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**AWARD NUMBER:** W81XWH-14-2-0012

**TITLE:** TREATMENT OF VESTIBULAR DYSFUNCTION USING A PORTABLE STIMULATOR

**PRINCIPAL INVESTIGATOR:** Jorge M. Serrador, PhD

**CONTRACTING ORGANIZATION:** Veterans Biomedical Research Institute  
East Orange, NJ 07018

**REPORT DATE:** April 2015

**TYPE OF REPORT:** Annual Report

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

**DISTRIBUTION STATEMENT:** Approved for Public Release;  
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# REPORT DOCUMENTATION PAGE

*Form Approved*  
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<b>1. REPORT DATE (DD-MM-YYYY)</b> April 2015		<b>2. REPORT TYPE</b> Annual Report		<b>3. DATES COVERED (From - To) 1</b> Apr 2014 - 31 Mar 2015	
<b>4. TITLE AND SUBTITLE</b> TREATMENT OF VESTIBULAR DYSFUNCTION USING A PORTABLE STIMULATOR				<b>5a. CONTRACT NUMBER</b>	
				<b>5b. GRANT NUMBER</b> W81XWH-14-2-0012	
				<b>5c. PROGRAM ELEMENT NUMBER</b>	
<b>6. AUTHOR(S)</b> Jorge M. Serrador, PhD Kelly Brewer, MS  email: jorge.serrador@va.gov				<b>5d. PROJECT NUMBER</b>	
				<b>5e. TASK NUMBER</b>	
				<b>5f. WORK UNIT NUMBER</b>	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> Veterans Biomedical Research Institute 385 Tremont Ave East Orange, NJ 07018				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> U.S. Army Medical Research and Materiel Command Fort Detrick, Maryland 21702-5012				<b>10. SPONSOR/MONITOR'S ACRONYM(S)</b>	
				<b>11. SPONSOR/MONITOR'S REPORT NUMBER(S)</b>	
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b> Approved for Public Release Distribution Unlimited					
<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b> As our research team has not been granted DoD HRPO approval, no subject research has taken place. Therefore, we are unable to provide any significant finding during this research period.					
<b>15. SUBJECT TERMS</b>					
<b>16. SECURITY CLASSIFICATION OF:</b> U			<b>17. LIMITATION OF ABSTRACT</b>  UU	<b>18. NUMBER OF PAGES</b>  13	<b>19a. NAME OF RESPONSIBLE PERSON</b> USAMRMC
<b>a. REPORT</b>	<b>b. ABSTRACT</b>	<b>c. THIS PAGE</b>			<b>19b. TELEPHONE NUMBER (include area code)</b>

**Standard Form 298 (Rev. 8-98)**  
Prescribed by ANSI Std. Z39.18

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## 1. INTRODUCTION

Vestibular symptoms seem to be a common problem with ~20% of veterans complaining of dizziness and those with dizziness demonstrating increased risk of Motor Vehicle Accidents. To treat veterans with vestibular dysfunction we will optimize stimulation using a portable stochastic noise electrical stimulator and determine the effectiveness of subsensory electrical stimulation in a population of veterans with verified impaired vestibular function. We will perform experimental and sham stimulation on patients with impaired function to improve clinical vestibular and balance function during testing. We will assess the effectiveness of using this portable stochastic noise electrical stimulator to improve driving performance and determine what effect subsensory electrical stimulation has on vestibular function.

## 2. KEYWORDS

None to report

## 3. ACCOMPLISHMENTS

### Major Goals of the Project

#### **Major Goal 1 - Develop a portable stimulator which can be worn continuously and used to improve vestibular function (April 2014 to June 2016)**

##### Subtask 1: Establish Project Management System/Develop Logistical Plan (April – Aug 2014)

- a. Train the current members of the team (research assistant and research engineer) on vestibular screenings, balance assessments, and electronic stimulation
- b. Research engineer will optimize equipment and write analysis scripts for aim 1

##### **Milestone #1: Establish project management system, hire and train research staff (Planned Completion Aug 2014) – Completed April 30, 2014**

##### Subtask 2: Regulatory Review and Approval Process (April – Sept, 2014)

- a. Finalize IRB paperwork including application, protocol and consent form  
**(Completed)**
- b. Submit any revisions requested by the regulatory board prior to approval  
**(Completed)**
- c. Obtaining DoD HRPO approval  
**(In Process)**

##### **Milestone #2: Regulatory review and approval obtained (Planned Completion Nov 2014) – 66% complete**

##### Subtask 3: Recruitment Plan (Sept 2014 – Jan 2015)

- a. Develop plan to meet recruitment goals **(Completed)**

- b. Mail IRB approved recruitment letters to Veterans seen at the WRIISC; follow up with phone calls
  - ~229 Veterans evaluated at the WRIISC screened positive for dizziness – 25 letters per week will be mailed to this subset followed by a phone call
- c. Distribute flyers to all VA facilities and their ambulatory services including community-based outpatient clinics to publicize the study
- d. Work with NJ VA Physical Medicine & Rehabilitation Department (TBI clinic) to recruit from their patient population
- e. Contact Veteran Service Organizations for support on best way to perform outreach

**Milestone #3: Recruitment Plan Executed (Planned Completion Jan 2015)**

**– 10% Completion**

Subtask 4: Development of Portable Stimulator (April 2014 – March 2016)

- a. PI to meet with Dr. Breen at University of Western Sydney to go over specifications for Portable Stimulator Design (**Completed**)
- b. Development of initial prototype design at University of Western Sydney (**Completed**)
- c. Production of first generation prototype portable stimulator at University of Western Sydney to be shipped to New Jersey for testing (**Completed**)
- d. Redesign of prototype unit at University of Western Sydney based on findings from experiments performed in New Jersey
- e. Production of second generation prototype vestibular stimulators at the University of Western Sydney for further testing in New Jersey
- f. Redesign of prototype unit at the at University of Western Sydney based on findings from experiments performed in New Jersey
- g. Production of third generation prototype vestibular stimulators at the at University of Western Sydney for shipping to New Jersey for further testing
- h. Redesign of third generation stimulators for fabrication of units for use in Specific Aim 2 performed at National University of Ireland Galway
- i. Fabrication of 20 units based on final design specifications at the National University of Ireland Galway
- j. Testing of initial fabricated units from the National University of Ireland Galway in New Jersey to ensure they are meeting required standards and creating desired improvement
- k. Shipment of remaining units from National University of Ireland Galway to New Jersey for use in Specific Aim 2

**Milestone #4: 20 portable stimulators received (Planned Completion March 2016)**

**– 27% Completion**

Subtask 5: Enroll subjects and conduct testing on Sub-sensory Galvanic Stimulation Study (Oct 2014 – June 2016)

- a. Screen subjects/ collect data: total of 277 subjects
  - 3 subjects per week/ 3 study visits (3 hours each)
  - Vestibular testing, balance assessments
- b. Data analysis (Post-doctoral fellow/research assistant will continually analyze data as collected)

- c. Biomedical engineer will continue to modify equipment and MATLAB analysis scripts as needed
- d. Present/publish work

**Milestone #5: Enrolled and tested subjects (Planned Completion April 2016)**

– 0% Completion

**Milestone #6: Data analysis completed (Planned Completion May 2016)**

– 0% Completion

**Milestone #7: Data presented/published (Planned Completion June 2016)**

– 0% Completion

**Major Goal 2 – To examine long term improvement of vestibular function in veterans with electrical stimulation (April 2016 to March 2017)**

Subtask 1: Examine effects of Stochastic Noise Over a 6 Week Stimulation Paradigm (April 2016 – April 2017)

- a. Screen subjects/collect data: total of 69 subjects
  - 3 unique subjects per week
  - Subjects return every 3 weeks for balance/vestibular testing
  - Subjects to wear portable stimulator over 6 week trial
- b. Data analysis
  - Analysis will be performed throughout data collection
- c. Present/publish work

**Milestone #8: Enrolled and tested subjects (Planned Completion Jan 2017)**

– 0% Completion

**Milestone #9: Data analysis completed (Planned Completion Feb 2017)**

– 0% Completion

**Milestone #10: Data presented/published (Planned Completion March 2017)**

– 0% Completion

**Major Goal 3 – To improve driving performance using Electrical Stimulation**

Subtask 1: Effect of Improving Vestibular Ocular Reflex on Driving Function (Sept 2016 to March 2018)

- a. Initial testing and safety verification previously completed on driving simulator
- b. Institutional approvals obtained
- c. Pilot motion profiles to obtain optimal motion profiles to test role of vestibular function in driving performance
- d. Engineer will write analysis scripts to measure reaction time, stopping time and trajectory, collision avoidance and emergency braking for driving simulator to measure driving performance
- e. Engineer will develop analysis system which will track acceleration of participant and eye movements to obtain vestibular ocular reflexes while performing driving task
- f. Screen subjects/collect data: total of 69 subjects
  - 3 subjects per week
  - Complete driving simulator protocol (sham and stimulator trials)
- g. Data analysis

- h. Present/publish work
- Milestone #11: Testing and safety confirmed (Planned Completion Sept 2016)**  
– 0% Completion
- Milestone #12: IRB approval obtained (Planned Completion Dec 2016)**  
– 0% Completion
- Milestone #13: Pilot testing completed (Planned Completion Feb 2017)**  
– 0% Completion
- Milestone #14: Data collection completed (Planned Completion Sept 2017)**  
– 0% Completion
- Milestone #15: Data analysis completed (Planned Completion Oct 2017)**  
– 0% Completion
- Milestone #16: Data presented/published (Planned Completion March 2018)**  
– 0% Completion

## ACCOMPLISHMENTS DURING THIS ANNUAL PERIOD

### Major Activities

#### Regulatory Review and Approval Process

- a. Completed the user manual for new optimized stimulator as requested by DoD HRPO and sent it as requested
- b. Obtained IRB approval from the VA which included all the final changes requested by the DoD.
- c. Submitted all necessary documents to HRPO for approval. Awaiting approval.

**Milestone #2: Regulatory review and approval obtained (Planned Completion Date Nov 28, 2014) – 66% complete**

#### Development of Portable Stimulator

- a. Went to University of Western Sydney to work with Dr. Breen on desktop prototype. Designed improved desktop version with improved stimulation characteristics.
- b. Produced several copies of the first generation desktop prototype in NJ for testing on Veterans once HRPO approval is received.
- c. Dr. Breen is working on portable version of desktop stimualtor.

**Milestone #4: 20 portable stimulators received (Planned Completion March 2016) – 27% Completion**

### Specific Objectives for Year 1

- 1) Hire research engineer and research assistant
- 2) Train staff on vestibular screenings, balance assessments, and electrical stimulation
- 3) Research engineer will optimize equipment and develop improved analysis scripts for laboratory based stimulator

- 4) Obtain IRB approval at the VA NJ
- 5) Obtain DoD HRPO approval to allow initiation of research
- 6) Form a recruitment plan to meet subject recruitment goals
- 7) Initiation of subject recruitment for data collection and analysis
- 8) Develop initial prototype of stimulator
- 9) Redesign of portable stimulator based on experimental findings

### **Significant Results of Year 1**

- 1) Research engineer and research assistant were hired
- 2) Staff was trained on vestibular screenings, balance assessments, and electrical stimulation
- 3) Research engineer developed new scripts to improve analysis for laboratory based stimulator
- 4) Approval by VA IRB was obtained on July 22, 2014
- 5) Submitted VA IRB approved documents to DoD HRPO on Oct 7, 2014. Notified by HRPO Program Officer that our review has been delayed awaiting expert advice on Feb 12, 2015.
- 6) A recruitment plan was developed to meet monthly and weekly recruitment goals
- 7) Subject recruitment has not been initiated due to pending approval from DoD HRPO
- 8) An initial prototype of the stimulator has been produced
- 9) No efforts for portable stimulator redesign have begun given the delay in experimental initiation

### **Major Findings, Developments, Conclusions, and Other Achievements**

- Nothing to Report

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

This project has provided training for all research staff to be competent at vestibular screenings, balance assessments, and electronic stimulation procedures. The post-doctoral fellow has been able to travel to Dr. Schubert's clinic at Johns Hopkins to be trained on most up to date vestibular testing techniques. Biomedical engineer has been able to develop improved stimulator prototype under guidance of Dr. Breen.

### **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?**

- 1) Obtain HRPO approval to allow initiation of recruitment



- 2) Initiate contact with potential participants and perform phone screenings
- 3) Enroll subjects and conduct research testing and analysis
- 4) Redesign of prototype unit in University of Western Sydney based on findings from experiments performed in New Jersey
- 5) Examine effects of stochastic noise over a 6 week stimulation paradigm

#### **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?**

- Nothing to Report

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

- Nothing to Report

#### **5. CHANGES/PROBLEMS**

- Nothing to Report

**Changes in approach and reasons for change**

- Nothing to Report

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

- We were unable to start recruitment due to delays in the IRB and HRPO process. We have continued to stay in touch with the HRPO office to ensure we are able to start recruitment as soon as HRPO approval is given.
- We have trained all staff and ensure all equipment is ready so that as soon as HRPO approval is given, we will begin recruitment and start bringing in Veterans for testing to

meet our goals. We have been working on optimizing recruitment plans and scheduling so that we can increase our ability to test a greater number of subjects per week to make up for the late start in testing.

**Changes that had a significant impact on expenditures**

- There were no changes in expenditures.

**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**

- No changes to use of care of human subjects to report
- Approval by VA IRB was obtained on July 22, 2014
- Submitted VA IRB approved documents to DoD HRPO on Oct 7, 2014. Notified by HRPO Program Officer that our review has been delayed awaiting expert advice on Feb 12, 2015.

**Significant changes in use or care of vertebrate animals.**

- No animal use research will be performed to complete the Statement of Work

**Significant changes in use of biohazards and/or select agents**

- No biohazards and/or select agents will be used to complete the Statement of Work

**6. PRODUCTS**

**Publications, conference papers, and presentations**

- Nothing to Report

**Journal publications.**

- Nothing to Report

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

- Nothing to Report

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

- Nothing 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**

- Nothing to Report

**7. PARTICIPANTS & OTHER COLLABORATING ORGANIZATIONS**

**What individuals have worked on the project?**

Name: Jorge Serrador, PhD  
Project Role: PI  
Nearest person month worked: 2.5  
Contribution to Project: no change

Name: Apollonia Fox, PhD  
Project Role: Postdoctoral Fellow  
Nearest person month worked: 1.5  
Contribution to project: No change

Name: Mosadoluwa Obatusin, MEng  
Project Role: Research Assistant  
Nearest person month worked: 3  
Contribution to Project: no change

Name: Bishoy Samy, MS  
Project Role: Research Engineer  
Nearest person month worked: 3  
Contribution to Project: no change

**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?**

1. Organization Name: University of Western Sydney- Paul Breen, PhD

Location of Organization: Australia

Partner's contribution to the project:

- Financial support – Nothing to report
- In-kind support – Dr. Breen's salary is covered by UWS as detailed in original proposal.
- Facilities – Nothing to report
- Collaboration – Designed a novel low power stochastic noise stimulator that will be used to improve vestibular function in our patients
- Personnel exchanges – Nothing to report
- Other – Nothing to report

2. Organization Name: National University of Ireland Galway- Gearóid Ó Laighin, PhD

Location of Organization: Ireland

Partner's contribution to the project:

- Financial support – Nothing to report
- In-kind support – Prof. Ó Laighin's salary is covered by NUIG as detailed in original proposal.
- Facilities – Nothing to report
- Collaboration – Assist Paul Breen in the design of a novel low power stochastic noise stimulator
- Personnel exchanges – Nothing to report
- Other – Nothing to report

3. Organization Name: Azusa Pacific University- Scott Wood, PhD

Location of Organization: California

Partner's contribution to the project:

- Financial support – Nothing to report
- In-kind support – Nothing to report
- Facilities – Nothing to report
- Collaboration – Provided expertise in scientific protocol development specifically with regards to driving performance assessment

- Personnel exchanges – Nothing to report
- Other – Nothing to report

## **8. SPECIAL REPORTING REQUIREMENTS**

- None

## **9. APPENDICES: None.**