annual Congress Feb 2020.
- "Telementoring Guidance for COVID-19 Ventilator and Acute Respiratory Distress Syndrome Management" drafted, with plans to submit to New England Journal of Medicine for review.
- Abstract accepted fall of 2019 for presentation February 2020 at Society of Critical Care Medicine Annual Congress in Orlando. How Telemedicine Impacts Clinical Decision and Performance in Prolonged Field Care Scenarios: A Preliminary Review. Published as an abstract in a supplement to Critical Care Medicine.
- Abstract presented at 2018 Military Health Systems Research Symposium Conference. Veazey et. al., "Developing a Validated Simulation Platform for Testing Telemedicine's Impact on Clinician Performance During Prolonged Field Care".
- Abstract submitted and accepted to 2019 SOMSA. Veazey et. al, "How Telemedicine Impacts Clinical Decision and Performance in Prolonged Field Care Scenarios: A Preliminary Review".
- SimVentors showcase presented at the 2019 International Meeting on Simulation in Healthcare. Cohen et. al, "Low-cost simulator modification to support repetitive practice and performance improvement of lower extremity escharotomy".

Website(s) or other Internet site(s)
List the URL for any Internet site(s) that disseminates the results of the research activities. A short description of each site should be provided. It is not necessary to include the publications already specified above in this section.

Nothing to report.

Technologies or techniques
Identify technologies or techniques that resulted from the research activities. Describe the technologies or techniques were shared.

Techniques have been identified for development of script based telementoring for procedures in the form of a formal procedure guide such as those utilized during the project. These scripts have been disseminated to other organizations and utilized by telementors of varied backgrounds and organizational affiliations during Field Training Exercises and simulations. These techniques will continue to be evaluated and developed through funded research seeking to automate the telementor role using these scripts.

SimClock:
Initial invention disclosure of the SimClock was submitted to MRMC on February 26, 2018. The patent committee meeting was held on June 13, 2018. The committee agreed that the software is not patentable but copyrightable. Contracting company Ciconix LLC (Sena Veazey is the employee) had interest in technology transfer of this software. Woodbury LLC (David Luellen is the employee) waived copyright rights. A simulation clock application was developed in order to be able to track the condensed time used for these scenarios (15 minutes of real time equated to 1 hour of simulation time). The clock also has the ability to transition out of simulation time to allow for real time tracking during procedures. The research team relied on this clock and the ability to pause/restart according to simulation breaks to track the amount of time a subject took to reach individual decision points.

Inventions, patent applications, and/or licenses
Identify inventions, patent applications with date, and/or licenses that have resulted from the research. Submission of this information as part of an interim research performance progress report is not a substitute for any other invention reporting required under the terms and conditions of an award.

Nothing to report.

- **Other Products**

  Identify any other reportable outcomes that were developed under this project. Reportable outcomes are defined as a research result that is or relates to a product, scientific advance, or research tool that makes a meaningful contribution toward the understanding, prevention, diagnosis, prognosis, treatment and /or rehabilitation of a disease, injury or condition, or to improve the quality of life. Examples include:

  - *data or databases;*
  - *physical collections;*
  - *audio or video products;*
  - *software;*
  - *models;*
  - *educational aids or curricula;*
  - *instruments or equipment;*
  - *research material (e.g., Germplasm; cell lines, DNA probes, animal models);*
  - *clinical interventions;*
  - *new business creation; and*
  - *other.*

- Manikin/Simulation Physiology "Programming" (vitals and other relevant patient data for setup of simulated ARDS, Burn, and TBI patients).
- Procedure guides for use during a tele-mentored procedure to include, intubation, cricothyroidotomy, tube thoracostomy, and escharotomy.
- Case Report Forms for the grading and data capture of the simulations.
- CHEST TUBE TRAINER: A standalone simulated chest trainer was developed for use with both needle decompression and chest tube procedures. The trainer is a unique combination of components that allows the subject to visualize and feel for correct anatomical landmarks as well as get realistic feedback for correctly performed procedures. The chest tube trainer was developed for use with both scenarios.
- ESCHAROTOMY TRAINER: The escharotomy trainer was refined for use in scenario 1. This trainer is put in place around the leg of the manikin and provides visual and tactile feedback to the subject as the escharotomy task is performed. The design of the trainer allows the procedure to be performed "on" the manikin without risk of harm to the manikin itself.
- DRAGON SKIN for SKIN SIMULATION: Dragon Skin® is a commercially available off the shelf product that creates a fast curing silicone rubber intended for making high performance molds along with a variety of industrial applications. With the assistance of an intern at ISR, the research team developed a method of creating realistic "skin" and anatomical features such as the nipple for the chest tube trainer. By adjusting the thickness and pigment of the "skin", the research team was able to enhance the original design of the chest tube trainer and create a very realistic outer "skin" layer. This layer is thin enough that anatomical landmarks such as ribs can still be felt through it.

- SIMULATION VIDEO DATABASE: Each scenario was recorded in full from two different camera angles; one angle is that of the entire room for a comprehensive view of events and the second angle is from a chest mounted camera worn by the subject. These videos are used for coding and verification of analysis once the scenario is complete. These videos will be able to be used for future research to assist with machine learning capabilities.
- PHYSIOLOGICAL COMPONENT DATABASE: In collaboration with Aptima, the research team finalized the ACLAMATE software platform that is used to collect and store all subject physiological components recorded during simulations. These components include continuous EEG and EKG readings collected by the Aptima cap and Hexoskin shirt. The ACLAMATE software then factors these elements to produce real-time cognitive load and stress models. The software is currently fully functional as a storage and collection platform, but the ease of use and display layout is undergoing continued improvements to ensure the most user-friendly and efficient model is available to the research team.
- EXTENDED TRACK MODEL FOR PFC SIMULATION: The simulation scenarios developed by the research team are unique in that they model a full prolonged field care environment. Many simulations are only based around trainers that have a subject perform a known set task. Our scenarios include the circumstances around these tasks and most importantly, capture the decision points that the subject reaches and has to make in the care of the simulated patient.

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?

NAME	COL Jeremy Pamplin
PROJECT ROLE	Primary Investigator/Co-investigator
NEAREST PERSON MONTH WORKED	3 months. COL Pamplin transitioned to the Telemedicine and Advanced Technology Research Center during Year 3 of the award.
CONTRIBUTION TO PROJECT	Lead project, scenario development, budget management, experimental design, lead meetings, meet with subject matter experts
FUNDING SUPPORT	COL Pamplin is an active duty military officer; his salary is paid by the federal government.

NAME	Sena Veazey
PROJECT ROLE	Co-investigator
NEAREST PERSON MONTH WORKED	4 months
CONTRIBUTION TO PROJECT	Project management, experimental design of simulation, administer tasks to other investigators assist in CRADA approvals, lead meetings, write protocols, simulation role development, meet with stakeholders for recruitment and simulation experiments
FUNDING SUPPORT	Ms. Veazey was a full-time employee at the USAISR and funds were provided directly to the ISR to support her effort.

NAME	LTC Christopher Colombo
PROJECT ROLE	Co-investigator/ Primary Investigator
NEAREST PERSON MONTH WORKED	5 months. LTC Colombo became the primary investigator in year 3 of the study.
CONTRIBUTION TO PROJECT	Lead project, scenario development, budget management, experimental design, lead meetings, meet with subject matter experts
FUNDING SUPPORT	LTC Colombo is an active duty military officer; his salary is paid by the federal government.

NAME	David Luellen
PROJECT ROLE	Associate Investigator, Biomedical Software Engineer
NEAREST PERSON MONTH WORKED	5 months.
CONTRIBUTION TO PROJECT	Write security plan and work with USAISR IMD, identifying device and software integration solutions, simulation role development, assist in CRADA approvals, attends all meetings
FUNDING SUPPORT	Mr. Luellen was a full-time employee at the USAISR and funds were provided directly to the ISR to support his effort.

NAME	Maria Seriomelvin
PROJECT ROLE	Associate Investigator, Research Coordinator
NEAREST PERSON MONTH WORKED	5 months.
CONTRIBUTION TO PROJECT	Assist with project management, edit and contribute to simulation scenarios, assist with protocol creation, simulation role development, assist with recruiting and consenting of subjects
FUNDING SUPPORT	Ms. Seriomelvin was a full-time employee at USAISR and funds were provided directly to the ISR to support her effort.

NAME	Katy Cohen
PROJECT ROLE	Research Nurse
NEAREST PERSON MONTH WORKED	24
CONTRIBUTION TO PROJECT	Assist with project management, edit and contribute to simulation scenarios, assist with protocol creation, simulation role development, assist with recruiting and consenting of subjects
FUNDING SUPPORT	Ms. Cohen was a full-time employee of the Geneva Foundation, the prime awardee for this study.

NAME	Kevin Ross
PROJECT ROLE	Program Manager
NEAREST PERSON MONTH WORKED	6
CONTRIBUTION TO PROJECT	Project management at MAMC, administer tasks to other team members, facilitate meetings, engage with stakeholders for recruitment and simulation experiments.
FUNDING SUPPORT	Mr. Cohen was a full-time employee of the Geneva Foundation, the prime awardee for this study.

NAME	Drew Thomas
PROJECT ROLE	Research Coordinator
NEAREST PERSON MONTH WORKED	6
CONTRIBUTION TO PROJECT	Assist with project management at MAMC, facilitate meetings, engage with stakeholders for recruitment and simulation experiments, role player in scenario, recruiting and consenting of subjects, assist with resource procurement.
FUNDING SUPPORT	Mr. Thomas was a full-time employee of the Geneva Foundation, the prime awardee for this study.

NAME	Stacie Barczak
PROJECT ROLE	Research Coordinator
NEAREST PERSON MONTH WORKED	8
CONTRIBUTION TO PROJECT	Facilitates administrative aspects of the project (regulatory support, coordination, document preparaton, etc.) and data collection and audits
FUNDING SUPPORT	Ms. Barczak was a full-time employee of the Geneva Foundation, the prime awardee for this study.

NAME	Justin Valovich
PROJECT ROLE	Research Coordinator
NEAREST PERSON MONTH WORKED	7
CONTRIBUTION TO PROJECT	Facilitates administrative aspects of the project (regulatory support, coordination, document preparaton, etc.) and data collection and audits
FUNDING SUPPORT	Mr. Valovich was a full-time employee of the Geneva Foundation, the prime awardee for this study.

NAME	Mark Espinosa
PROJECT ROLE	Research Assistant
NEAREST PERSON MONTH WORKED	12
CONTRIBUTION TO PROJECT	Assist with project management at the USAISR, facilitate meetings, engage with stakeholders for recruitment and simulation experiments, role player in scenario, recruiting and consenting of subjects.
FUNDING SUPPORT	Mr. Espinosa was a full-time employee of the Geneva Foundation, the prime awardee for this study.

NAME	Deana Apple
PROJECT ROLE	Research Coordinator
NEAREST PERSON MONTH WORKED	4
CONTRIBUTION TO PROJECT	Assist with project, edit and contribute to case review forms, data analysis, simulation role development, assist and recruit consenting of subjects
FUNDING SUPPORT	Ms. Apple was a full-time employee of the Geneva Foundation, the prime awardee for this study.

NAME	Joanne Kunze
PROJECT ROLE	Research Assistant
NEAREST PERSON MONTH WORKED	12
CONTRIBUTION TO PROJECT	Assist with project, edit and contribute to case review forms, data analysis, simulation role development, assist and recruit consenting of subjects
FUNDING SUPPORT	Ms. Kunze was a full-time employee of the Geneva Foundation, the prime awardee for this study.

NAME	Linda Fryer
PROJECT ROLE	Simulations Research Nurse
NEAREST PERSON MONTH WORKED	2
CONTRIBUTION TO PROJECT	Provide consultation services as a research nurse during study simulations
FUNDING SUPPORT	Ms. Fryer was funded via an independent consultant agreement under this study.

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

If the active support has changed for the PD/PI(s) or senior/key personnel, then describe what the change has been. Changes may occur, for example, if a previously active grant has closed and/or if a previously pending grant is now active. Annotate this information so it is clear what has changed from the previous submission. Submission of other support information is not necessary for pending changes or for changes in the level of effort for active support reported previously. The awarding agency may require prior written approval if a change in active other support significantly impacts the effort on the project that is the subject of the project report.

Nothing to report.

What other organizations were involved as partners?
If there is nothing significant to report during this reporting period, state "Nothing to Report."

Describe partner organizations – academic institutions, other nonprofits, industrial or commercial firms, state or local governments, schools or school systems, or other organizations (foreign or domestic) – that were involved with the project. Partner organizations may have provided financial or in-kind support, supplied facilities or equipment, collaborated in the research, exchanged personnel, or otherwise contributed.

Nothing to report.

8. SPECIAL REPORTING REQUIREMENTS

COLLABORATIVE AWARDS: *N/A*

QUAD CHARTS: *N/A*

9. APPENDICES: *N/A*