AWARD NUMBER: CDMRPL-19-0-DM190355

TITLE: Virtual Reality Trauma Simulation: An Immersive Method to Enhance Medical Personnel Training and Readiness

PRINCIPAL INVESTIGATOR: MAJ Kyle Couperus MD

CONTRACTING ORGANIZATION: Madigan Army Medical Center, Tacoma, WA

REPORT DATE: April 2022

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Development Command
Fort Detrick, Maryland 21702-5012

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 07040188

1. REPORT DATE	**2. REPORT TYPE**	3. DATES COVERED
April 2022	Annual	23Mar2021-22Mar2022

4. TITLE AND SUBTITLE
Virtual Reality Trauma Simulation: An Immersive Method to Enhance Medical Personnel Training and Readiness

5a. CONTRACT NUMBER

5b. GRANT NUMBER
CDMRPL-19-0-DM190355

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
MAJ Kyle Couperus MD

E-Mail: kyle.s.couperus.mil@mail.mil

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES

Madigan Army Medical Center
9040 Jackson Ave
Tacoma, WA 98431

8. PERFORMING ORGANIZATION REPORT NUMBER
Annual Report 2022

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Medical Research and Development Command
Fort Detrick, Maryland 21702-5012

10. SPONSOR/MONITOR'S ACRONYM(S)
USAMRMC

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for Public Release; Distribution Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Annual report reviewing progress on the Déjà Vu project. This report covers work to date and reviews the current collaborators, participants, and overall accomplishments during year two. Virtual reality may offer a unique method to create training content that can operate without expensive facilities or instructors. This report describes a process to further develop, pilot, and study training content that is specifically designed to replicate a real-world environment. It also reviews a series of trauma training outcome metrics, including gaze data metrics and methods.

Please be advised, there are some potentially disturbing images (computer generated images of traumatic injuries) within this report.

Disclaimer: The views expressed are those of the author(s) and do not reflect the official policy of the Department of the Army, the Department of Defense, or the US Government.

15. SUBJECT TERMS
Virtual Reality, Emergency Medicine, Trauma Simulation

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
					USAMRDC
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**	Unclassified	28	**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified			

TABLE OF CONTENTS

1. INTRODUCTION:

Military clinicians often arrive at deployment locations only having a few days to assume full medical treatment capabilities. British medical teams assuming control of in-theater ROLE III facilities have been trained in an identical medical environment prior to their arrival. U.S. medical teams attempt this practice, but simulated training environments frequently fail to accurately and realistically recreate the range and multitude of deployable settings/scenarios in which clinicians find themselves. Immersive virtual reality (IVR) may fill this gap by providing a high-fidelity, realistic experience that enhances task performance by creating a sense of presence and thoroughly engaging spatial memory. (1,2) Immersive virtual reality (IVR) can be highly effective as a medical simulation training platform. (3-6) Recent advancements have rendered this technology increasingly portable and visually realistic. While IVR technology appears to hold promise, there is a great deal to learn about the best methods to develop, implement, and share these training resources functionally. Several groups have created models that recreate current simulation lab environments with instructor input. While these systems increase training opportunities, decrease equipment needs, and offer broad potential, they still require a skilled trainer to 'prompt the system.' Removing this limitation increases scalability and accessibility while mitigating the training resource burden. We collaboratively reviewed/guided development of, to our knowledge, the only simulator that would offer immediate autonomous feedback to users through both real-time patient physiologic responses and overall grading. We hypothesize that training individuals in identical virtual environments with autonomous interactive trauma scenarios will allow more rapid assimilation to deployed treatment environments, shorten the time to life-saving interventions, decrease the risk of psychological trauma, and help maintain medical provider readiness.

The team that submitted for this project proposed evaluating various virtual medical treatment environments, developing metrics to assess trauma resuscitation performance, and evaluating the ability of virtual reality immersion to help providers prepare to treat a patient in a new treatment environment.

1. Mania K, Badariah S, Coxon M, Watten P. Cognitive transfer of spatial awareness states from immersive virtual environments to reality. February 2010.
https://doi.org/10.1145/1670671.1670673. Accessed April 13, 2020.
2. van Hoef R, Tinga AM, Tinga AM, Louwerse MM, Louwerse MM. Presence is Key: Unlocking
Performance Benefits of Immersive Virtual Reality. :6.
3. 18. Gallagher, A. G., Seymour, N. E., Jordan-Black, J.-A., Bunting, B. P., McGlade, K., & Satava, R.
M. (2013). Prospective, Randomized Assessment of Transfer of Training (ToT) and Transfer Effectiveness Ratio (TER) of Virtual Reality Simulation Training for Laparoscopic Skill Acquisition.
Annals of Surgery, 257(6), 1025–1031. https://doi.org/10.1097/SLA.0b013e318284f658
4. Pulijala, Y., Ma, M. E., Pears, M., Peebles, D., & Ayoub, A. (2018). Effectiveness of Immersive
Virtual Reality in Surgical Training: A Randomized Control Trial. Journal of Oral and Maxillofacial

Surgery, 76(5), 1065–1072. https://doi.org/10.1016/j.joms.2017.10.002
5. Huber, T., Paschold, M., Hansen, C., Wunderling, T., Lang, H., & Kneist, W. (2017). New dimensions in surgical training: immersive virtual reality laparoscopic simulation exhilarates surgical staff. Surgical Endoscopy, 31(11), 4472–4477. https://doi.org/10.1007/s00464-017-5500-6
6. Grantcharov, T. P., Kristiansen, V. B., Bendix, J., Bardram, L., Rosenberg, J., & Funch-Jensen, P.
(2004). Randomized clinical trial of virtual reality simulation for laparoscopic skills training. The British Journal of Surgery, 91(2), 146–150. https://doi.org/10.1002/bjs.4407

2. KEYWORDS:

- Virtual Reality
- Emergency Medicine
- Military Medicine
- Medical Simulation
- Trauma Simulation

3. ACCOMPLISHMENTS:

What were the major goals of the project?

Specific Aim 1 – Create immersive 3D virtual replicase of real role 1, role 2, and medical evacuation platforms.	Timeline	Date (if relevant)	% Complete
	Months		
Task 1: Create immersive 3D virtual replica of role 1 through contractor	1-10	1/15/2021	100%
Milestone #1 Ensure role 1 3D virtual replica accuracy	10	1/20/2021	Complete
Task 2: Create immersive 3D replica of role 2 and 3 through contractor	1-12	1/20/2021	100%
Milestone # 2 Ensure role 2 and 3 3D virtual replica accuracy	12	1/30/2021	Complete
Task 3: Create immersive 3D replica of MEDEVAC platform through contractor	1-12	04/29/2021	100%
Milestone # 3 Ensure medical evacuation 3D virtual replica accuracy	1-12	05/29/2021	Complete

Specific Aim 2 – Augment current trauma simulator cases to expand treatment complexity continuing to reflect tactical combat casualty care and joint trauma system clinical practice guidelines			
Task 1: Ensure JTS CPG and TCCC guideline incorporation	1-16	08/15/2021	100%
Milestone # 1 Complete review with internal team/nurses/medics/physicians	1-16	09/15/2021	Completed
Task 2: Modular case builder through the contractor	4-16	09/30/2021	100%
Milestone # 2 Implement case builder for scenario creation	4-16	10/30/2021	Complete
Task 3: Modular equipment placement through the contractor	4-16	09/30/2021	100%
Milestone # 3 Implement modular equipment placement	4-16	10/30/2021	Complete
Task 4: Data Distribution System and Advanced Modular Manikin Integration through contract in coordination with the University of Washington	4-16	08/30/2021	100%
Milestone # 4 Implement DDS	4-16	09/30/2021	Complete
Task 5: Physiology engine integration through the contractor	4-16	10/30/2021	100%
Milestone # 5 Complete integration of additional physiology engines	4-16	10/30/2021	Complete
Specific Aim 3 – Incorporate multiplayer capability and mass casualty scenarios			
Task 1: Fully incorporate multiplayer capability and communication modules through the contractor	4-16	08/30/2021	100%
Milestone # 1 feedback testing from the end-user group on the functionality of multiplayer	4-16	10/20/2021	Complete
Task 2: Develop mass casualty scenarios leveraging physiology engine/case builder through the contractor	4-16	08/30/2021	100%
Milestone # 2 feedback testing from the end-user group on the functionality of mass casualty scenarios.	4-16	10/30/2021	Complete
Specific Aim 4 – Test individual subject and team performance in simulated trauma scenarios in the 'real' location replicated by the 'virtual' environment. for evaluation standards.			

Task 1: Complete IRB Protocol	10-18	05/28/21	100%
Milestone # 1 MAMC IRB Approval/HRPO Approval	18	01/12/2022	Complete
Task 2a: SAMMC IRB Review/concurrence	18-20		40%
Task 2b: HRPO approval for SAMMC	20-24		0%
Milestone # 2 SAMMC IRB protocol approval	24		Pending
Task 3: Madigan study implementation	18-30		20%
Milestone # 3 Madigan study completed enrollment	30		Pending
Task 4: SAMMC study implementation	24-31		0%
Milestone # 4 SAMMC study completed enrollment	31		Pending
Task 5: Data analysis, publication, and presentation	31-36		30%

What was accomplished under these goals?

Throughout this description, references are made to identified outcome products from this project thus far, these are henceforth referred to as (P1,P2,P3,etc) in the descriptions below.

Aim 1) Create immersive 3D virtual replicas of real role 1, role 2, role 3, and medical evacuation platforms at MAMC. (Complete)

- Task 1: Create an immersive 3D virtual replica of role 1 through the contractor (Complete)
    - Complete. Please see Annual Report Y1.
- Task 2: Create immersive 3D replica of role 2 and 3 through contractor (Complete)
    - Complete. Please see Annual Report Y1.
- Task 3: Create immersive 3D replica of MEDEVAC platform through contractor (Complete)
    - The updated 3D Deja Vu room and a few equipment items are created using the Leo 3D scanner for the accurate dimension and appearance to the real-world environment. The final equipment set up of Deja Vu room and Mass Casulaty environment are also completed. (Please see P10, P11 and P12)
    - The development team has created an additional medevac vehicle: Field Litter Ambulance (FLA), and it is implemented into the Trauma Simulator with the patient and medical equipment inside the FLA (P1).
    - Medivac helo platform is tested and implemented into different environments such as snow and desert in the Trauma Simulator (P8)

Aim 2) Augment current trauma simulator cases to expand treatment complexity continuing to reflect tactical combat casualty care and joint trauma system clinical practice guidelines at MAMC. (Complete)

- Task 1: Ensure JTS CPG and TCCC guideline incorporation (Complete)

    - The PI and AI completed the recording for 360 intervention lectures for TCCC breathing, airways, and hemorrhage. The 360 videos are edited and sent to developers for review. (P2)
    - All 360 intervention lectures are completed and reviewed by the developer. All the lectures follow the CPG and TCC guidelines.
    - The trauma simulator is presented to the Medical Simulation Training Center at JBLM for demonstration and testing. Feedback is received from medics and Physician Assistants.
- Task 2: Modular case builder through contractor (Complete)
    - Coding is completed to achieve the goals/backing of this wireframe design
    - An updated GUI scenario pilot is tested and reviewed by the PI (P3). Feedbacks are sent to the development team.
    - Guided scenarios for Deja Vu and Mass casualty are created and have been tested multiple times by the research team for synchronization with grading and feedback. Please see Attachment P18-[S6] and P19-[S7] for the guided scenarios.
    - New burn visualization for 1st degree, 2nd degree, and 3rd degree is created (P4)
    - New gunshot wounds visualization are created (P5)
    - The development team added more new 3D visualization for blistering and other injuries on the body (P6)
- Task 3: Modular equipment placement through contractor (Complete)
    - The subcontractor Exonicus, Inc has implemented a system to place equipment for our required environments in a modular fashion. In addition, they are integrating an equipment management system within the scenario builder to achieve this task.
    - All the equipment items are scanned for 3D objects and implemented into the Deja Vu room and Mass casualty environment. (See P10 and P11 for equipment set-up). All the equipment is tested for correct visualization and mechanical functionality by the research team and development team.
    - The portable X-ray machine is created and is implemented into the Trauma Simulator - Mass Casualty environment (P7).
    - Equipment items in the Deja Vu room are matched 100% with the real-life environment for the location.
    - The Deja Vu VR room is re-scaled to match with the real-world room to improve the realism of spatial orientation for the player. See P12 for the real-world room-scale layout and VR room-scale
- Task 4: Data Distribution System and Advanced Modular Manikin Integration (Complete)
    - Integrated xAPI framework: Learning Management System Moodle was used in the experiment. (P9)
    - The BioGears engine system has been implemented into Unity. Multiple tests are performed for the engine for correction. Ventilator codes for the pulse and Biogears engines are revised and improved. BioGears Integration Plan for Sepsis/Burn and Patient case for sepsis burn to upload as a grant product (Please see Attachment for P13-[S1] and P14-[S2]). Sepsis parameters are also integrated into the BioGears. (Please see attachment for P16-[S4])
    - The AMM connection with the Trauma Simulator was successfully completed. The Black Box was delivered to MAMC and multiple testing with the AMM black box connection has been done.

AIM 3) Incorporate multiplayer capability and mass casualty scenarios. (Complete)

- Fully incorporate multiplayer capability and communication modules through the contractor (Complete)
    - Three more live multiplayer tests have been run with transatlantic trauma team experiment from Madigan, Exonicus, Riga Technical University XR Lab, University of Latvia Faculty of Medicine, Rigas Stradins University Medical Education and Technology Center, and Military Medical Research and Education Center. In addition, the learners now have name tags for each individual within the multiplayer case/system. The users can now see each other interaction with the patient and equipment and see the procedure occur during the live.
- Developing mass casualty scenarios leveraging physiology engine/case builder through the contractor (Complete)
    - The Exonicus, Inc team also improved the patient 3D animation movement and injury visualization. Additional 3D equipment items are also in the Trauma Simulator (Product P4, P5, P6, and P7).
    - Multiple testing between the research team and development team is done for the revision and correction of the physiology engine.
    - The scenarios are tested by emergency medicine residents and physicians. feedback for improvement is received.
    - The development team created a learner orientation Wiki page that shows the layout and steps by steps to help the learners convey scenario-specific information.
        - Non-Player Character (NPC) will be added to the tutorial to help with the instruction.
    - To minimize motion sickness, a new teleportation feature is proposed by developers. The new feature allows teleportation to pre-defined spots only, instead of free teleportation.

AIM 4) Test individual subject and team performance in simulated trauma scenarios in the 'real' location replicated by the 'virtual environment, for evaluation standards at MAMC and SAMMC. (in progress)

- Task 1: Complete IRB Protocol (Complete)
    - Both Deja Vu and Mass Casualty protocols are approved. Please see Supplement P1, P2, P3, P4 for copies of approved protocols and eIRB approval letters
- Task 2a: SAMMC IRB Review/concurrence (in progress)
    - PI and research coordinator at SAMMC are currently completing the site-specific application for SAMMC IRB review for MCI protocol.
    - SAMMC Site PI is working on the "Site Specific Application" to complete the core protocol and protocol application.
- Task 3: Madigan study implementation (in progress)
    - Deja Vu simulation cases walkthrough took place on 18 APR 2022 by PI, AI, and the research staff. The team reviewed the simulation cases and revised them according to the scenario and equipment setup. (Please see P30-[S18], P31-[S19], P32-[S20], and P33-[S21] for the sim cases drafts). The researchers are working on simulation staging, including securing equipment and pre/post-simulation location. The second and final walkthrough meetings are scheduled in May. The main goals are to test out the

physiology engine with scenario builder, developed by the Exonicus, and allow the research staff to run the simulation rehearsals.

- Task 4: SAMMC study implementation
    - Pending above tasks
- Task 5: Data analysis, publication, and presentation (in progress)
    - Both Deja Vu and Mass Casualty Incident (MCI) studies are demonstrated at IMSH 2022 with TARC and Dr. Richa -Ophthalmology SME from DMMSO/DHA [Please see P25-[S13] for the pictures of MAMC team meeting with TARC representatives at IMSH]
    - Both Deja Vu and MCI abstracts are submitted to Military Health System Research Symposium 2022 and NATO Training Technology Conference 2022. Results are pending. Please see supplemental attachment P28-[S16] for MHSRS 2022 Mass Casualty Incident (MCI) Abstract and attachment P27-[S15] for MHSRS 2022 Deja Vu Abstract
    - Deja Vu and MCI studies are accepted for presentation for below conferences. Please see attachments P17-[S5] and P29-[S17] for the digital poster files.

Conference	Delivery Method	Tittle	Presenter
Government Services Symposium 2022 (GSS22) 08-10 April 2022 Orlando, Florida	Poster Presentation	Déjà vu: Virtual Reality In Situ Training in an Unfamiliar Environment and Trauma Resuscitation Performance	Dr. Nicholas Walther MD
Madigan Research Day 06 May 2022	Poster Presentation	Déjà vu: Virtual Reality In Situ Training in an Unfamiliar Environment and Trauma Resuscitation Performance	Oanh Tran - Project Manager
Madigan Research Day 06 May 2022	Poster Presentation	Development and Usability of an Instructorless Mass Casualty Incidents (MCI) Training Scenario in Virtual Reality (VR)	Dr. Marcus Voss, DO
Society for Academic Emergency Medicine (SAEM) Annual Meeting 10-13 May 2022 New Orleans, LA	Oral/Poster Presentation	Development and Usability of an Instructorless Mass Casualty Incidents (MCI) Training Scenario in Virtual Reality (VR)	Dr. Marcus Voss, DO

What opportunities for training and professional development has the project provided?

- Dr. Couperus and two research coordinators (Drew Thomas and Oanh Tran) attend IMSH 2022 and present the studies to TARC and Dr. Richa -Ophthalmology SME from DMMSO/DHA.
- Dr. Nicholas Walther submitted the abstract to Government Services Symposium 2022 and was selected for the presentation, which took place on 08-10 April 2022 in Orlando, Florida. Please see attachment P26-[S14] for the picture of Dr. Walther presented at GSS22.
- Dr. Marcus Voss submitted an abstract to Society for Academic Emergency Medicine (SAEM) Annual Meeting and was selected for an oral/poster presentation which will take place on 10-13 May 2022 in New Orleans, LA.

How were the results disseminated to communities of interest?

To date (2 years into this effort), no specific publications have been completed. Posters for Daja Vu have been presented at GSS 22 and will be presented at Madigan Research Day (MRD) in May 2022. Abstract for MCI has been accepted for presentation at SAEM 22 and MRD. We submitted MCI and Deja Vu abstracts to MHSRS 2022 and NTTC 2022.(Please see attachments P17-[S5], P27-[S15], P28-[S16], P29-[S17], P34-[S22], and P35-[S23])

Additionally, we have continuously had correspondences with the University of Washington (David Hananel, Ph.D.), the University of Vanderbilt (Dr. Ryan Walsh), Applied Research Associates (ARA, Austin Baird), among other collaborators in this field regarding the developments in this project.

What do you plan to do during the next reporting period to accomplish the goals?

The following report will complete the study subject recruitment plans and data collection preparation. The research team will also complete reviewing the physiology engine of the scenario builder during the simulation rehearsal before the data collection takes place. We aim to have the data collection occur in late June/early July. MAMC team will work with the SAMMC Site PI to complete the site MCI protocol and aim to finish by the following report. The research team will continue working with the contractors to finalize the multiplayer for MCI and Deja Vu scenario. We will also submit the Deja Vu and MCI abstracts to IMSH 2023.

4. IMPACT:

What was the impact on the development of the principal discipline(s) of the project?

This project supports developing a training system that we hypothesize will improve medical training readiness and improve the care provided to individuals injured through traumatic mechanisms (military and civilian). Extensive progress has been made on the mass casualty scenario multiplayer program and the scenario builder (P3 and P9). In addition, the Deja Vu protocol is completed and approved by Madigan IRB and ready for the study subject recruitment and data collection by the following report period (please see P21-[S9] and P22-[S10] for Deja Vu Madigan approved protocol and letter). The MCI protocol is completed and approved by Madigan IRB and is in the progress of completion and approval by SAMMC IRB as the site protocol (please see P23-[S11] and P24-[S12] for MCI Madigan approved protocol and letter). The studies have been presented at multiple local and national conferences. The studies' abstracts are also submitted to multiple national conferences, which will take place in late 2022 and early 2023. A discussion was held between the PI and Dr. Linda Sonesson from Imperial College London regarding the possible future use of the simulator in large-scale NATO exercises. We propose this will helpfully evaluate whether virtual reality can 'prepare' a medical provider for a treatment location they have never seen in real life. In addition, the findings from this study could have significant impacts on training processes in civilian and military settings crossing multiple disciplines.

What was the impact on other disciplines?

As related to the ability of virtual reality to ‘prepare’ an individual for performing life-saving tasks in that same real-world location, the findings from this project may impact training processes in the civilian and DoD sectors. Currently, our modular building system/grading system/processes have been communicated.

What was the impact on technology transfer?

The overall scenario/case design process we have leveraged to communicate with the subcontractor (Exonicus, Inc) was communicated with UWCREST and iVIR during their concurrent efforts to create industry standards and similar scenario editing tools.

Experience from this was transferred as legally able to the TRIAGE project to optimize a similar (yet quite different based on AIMs) mixed reality training system. Multiple meetings were attended, and feedback was provided regarding grading systems/processes based on lessons learned in this project.

Exonicus, Inc has expressed interest in continuing to develop these technologies beyond the study effort.

The results of this project (to-date) have been provided to the 5G Medical Steering Committee and multiple other DoD individuals to showcase capabilities/processes and to engage feedback for system optimization.

What was the impact on society beyond science and technology?

Two concurrent protocols are being developed (University of Washington, Anesthesia) and (Virginia Commonwealth University, Emergency Medicine) to leverage/evaluate the ability of this platform to help train within their respective specialties.

5. CHANGES/PROBLEMS:

Nothing to Report.

Changes in approach and reasons for change

No significant changes have occurred to date.

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

Nothing to report

Changes that had a significant impact on expenditures

Nothing to report

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

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:

- **Publications, conference papers, and presentations**

Journal publications.

Nothing to report

Books or other non-periodical, one-time publications.

Nothing to report

Other publications, conference papers and presentations.

Abstracts submitted to 2021/2022 Military Health System Research Symposium (MHSRS):
1. Couperus et. al "Mass Casualty Incident (MCI) Management In VR: Development and Usability of an Instructorless MCI Training Scenario In Virtual Reality". Please see attachment P28-[S16].
2. Couperus et. al "Déjà vu: Virtual Reality In Situ Training in an Unfamiliar Environment and Trauma Resuscitation Performance". Please see attachment P27-[S15].

Posters submitted to 2022 Madigan Research Day:
1. Couperus et. al "Mass Casualty Incident (MCI) Management In VR: Development and Usability of an Instructorless MCI Training Scenario In Virtual Reality". Please see attachment P17-[S5].
2. Couperus et. al "Déjà vu: Virtual Reality In Situ Training in an Unfamiliar Environment and Trauma Resuscitation Performance". Please see attachment P29-[S17].

Poster submitted to 2022 Government Services Symposium (GSS22) and presented by Dr. Nicholas Walther:
1. Couperus et. al "Déjà vu: Virtual Reality In Situ Training in an Unfamiliar Environment and Trauma Resuscitation Performance". Please see attachments P29-[S17] and P26-[S14].

Abstracts submitted to 2022 NTTC:
1. Couperus et. al "Mass Casualty Incident (MCI) Management In VR: Development and Usability of an Instructorless MCI Training Scenario In Virtual Reality". Please see attachment P35-[S23].
2. Couperus et. al "Déjà vu: Virtual Reality In Situ Training in an Unfamiliar Environment and Trauma Resuscitation Performance". Please see attachment P34-[S22].

Poster submitted to 2022 Society for Academic Emergency Medicine (SAEM):
1. Couperus et. al "Mass Casualty Incident (MCI) Management In VR: Development and Usability of an Instructorless MCI Training Scenario In Virtual Reality". Please see attachment P17-[S5].

Abstract submitted to 2022 International Meeting on Simulation in Healthcare (IMSH):

1. Couperus et. al “Mass Casualty Incident (MCI) Management In VR: Development and Usability of an Instructorless MCI Training Scenario In Virtual Reality". Please see attachment P20-[S8].

- **Website(s) or other Internet site(s)**

Nothing to report

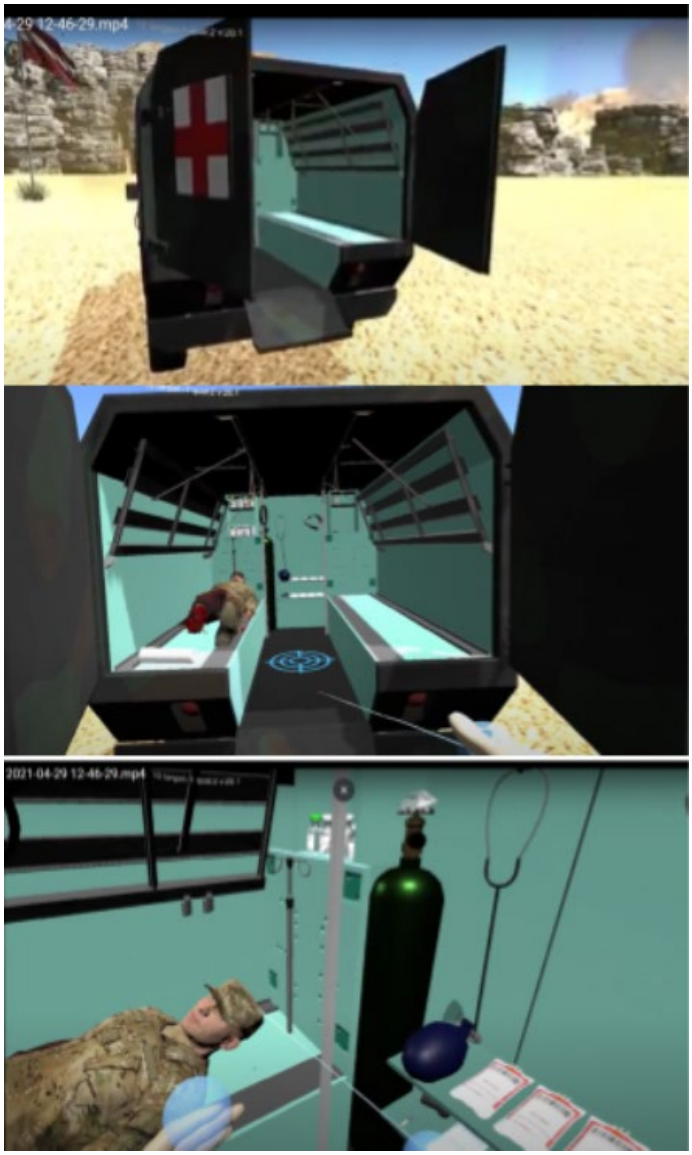
- **Technologies or techniques**

Nothing to report

- **Inventions, patent applications, and/or licenses**

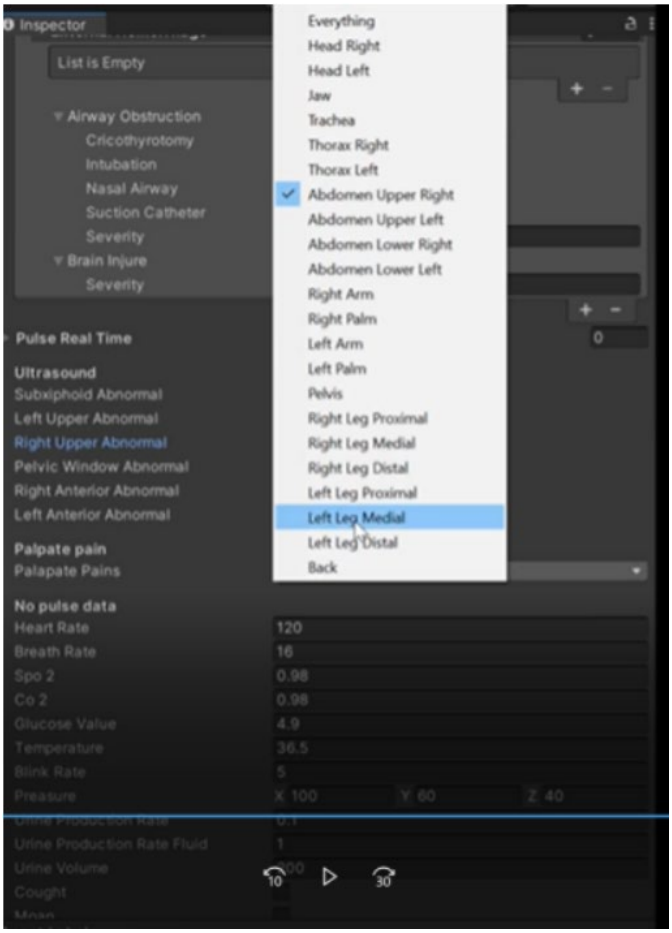
Nothing to report

- **Other Products**

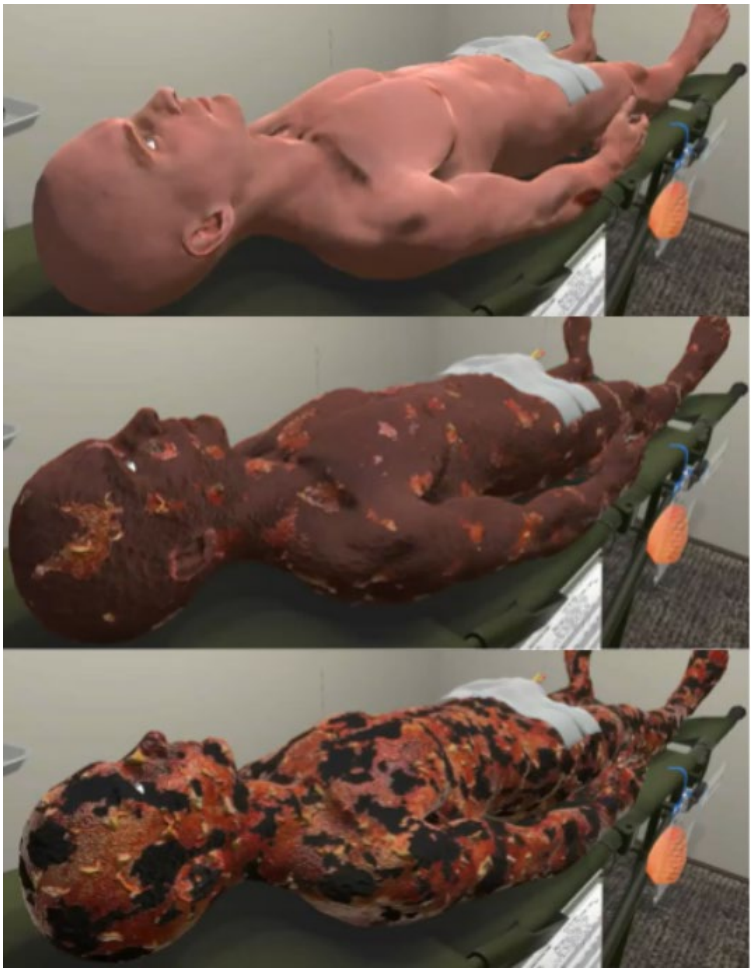


P1: MEDEVAC: FLA in a desert environment with the patient and medical equipment inside the vehicle.

P2: TCCC Airway, Breathing, and Massive Bleeding and Hemorrhage 360 lecture videos are presented by the PI and AI in the Deja Vu room setup at IDES 6100



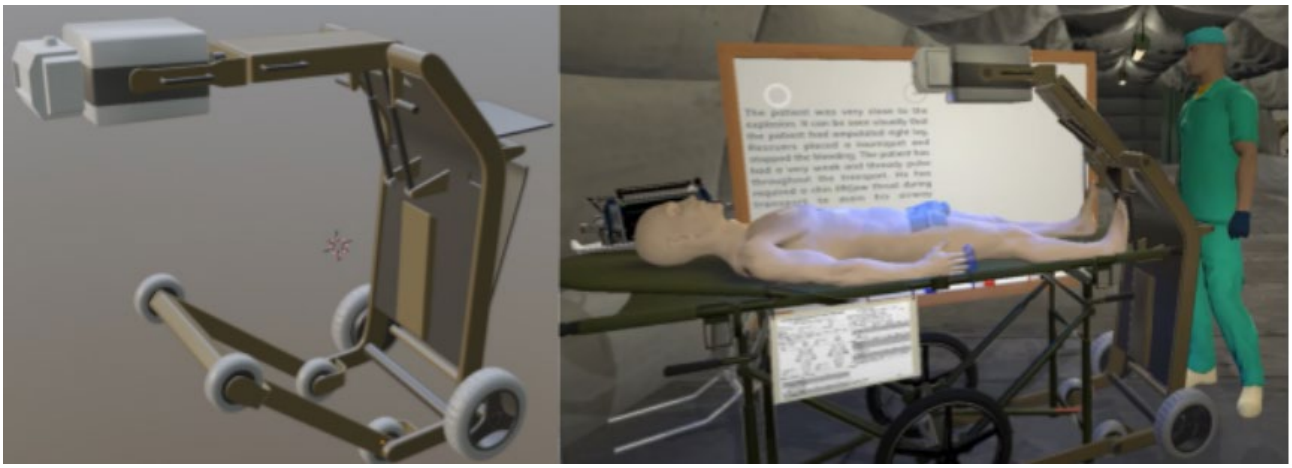
P3: Testing new GUI scenario builder pilot



P4: Burn visualization for 1st degree, 2nd degree, and 3rd degree

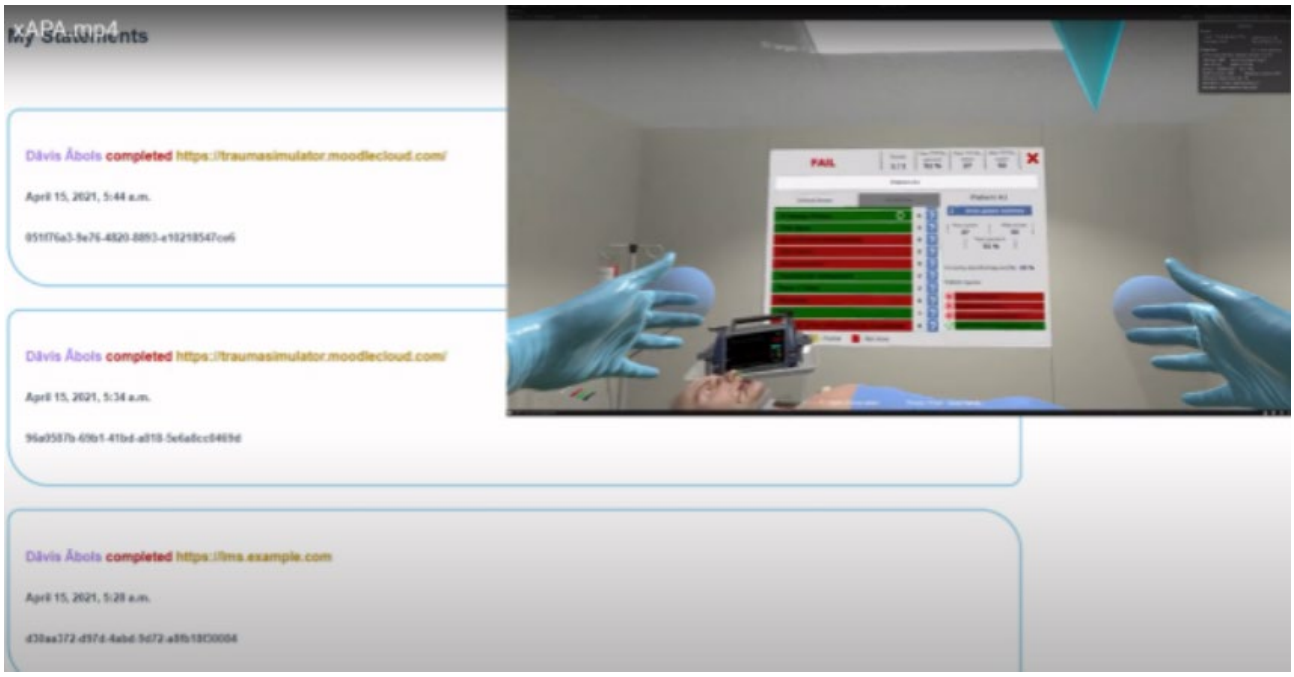
P5: Gunshot wounds visualization

P6: Visualization for blistering and other injuries on the body.



P7: Portable X-Ray and its implementation in the Mass Casualty environment.

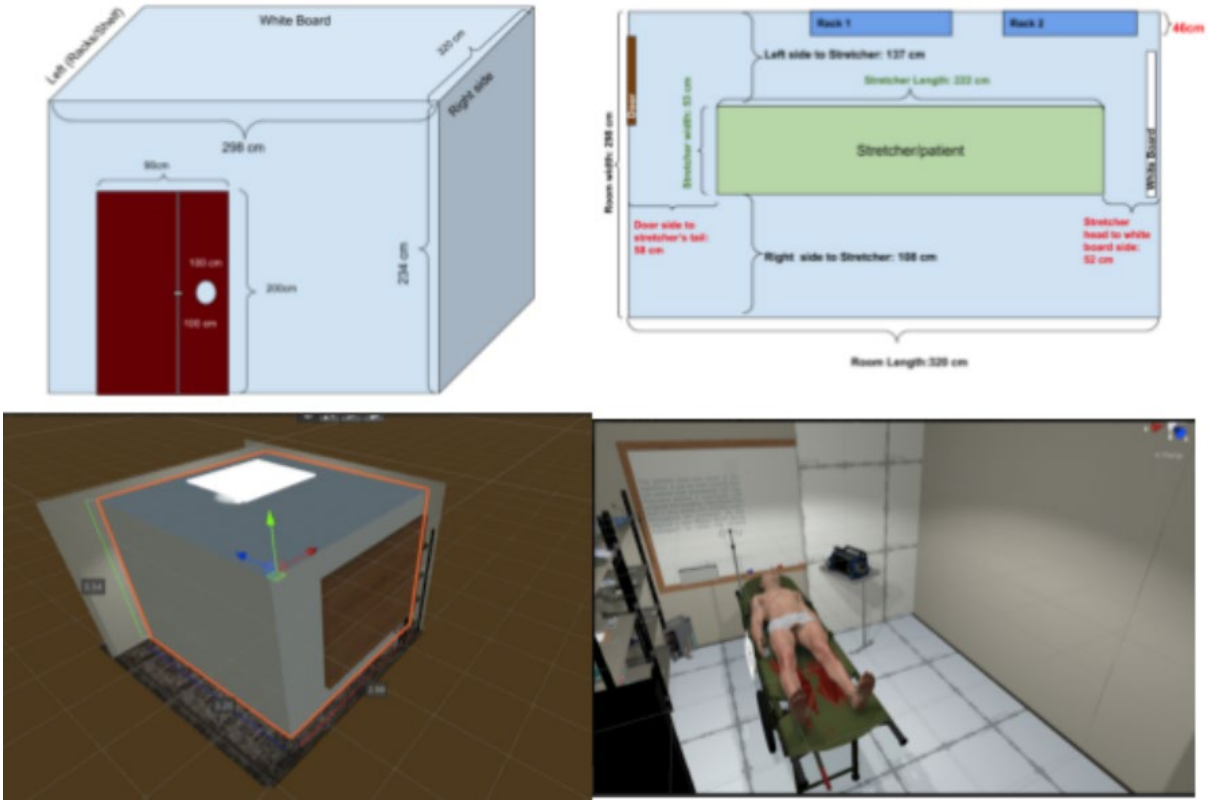
P8: Medevac helicopters in snow and desert environments.



P9: Integrated xAPI framework: Learning Management System Modle.

P10: Final setup of all types of equipment needed for the Deja Vu room. The items' positions are matched with real world environment. All the equipment are tested for correct visualization and mechanic functionality.

P11: Final equipment setup in Mass-casualty environment. All the medications are up to date and tested for visualization and functionality on the patients by the research team and development team.



P12: Deja Vu room scaling in real world and in VR are matched to improve the realism of spatial orientation/dimension.

P13: Deja Vu Sepsis and Burn Update - Please see supplement attachment [S1]
P14: Deja Vu Burns and Sepsis Patient Cases - Please see supplement attachment [S2]
P15: Trauma Simulator Basic Tutorial Document - Please see supplement attachment [S3]
P16: Sepsis Parameters BioGears Integration - Please see supplement attachment [S4]
P17: SAEM 2022 and MRD MCI Poster - Please see supplement attachment [S5]
P18: Deja Vu Guided Scenario - Please see supplement attachment [S6]
P19: Mass Casualty Guided Scenario - Please see supplement attachment [S7]
P20: Mass Casualty Abstract for International Meeting on Simulation in Healthcare 2022 - Please see supplement attachment [S8]
P21: Deja Vu Approved Protocol - Please see supplement attachment [S9]
P22: Deja Vu eIRB Approved Letter - Please see supplement attachment [S10]
P23: Mass Casualty (MCI) Approved Protocol - Please see supplement attachment [S11]
P24: Mass Casualty (MCI) eIRB Approved Letter - Please see supplement attachment [S12]
P25: CBRN Demonstration with TATRC Representatives at IMSH 2022 - Please see supplement attachment [S13]
P26: Deja Vu Poster Presentation by Dr. Walther at GSS22 - Please see supplement attachment [S14]
P27: MHSRS 2022 Deja Vu Abstract - Please see supplement attachment [S15]
P28: MHSRS 2022 Mass Casualty Incident (MCI) Abstract - Please see supplement attachment [S16]
P29: Deja Vu GSS22 and MRD Poster - Please see supplement attachment [S17]

P30: Deja Vu Hemopneumothorax Case Treatment Flowchart - Please see supplement attachment [S18]
P31: Deja Vu Hemopneumothorax Simulation Documentation - Please see supplement attachment [S19]
P32: Deja Vu IED Case Treatment Flowchart - Please see supplement attachment [S20]
P33: Deja Vu IED Case Simulation Documentation - Please see supplement attachment [S21]
P34: NTTC 2022 Deja Vu Proposal Application - Please see supplement attachment [S22]
P35: NTTC 2022 Mass Casualty Incidents (MCI) Proposal Application - Please see supplement attachment [S23]

7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

What individuals have worked on the project?

Name: Kyle Couperus, BSN, MD
Project Role: Principal Investigator
Researcher Identifier: N/A
Nearest person month worked this quarter: 0.75 (18% effort x 4 months)
Contribution to Project: Dr. Couperus continues to oversee the project's progress, development plan, contracting, IRB development, curriculum development, and overall coordination. His time contribution has been somewhat higher than initially proposed secondary to fulfilling a research coordinator contract

Name: Scott Young, DO
Project Role: Assistant Investigator
Researcher Identifier: N/A
Nearest person month worked this quarter: 0.19 (5% effort x 4 months)
Contribution to Project: Dr. Young has taken lead in developing our primary outcome metric measurement tool (Trauma Team Score) based on prior CDMRP funded efforts (Dr. Holcomb) almost 2 decades ago.

Name: Alex Koo, MD
Project Role: Assistant Investigator
Researcher Identifier: N/A
Nearest person month worked this quarter: 0.19 (5% effort x 4 months)
Contribution to Project: Dr. Koo has assisted with site selection and overall curriculum development. He is leading curriculum development for circulation and hemorrhage.

Name: Zachary Sletten, MD
Project Role: Assistant Investigator
Researcher Identifier: N/A
Nearest person month worked this quarter: 0.10 (2.5% effort x 4 months)
Contribution to Project: Dr. Sletten has assisted with standardized testing simulation case development (for pre-post testing scenarios).

Name: Chad Gorbatkin, MD

Project Role: Assistant Investigator
Researcher Identifier: N/A
Nearest person month worked this quarter: 0.10 (2.5% effort x 4 months)
Contribution to Project: Dr. Gorbatkin has assisted with overall curriculum design planning, planned study design, and site selection.

Name: Stacie Barczak
Project Role: Research Coordinator
Researcher Identifier: N/A
Nearest person month worked this quarter: 0.75
Contribution to project: Protocol drafting, eIRB entry/query resolution, scheduling, and other administrative tasks, and participation in weekly sync calls for project tracking and planning.

Name: Jonah Beck
Project Role: Research Assistant II
Researcher Identifier: N/A
Nearest person month worked this quarter: 1.00
Contribution to project: Protocol drafting, room staging, eIRB entry/query resolution, scheduling, and other administrative tasks, and participation in weekly sync calls for project tracking and planning.

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

Nothing to report

What other organizations were involved as partners?

Organization Name	The Geneva Foundation
Location of Organization	917 Pacific Ave Suite 600, Tacoma, WA 98402.
Contribution to the Project	Financial support. The Geneva Foundation provided Research Assistant II contract services.

Organization Name	Exonicus
Location of Organization	CoMotion Labs – University of Washington Fluke Hall 215 4000 Mason Rd Seattle, WA 98105
Contribution to the Project	Financial Support and in-kind support. The Exonicus engineer team worked with the research team to develop VR environments that replicate the real-world setting.

Organization Name	University of Washington
Location of Organization	1959 NE Pacific Street | Box 356410 | Seattle, WA 98195-6410

Contribution to the Project	Collaboration support. The University of Washington, Center for Research in Education and Simulation Technologies (UWCREST) work with the ARA and MAMC research team on DDS/AMM integration.

Organization Name	Applied Research Associates, Inc
Location of Organization	4300 Sam Mateo Blvd, NE, Suite A-220 Albuquerque, NM 878110
Contribution to the Project	Collaboration. ARA and UWCREST work with the MAMC research team on DDS/AMM integration.

Organization Name	Kitware, Inc
Location of Organization	1712 Route 9 Suite 300 Clifton Park, New York 12065 USA
Contribution to the Project	Collaboration support. The Kitware staff have provided guidance on physiology engine integration processes/code/systems. We appreciate their insights and involvement.

8. SPECIAL REPORTING REQUIREMENTS

COLLABORATIVE AWARDS:

QUAD CHARTS:

9. APPENDICES:

Supplements information:

- [S1] Deja Vu Sepsis and Burn Update
- [S2] Deja Vu Burns and Sepsis Patient Cases
- [S3] Trauma Simulator Basic Tutorial Document
- [S4] Sepsis Parameters BioGears Integration
- [S5] SAEM 2022 and MRD MCI Poster
- [S6] Deja Vu Guided Scenario
- [S7] Mass Casualty Guided Scenario
- [S8] Mass Casualty Abstract for International Meeting on Simulation in Healthcare 2022
- [S9] Deja Vu Approved Protocol
- [S10] Deja Vu eIRB Approved Letter
- [S11] Mass Casualty (MCI) Approved Protocol
- [S12] Mass Casualty (MCI) eIRB Approved Letter
- [S13] CBRN Demonstration with TATRC Representatives at IMSH 2022
- [S14] Deja Vu Poster Presentation by Dr. Walther at GSS22
- [S15] MHSRS 2022 Deja Vu Abstract
- [S16] MHSRS 2022 Mass Casualty Incident (MCI) Abstract
- [S17] Deja Vu GSS22 and MRD Poster
- [S18] Deja Vu Hemopneumothorax Case Treatment Flowchart
- [S19] Deja Vu Hemopneumothorax Simulation Documentation
- [S20] Deja Vu IED Case Treatment Flowchart
- [S21] Deja Vu IED Case Simulation Documentation
- [S22] NTTC 2022 Deja Vu Proposal Application
- [S23] NTTC 2022 Mass Casualty Incidents (MCI) Proposal Application