

**AWARD NUMBER:** W81XWH-20-2-0056

**TITLE:** A Proprioceptive Training Program Using an Uneven Terrain Treadmill for Patients with Ankle Instability

**PRINCIPAL INVESTIGATOR:** CDR John Fraser

**CONTRACTING ORGANIZATION:** The Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc., Bethesda, MD

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# REPORT DOCUMENTATION PAGE

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|  |  |   |  |                                   | <b>5f. WORK UNIT NUMBER</b>                     |   |
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| <b>13. SUPPLEMENTARY NOTES</b>   |  |   |  |                                   |   |   |
| <b>14. ABSTRACT</b><br>Lower limb sprains and strains are three-times more prevalent than any other acute injury in the Armed Forces, with lateral ankle sprains being the most common injury sustained during active-duty. Forty percent of individuals who experience an ankle sprain will go on to develop chronic ankle instability. Training and rehabilitation programs that incorporate proprioceptive training are particularly effective at improving outcomes and reducing re-injury rates. Proprioceptive training targets how the body receives sensory information from the environment to produce a movement. However, current techniques (Bosu balls, foam mats, etc.) do not help individuals "train to the tasks" they will encounter once they leave physical therapy and re-injury rates remain high. The proposed intervention uses a rocky uneven terrain treadmill that specifically targets aspects of the real-world environment to restore and improve short-term function and performance and reduce the long-term risk of re-injury.<br>We aim to (1) compare the effectiveness of a targeted proprioceptive and physical rehabilitation intervention against standard of care physical therapy for persons with ankle sprains and chronic ankle instability. The intervention will use a rocky uneven terrain treadmill as part of a progressive intervention for these individuals. Two groups will be studied. Seventy-eight individuals with ankle sprains and chronic ankle instability will participate. Half of individuals will receive physical therapy as normal and will be in the control group. The other half will be in the experimental group and will receive the rocky terrain treadmill intervention in addition to their normal physical therapy. The intervention involves tasks while moving on the uneven terrain such as walking with head turns, low light conditions, and walking without being able to see the ground. The intervention will be progressive and participants will perform more challenging tasks as their recovery progresses. Patient-reported outcomes, performance tests, and biomechanical measures of muscle activity and foot pressures will be investigated to compare differences between the groups. We aim to (2) identify the predictors and mediators of clinical benefits and successful outcomes in individuals who did and did not receive standard of care incorporated with the uneven terrain progressive rehabilitation program. The ability to identify individuals who have a high probability of success with the intervention can help us develop customized programs that better meet the needs of the individual patient. We aim to (3) compare long-term outcomes and re-injury rates. Participants who received the rocky terrain rehabilitation intervention will be compared to those who received the standard of care physical therapy over an 18 month period after they leave physical therapy. Patient-reported outcomes and re-injury rates will then be tracked for 18 months after discharge from physical therapy. Our study has approvals to begin data collection at two of our sites. |  |   |  |                                   |   |   |
| <b>15. SUBJECT TERMS</b><br>lateral ankle sprains, chronic ankle instability, proprioceptive rehabilitation, rocky treadmill, uneven surface, physical therapy   |  |   |  |                                   |   |   |
| <b>16. SECURITY CLASSIFICATION OF:</b>   |  |   |  | <b>17. LIMITATION OF ABSTRACT</b> | <b>18. NUMBER OF PAGES</b>                      | <b>19a. NAME OF RESPONSIBLE PERSON</b><br>USAMRDC |
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## 1. INTRODUCTION:

Lateral ankle sprains are the most ubiquitous musculoskeletal injury sustained in the military. We are limited in our ability to successfully rehabilitate Service members to a full, unlimited return to active duty after a destabilizing ankle injury. The intervention uses a novel rehabilitation strategy (a rocky terrain treadmill) that specifically targets aspects of the military training environment to restore and improve short-term function and performance and reduce the long-term risk of re-injury for retention on duty. It also has the potential to improve performance beyond even baseline levels for enhanced force readiness post-injury. We aim to (1) compare the effectiveness of a progressive rehabilitation intervention against standard of care, (2) identify predictors and mediators of clinical benefits, and (3) compare long term outcomes and re-injury rates in Service Members and Veterans with lateral ankle sprains and chronic ankle instability.

## 2. KEYWORDS:

Military personnel, ankle injuries, rehabilitation, recovery of function, secondary prevention, ankle sprain, treadmill.

## 3. ACCOMPLISHMENTS:

### What were the major goals of the project?

*Specific Aim 1. Compare the effectiveness of a targeted proprioceptive and physical rehabilitation intervention against standard of care physical therapy for destabilizing ankle injuries.*

*Specific Aim 2: Identify the predictors and mediators of clinical benefits and successful outcomes.*

*Specific Aim 3: Compare long-term outcomes and re-injury rates.*

### What was accomplished under these goals?

#### **Prepare regulatory documents and research protocol for study.**

*Milestone 1: Research and Data sharing agreements established.*

All Research and Data Sharing/Use Agreements are either approved, or awaiting submission pending IRB approval. Cooperative Research Agreements for Ft. Sam Houston were submitted following receipt of local IRB approval. CRADA and Research Agreements are not required for NMCS D or NHRC/CP. A DHA-level DSA is fully executed. Lastly, our study is registered on ClinicalTrials.gov (NCT04999904)

*Milestone 2: Approvals or deferred approvals from local IRB*

NMCS D (IRB of record) was approved 2/10/2021. NHRC and NHCP deferrals have been approved.

VAPSHCS received an exemption to the single IRB mandate and approved the study on 10/8/2020. Advarra received an exemption to the single IRB mandate and study documents were approved for HJF employees to conduct research at the VAPSHCS. FSH site specific protocol approved 1/7/2022.

*Milestone 3: Approval from HRPO*

HRPO Approvals received at the NMCS D (9/27/2021, E01628.1c), NHRC (10/5/2021, E01628.1d), and NHCP (10/7/2021, E01628.1f), FSH (02/28/2022, E01628.g).

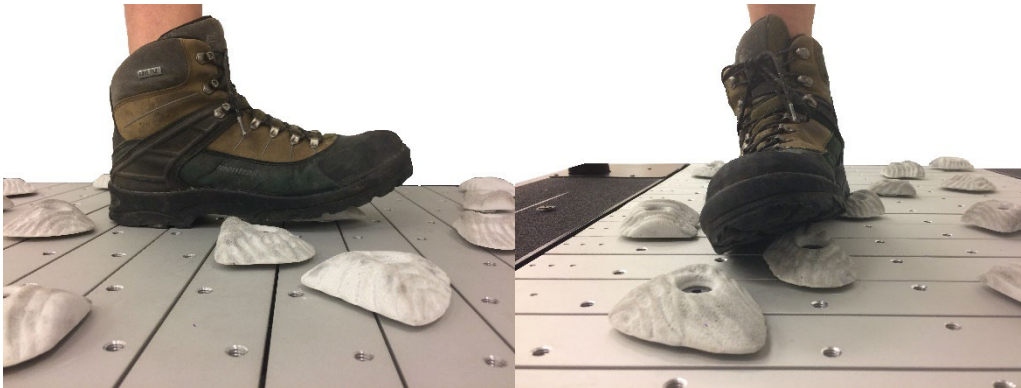
#### **Equipment purchases**

*Milestone 1: All equipment purchased in time for regulatory approval start date*

All equipment has been purchased and evaluated for data quality assurance. Rocky treadmills delivered and installed at FSH, NMCS D, and NHCP sites. MAMC Treadmill being moved to NHCP following MAMC site closure.

*Evaluation of the data processing procedures to be used by all the sites has been rigorously completed at VAPSCHS.*

*As part of this milestone we defined the rock geometry in collaboration with clinical teams. This included trialing various geometries, and densities to elicit appropriate ankle perturbations in a broad variety of footwear types.*



*Ankle perturbations during walking on the uneven treadmill.*



*Finalized rock treadmill.*

### **Hiring and training of study personnel**

#### ***Milestone 1: Research personnel hired and trained***

Positions are currently being hired for at FSH site. Trainings are prepared and will be coordinated to occur with recruitment.

### **Data analysis and quality control**

#### ***Milestone 1: Recruitment and retention procedures optimized to ensure target enrollment is met***

First subject recruited at MCSD on 11/23/2021 and at NHCP on 2/10/2022. FSH sites will begin as soon as the open PT position is filled.

#### ***Milestone 2: Target enrollment achieved***

23/312 total subjects have been enrolled as of 9/30/2022. Recruitment has proved challenging due to participant time availability and a tendency to seek care outside of the recruitment window. Process improvements to quickly identify potential participants and adjust inclusion criteria to match the population seeking care are being continually implemented and updated.

**Milestone 3: 18 month follow up data from target sample**

Follow-up progressing in initial participants. First participant has received a 9 month follow-up.

**Data Analysis & Quality Control**

**Milestone 1: Quarterly data quality checks complete with revisions made, as required.**

The study team meets biweekly to ensure quality control. Biomechanical data is processed as collected and examined for issues. A catalog of all the data collection and evaluation activities has been created for consistency across sites. Examples include low visibility (a), obscured foot placement (b), uphill/downhill carrying load, and distracted walking



(a)



(b)



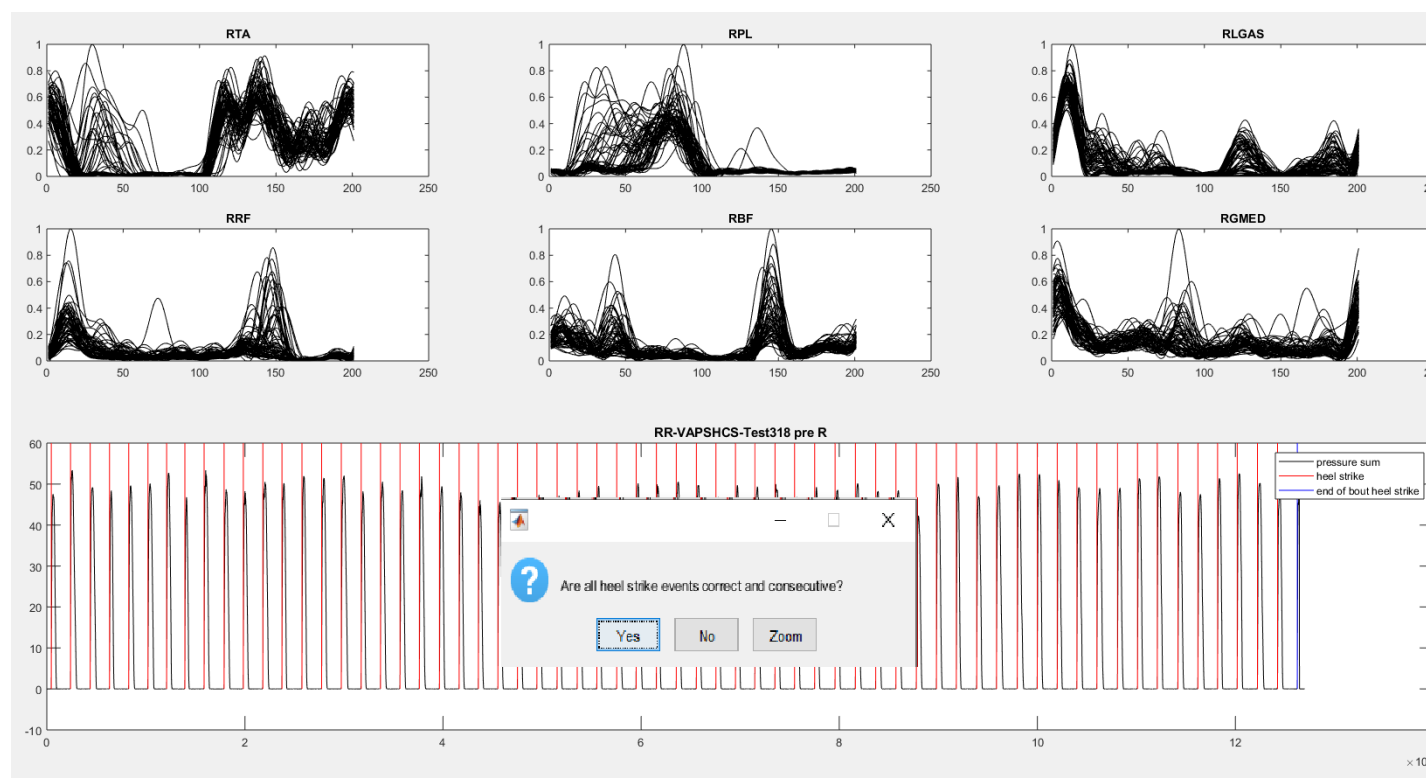
(c)



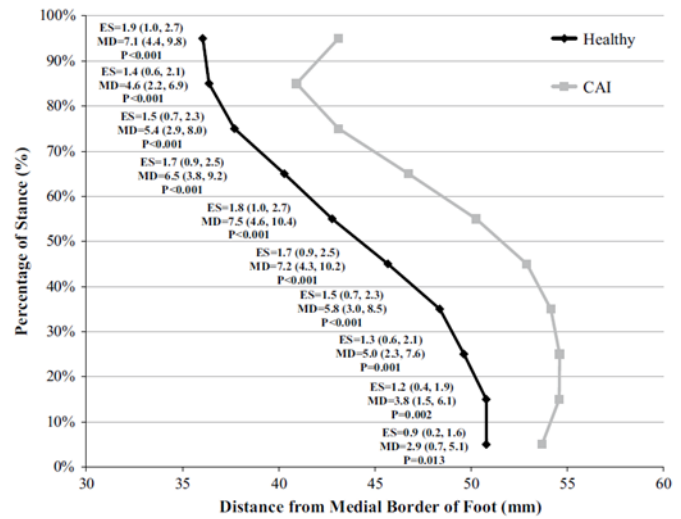
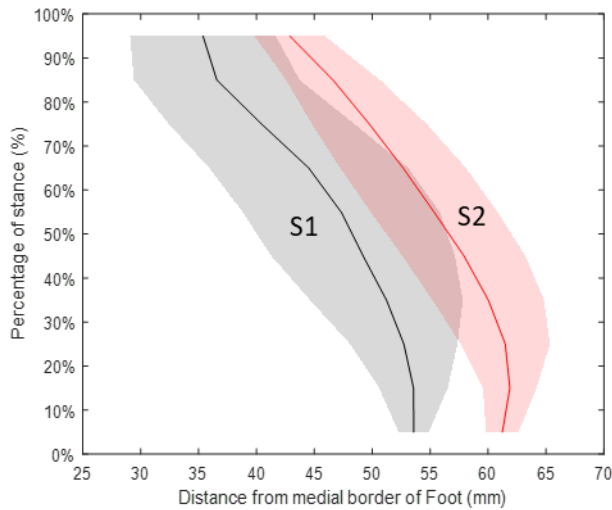
(d)

**Milestone 2: Consensus on final analysis procedures**

All outcome measures and data collection procedures have been rigorously evaluated at each site. Data analysis pipelines to process EMG and pedography data has been completed and adjusted for site specific differences in equipment to ensure uniform calculation of biomechanical outcome variables.



Custom GUI for data quality analysis.



(Left) Sample test outcome data for mediolateral center of pressure progression throughout the gait cycle compared to literature data (Right) Ref: Koldenhoven, et al. Knee Surg Sports Tramamol Arthrosc 2016.

**Milestone 3: Final dataset compiled and analyzed for Specific Aims**

Nothing to report

**Distribution of Findings**

**Milestone 1: Report and distribute results from data compilation and analyses**

Our protocol paper had been published in the Journal of Medical Internet Research and is in review by the authors. In addition, two conference presentations, highlighting the upcoming study have been presented (see results dissemination section below).

**Milestone 2: Identify follow-on studies and funding**

An AMTI-funded study will identify the dose response of this rocky treadmill intervention and evaluate the biomechanical response to walking on the rocky treadmill in different footwear. This information will make it possible to replicate the treadmill design at different facilities and discuss the study findings in the context of the magnitude of the perturbation imposed. Data collection has begun on this research study. Discussions are currently underway with the FSH team to expand this intervention to patients with TBI.

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

Nothing to report

**How were the results disseminated to communities of interest?**

Nothing to Report

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

Throughout the next reporting period, we intend to continue enrollment at our approved sites: NMCS D and NHCP. We intend to initial enrollment at FSH. The treadmill at the former MAMC site is being moved to NHCP to increase enrollment at that site. Staff at NMCS D will continue to train all study therapists at the other data collection sites. Trainings will be held as needed to maintain personnel readiness and data quality checks will be performed on an ongoing basis as data is collected. Recruitment procedures will be continue to be reviewed quarterly to ensure good retention and site collection rates.

#### 4. IMPACT:

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

Nothing to Report

##### **What was the impact on other disciplines?**

Nothing to Report

##### **What was the impact on technology transfer?**

If successful at improving rehabilitation outcomes, the rocky treadmill provides an accessible platform that could be broadly incorporated in clinical settings. This would constitute an attractive rehabilitation or training tool as the treadmill does not require specialist training to operate or maintain. Its incorporation into existing virtual reality-based rehabilitation programs is also an attractive feature that our study team is pursuing.

##### **What was the impact on society beyond science and technology?**

If successful at improving rehabilitation outcomes, the rocky treadmill will improve the physical readiness of Service men and women, and may both improve the quality of life, and reduce the cost of care in both Service Members and Veterans. Successful results open the door to applying similar practices to other Service member and civilian populations

#### 5. CHANGES/PROBLEMS:

##### **Changes in approach and reasons for change**

**Issue:** Recruitment at NMCS D and NHCP is less than the anticipated throughput. Time commitment, ability to contact potential participants, and timely identification of potential participants represent the largest challenges to recruitment.

**Resolution:** We are working to get the third site (FSH) operational and expand data collection at NHCP by repurposing MAMC's equipment. Within the currently operating sites we are working to expand patient identification and improve timely identification. Additional efforts to expand recruitment is direct referral from NMCS D ED to PT and meetings with DBC/SMO to increase awareness of research effort among branch clinic providers. We have also modified our inclusion criteria (pending approval) for time since injury to better align with the patient population being seen at NMCS D and NHCP

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

**Issue:** Identify an alternative study site to MAMC.

**Resolution:** Area 13 branch clinic at NHCP has been identified as additional site. We are in the process of transferring the MAMC equipment to support data collection.

**Issue: PT Recruitment** Identification and hiring of qualified support staff at FSH site have delayed recruitment at that site.

**Resolution:** We are continuing to post job openings and are reviewing all applicants for minimum qualifications.

**Issue:** COVID-19 presents an ongoing concern for the safety of study personnel and participants. Data collection may be delayed or limited at each site depending on implementation of local restrictions or on-site patient visits

**Resolution:** Potential mitigation strategies may include focusing study recruitment efforts on less impacted sites as conditions permit. The study team will continue to stay abreast of and follow the local guidance at each site to abide with COVID-19-relation policies. Patient throughput at each site will continue to be evaluated each quarter as the pandemic progresses.

**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.**

Russell Esposito, E, et al. “Rocky Treadmills for Proprioceptive Rehabilitation of Destabilizing Ankle Injuries: A Randomized, Controlled, Pragmatic Clinical Trial.” *Journal of Medical Internet Research*. June 11.6 2022. doi: 10.2196/38442  
Acknowledgement of federal support: Yes

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

*Nothing to Report*

**Other publications, conference papers and presentations.**

Nothing New to Report

- **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**

|                          |
|--------------------------|
| <i>Nothing to Report</i> |
|--------------------------|

## 7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS

### What individuals have worked on the project?

*Name:* CDR John Fraser  
*Project Role:* Primary Investigator  
*Researcher Identifier (e.g. ORCID ID):*  
*Nearest person month worked:* 2  
*Contribution to Project:* Dr. Fraser provided the lead project management for this project.  
*Funding Support:* US Navy

*Name:* Elizabeth Russell Esposito, PhD  
*Project Role:* Former Primary Investigator  
*Researcher Identifier (e.g. ORCID ID):*  
*Nearest person month worked:* 1  
*Contribution to Project:* Dr. Russell Esposito formerly provided the lead project management for this project.  
*Funding Support:* EACE

*Name:* Benjamin R. Shuman  
*Project Role:* Co-Investigator  
*Researcher Identifier (e.g. ORCID ID):*  
*Nearest person month worked:* 5  
*Contribution to Project:* Dr. Shuman developed the data processing pipelines, developed the rocky treadmill, completed all purchases, conducted data quality checks, and served as a scientific project manager on this award.  
*Funding Support:* Award

*Name:* Dr. Shawn Farrohki  
*Project Role:* NHMCSD Site PI  
*Researcher Identifier (e.g. ORCID ID):*  
*Nearest person month worked:* 1  
*Contribution to Project:* Site PI, IRB of record PI, clinical leader in the finalization of the progressive intervention protocol  
*Funding Support:* EACE

*Name:* LTC Carrie Hoppes  
*Project Role:* FSH Site PI  
*Researcher Identifier (e.g. ORCID ID):*  
*Nearest person month worked:* 0  
*Contribution to Project:* Site PI, initiated study start-up activities for bringing FSH on as a data collection site  
*Funding Support:* US Army

*Name:* Pinata Sessoms, PhD  
*Project Role:* NHCP Site Co-I  
*Researcher Identifier (e.g. ORCID ID):*

*Nearest person month worked:* 1  
*Contribution to Project:* Site PI on protocol; facilitated all local data quality checks and study start-up activities at NHCP.

*Funding Support:*

*Name:* Robert Smetanka  
*Project Role:* NMCS D Protocol Coordinator

*Researcher Identifier (e.g. ORCID ID):*  
*Nearest person month worked:* 2  
*Contribution to Project:* Facilitated regulatory approvals for the entire study  
*Funding Support:* Award

*Name:* Laura Bechard  
*Project Role:* NMCS D Research PT  
*Researcher Identifier (e.g. ORCID ID):*  
*Nearest person month worked:* 4  
*Contribution to Project:* Evaluated all study procedures, initiate training procedures for PTs at all other sites  
*Funding Support:* Award

*Name:* Sara Gorczynski  
*Project Role:* NMCS D Research PT  
*Researcher Identifier (e.g. ORCID ID):*  
*Nearest person month worked:* 6  
*Contribution to Project:* Conducting study procedures and data collections at NMCS D  
*Funding Support:* Award

*Name:* Brian Green  
*Project Role:* NHCP Research PT  
*Researcher Identifier (e.g. ORCID ID):*  
*Nearest person month worked:* 4  
*Contribution to Project:* Conducting study procedures and data collections at NHCP  
*Funding Support:* Award

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

Dr. Elizabeth Russell Esposito left the project and been replaced by CDR John Fraser. MAMC site has been closed and all site specific personnel (MAJ Halle, and MAJ Szymanek, Ms. Mayhew) are no longer involved.

**What other organizations were involved as partners?**

Organization Name: Veterans Affairs Puget Sound Health Care System (VAPSHCS)  
Location of Organization: Seattle, WA  
Partner's contribution to the project: Facility, Collaboration, and Personnel support.

Site provides main administration of the project, developed data analysis pipelines, and will be the main data analysis site.

Organization Name: Naval Medical Center San Diego (NMCS D)  
Location of Organization: San Diego, CA

Partner's contribution to the project: Facility, Collaboration, and Personnel support.

Data collection site. IRB of record.

Organization Name: Naval Health Camp Pendleton (NHCP)

Location of Organization: Marine Corps Base Camp Pendleton, CA

Partner's contribution to the project: Facility, Collaboration, and Personnel support.

Data collection site.

Organization Name: Fort Sam Houston (FSH)

Location of Organization: Joint Base San Antonio, Tx

Partner's contribution to the project: Facility, Collaboration, and Personnel support.

Data collection site.

Organization Name: The Henry Jackson Foundation for the Advancement of Military medicine (HJF)

Location of Organization: Bethesda, Md

Partner's contribution to the project: Collaboration, and Personnel support.

Project administration and statistical analyses.

## **8. SPECIAL REPORTING REQUIREMENTS**

**COLLABORATIVE AWARDS:**

**QUAD CHARTS:**

## **9. APPENDICES:**