

AWARD NUMBER: W81XWH-17-2-0046

TITLE: POrtable WARrior Test Of Tactical AgiLity: POWAR-TOTAL

PRINCIPAL INVESTIGATOR: Karen L. McCulloch

CONTRACTING ORGANIZATION: University of North Carolina at Chapel Hill
CB 7135 Bondurant Hall 3024 UNC Chapel Hill,
Chapel Hill, NC 27599-7135

REPORT DATE: October 2020

TYPE OF REPORT: Annual

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

DISTRIBUTION STATEMENT: Approved for Public Release;
Distribution Unlimited

The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE October 2020		2. REPORT TYPE Annual		3. DATES COVERED 15 Sept 2019 - 14 Sept 2020	
4. TITLE AND SUBTITLE POrtable WARrior Test Of Tactical AgiLity: POWAR-TOTAL				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER W81XWH-17-2-0046	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Karen McCulloch (PI), Amy Cecchini (Project manager) E-Mail: kmac@med.unc.edu				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Karen McCulloch University of North Carolina at Chapel Hill CB 7135 Bondurant Hall 321 S Columbia Street Chapel Hill NC 27599-7135				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Medical Research and Materiel Command Fort Detrick, Maryland 21702-5012				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release, distribution unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT The goals of this project are to establish project infrastructure and regulatory approvals, compare POWAR-TOTAL performance in healthy controls (n=60) to those with concussion (n=100) recruiting from Fort Bragg and Madigan Army Medical Center (MAMC), and examine how POWAR-TOTAL scores change with rehabilitation recovery for those with concussion. We had inordinate delays in regulatory approval at both sites, beginning data collection at Fort Bragg in May of 2018, with the MAMC approval in November of 2018. As of September 2020 we have collected data on 60/60 healthy control participants and 75/100 individuals with mTBI using the POWAR-TOTAL, (50 pre- post-test). We have completed all infrastructure tasks (procedures, personnel, equipment, training, database establishment, FITBIR, ongoing regulatory approvals). We are requesting an additional no cost extension for the Geneva subcontract to allow us to continue to work on publications and dissemination of project information given					
15. SUBJECT TERMS mTBI, concussion, return to duty					
16. SECURITY CLASSIFICATION OF: U			17. LIMITATION OF ABSTRACT Unclassified	18. NUMBER OF PAGES 24	19a. NAME OF RESPONSIBLE PERSON USAMRMC
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (include area code)

Table of Contents

	<u>Page</u>
1. Introduction.....	2
2. Keywords.....	2
3. Accomplishments.....	2
4. Impact.....	7
5. Changes/Problems.....	7
6. Products, Inventions, Patent Applications, and/or Licenses.	8
7. Participants & Other Collaborating Organizations	10
8. Special Reporting Requirements.....	15
9. Appendices	18

1. INTRODUCTION:

This project plans to translate components of the Assessment of Military Multitask Performance (AMMP) to a clinic-ready test providing real-time feedback about high-level mobility and dual task performance with the use of smartphone based sensor technology. Similar tasks from the AMMP project empirically demonstrated that service members with persistent symptoms after mTBI have movement characteristics that are not clearly discernible to the naked eye but that differ from healthy active duty service members. Expensive laboratory equipment and analyses were used in the AMMP proof-of-concept project to document these subtle movement differences. This project combines the most sensitive elements of two AMMP tasks in a clinical test that is time efficient, uses inexpensive wearable sensors, is more clinically feasible, and that will have the ability to provide immediate performance feedback to the clinician. This dual-task assessment is innovative as it is the first and currently only military post-concussion standardized, externally valid multi-domain functional assessment that is time, space, and cost efficient for clinic use. The data collection and analysis is innovative, as data collection will be done via smartphone and immediately following collection, uploaded to a computer that uses healthy control data to compare performance. Data are analyzed using vector analysis to provide the clinician with quick results regarding a SMs mobility during simulated tactical maneuvers. These additional data points for evaluating abilities are clearly related to functional demands associated with warfighting and can aid the clinician in verifying that a SM is not only symptom-free but duty ready.

2. KEYWORDS:

Mild traumatic brain injury, mTBI, concussion, military, vestibular, functional assessment, return to duty, movement analysis, dual-task

3. ACCOMPLISHMENTS:

+ What were the major goals of the project?

	Project month	Percent completed
Major Task 1: Establish infrastructure, procedures		
Coordinate with Sites for CRADA submission	1-3	100%
Refine eligibility criteria, exclusion criteria, screening protocol	1-3	100%
Finalize consent form & human subjects protocol	1-3	100%
Coordinate with Sites for IRB protocol submission, ISC-FB first, UNC to rely on WAMC. Obtain ORP/HRPO review for ISC-FB.	1-3	100%

Pilot test with 3-5 healthy controls and 2-3 patients with concussion to confirm planned methods are appropriate.	4-5	100%
Coordinate activities for healthy control recruitment with DVBIC Education Outreach coordinator.	3-6	100%
Initiate MAMC IRB approval process, obtain ORP HRPO approval	3-5	100%*
<i>Milestone: IRB and HRPO approval at all sites.</i>	1-6	100%
Submit amendments, adverse events and protocol deviations	PRN	ongoing
Coordinate annual IRB report for continuing review	annually	ongoing
Create manual of procedures, finalize instruments for use in study, build RedCap database.	1-3	100%
Clarify return to duty indicators in common use across sites, and indicators unique to ISC-FB or MAMC.	2-4	100%
Coordinate with Sites for job descriptions design	1-2	100%
Advertise and interview for project related staff (Ft Bragg hire first, then MAMC hire once IRB is in process there)	3-6	100%
Coordinate for space allocation, credentialing, and training necessary to obtain access to MTF and patients.	1-6	100%
RedCap database ready for use by project staff	4-6	100%
Conduct training with ISC-FB RA, revise training procedures and manual as necessary.	4-6	100%
Conduct training with MAMC RA (RA to travel to ISC-FB)	5-7	100%
Coordinate with Sites for flow chart for all study steps, web data collection and database requirements	4-7	100%
<i>Milestone Achieved: Research staff trained</i>	4-8	100%
Major Task 2: Compare POWAR-TOTAL scores between cohorts; examine change in performance after intervention		
Subtask 1: Data collection initiated at both sites (ISC-FB first, followed by MAMC).	5-9	100%
Complete healthy control data collection	4-15	100%
Complete post-intervention assessments after completion of intervention.	6-24	100%
Subtask 2: Preliminary accelerometry data analysis with first 20 subjects in each group.	9-15	100%
Confirm custom algorithm is functioning as expected.	9-10	100%
Assess 10 concussion patients for change in POWAR-TOTAL response post-intervention.	12-13	100%
Determine need to repeat test healthy control subjects based on post-intervention testing.	13-14	100%
If necessary, test additional healthy control subjects 2 nd time.	14-18	100%

Tested additional healthy control subjects 2 nd time (n=10)		100%
Major Task 3: Planning for translation		
In conjunction with T2 collaborators/consultants, develop a plan for transition of technology use toward clinical practice.	3-6	75%
Seek feedback from clinicians about the test procedure, interface, administration and feedback screens.	3-24	ongoing
Seek feedback from patients tested about the test process and feedback screens.	8-24	ongoing
Develop plans to translate the test and application to practice, as appropriate	18-24	75%
Major Task 4: Data analysis		
Coordinate with Sites & database manager for monitoring data collection rates and data quality	4-24	100%
Perform all analyses according to specifications, share output and findings with all investigators	12-24	75%
Dissemination and reporting of findings (abstracts, presentation, publications, DOD)	12-24	25%

✦ **What was accomplished under these goals?**

We have met our data collection goal at Fort Bragg, testing 50 individuals with TBI, with 32 of those post-tested. At JBLM, we were only able to collect data on 25 subjects with 18 of those post-tested. When COVID struck, we necessarily halted data collection for a period of time. Fort Bragg data collection was only 2 short of the planned number for recruitment, so when our project was approved to resume, we were able to meet the target there. JBLM still is not back online for data collection, so we are halting our data collection efforts in order to shift our focus to the CAMP project that is continuing to use the POWAR run/roll maneuver as part of that test battery. COVID prevented us from attending and presenting at several conferences where abstracts were accepted, and generally caused difficulty at the University as personnel there (including the PI) were enlisted to shift coursework online and into the summer months to accommodate students who were not able to engage in their typical clinical rotations. This caused a significant reduction in time available to work on publications from the project (which is typically a summer focus for the project PI).

In order to continue our dissemination efforts, we are requesting a no-cost

extension for an additional year that applies to the Geneva subcontract.

This will allow us to increase efforts of Dr. Cecchini to work on coordinating and formatting publications, work with our statistician to obtain necessary analyses and invest time in additional dissemination efforts.

With our healthy control data we developed prototype feedback screens to evaluate best options for display for patient and clinicians, and sought feedback about therapist preferences for these displays at the APTA Combined Sections meeting from active duty therapists who will be endusers of the test.

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

Our group has been active in providing presentations to share preliminary results of our work in the past year, sharing results in numerous professional meetings that allow us to interact with professionals who treat concussion and therapists who serve the US military.

+ How were the results disseminated to communities of interest? ACRM 2019 (American Congress of Rehabilitation Medicine)

McCulloch KL, Cecchini AS, Prim JH. Portable Warrior Test of Tactical Agility (POWAR-TOTAL) Differences in Healthy Control and mTBI Service Members American Congress of Rehabilitation Medicine, Chicago, IL, November 2019

Cecchini AS, Favorov O, Prim JH, McCulloch KL. Service Members with Concussion Improve Performance on a Test of Tactical Agility After Rehabilitation. American Congress of Rehabilitation Medicine, Chicago, IL, November 2019

AMSUS December 2019 Poster Presentation:

Klimp S, Cecchini A, Favorov O, Prim JH, McCulloch KL. Comparison of healthy and concussed servicemembers using POWAR-TOTAL: a test of return to duty readiness following concussion, Washington DC, December 2019

CSM 2020 (American Physical Therapy Association)

Cecchini AS, Prim JH, Favorov O, O'Block LM, McCulloch KL. Test-Retest Reliability of a Return to Duty Performance-Based Assessment: Practice Effects in Healthy Servicemembers, APTA Combined Sections Meeting, Denver CO February 2020

McCulloch KL, Cecchini AS, Prim JH, O'Block LM, Favorov O. Servicemembers with mTBI Improve in Tactical Agility Task Performance after Physical Therapy APTA Combined Sections Meeting, Denver CO February 2020

MHSRS

McCulloch KL, Cecchini AS, O'Block L, Prim J, Oh A, Zhang W. Further development of the portable warrior test of tactical agility: a test of return to duty readiness: Comparison of performance between active duty servicemembers diagnosed with concussion and healthy controls. MHSRS 2020 (invited as

poster, meeting cancelled)

Cecchini AS¹, Prim JH², O'Block LM³, Oh A⁴, Wanqing Zhang², McCulloch KL-The portable warrior test of tactical agility (POWAR-TOTAL): service members with concussion improve performance after rehabilitation. MHSRS 2020 (invited as platform, meeting cancelled)

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

We will be presenting a platform at American Congress of Rehabilitation Medicine in October, and have submitted an abstract for Federal American Physical Therapy Association in 2021. Both of these presentations will be virtual as the conferences have been cancelled because of COVID. We have a draft of our first paper ready to submit that compares individuals with mTBI and comparable healthy controls on the POWAR-TOTAL measures that are easily obtained clinically (hand timing, observational scoring) that we were surprised to find demonstrated group differences. Dr. Favorov is drafting a similar paper about the findings related to the movement sensors that provides a more sensitive illustration of group differences during different parts of the POWAR task. We intend to submit these papers together to Military Medicine and hope that they may be published together given the methods for them are similar. We are currently working on a paper that focuses on the pre- post differences for the mTBI group after therapy, where improvements in performance on POWAR and self-report measures is robust. In addition we have plans to analyze the individuals from the mTBI group that were "responders" and "non-responders" to therapy so that we might analyze comorbid factors or predictors that are associated with their perceived readiness to return to duty. We also intend to examine the therapy course for these individuals so that we might begin to understand how PT intervention is related to the outcomes identified by POWAR and other measures.

We have begun work on the Complex Assessment of Military Performance project, and this testing is completed with the use of a computer to coordinate the various sensors and programs used in the test battery. Feedback from therapists about the optimal displays of information from the POWAR task will be integrated into therapist and patient data displays as part of this project.

4. **IMPACT:** *Describe 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?** Nothing to report.
- ✦ **What was the impact on other disciplines?** Nothing to report.
- ✦ **What was the impact on technology transfer?** We have decided to move in the direction of using a laptop for collecting and displaying test data, as we are planning for the Complex Assessment of Military Performance project, where we have need for additional Bluetooth physiologic measurement that is better handled with a laptop vs. a tablet.
- ✦ **What was the impact on society beyond science and technology?** Nothing to report.

5. **CHANGES/PROBLEMS:**

- ✦ **Changes in approach and reasons for change**

Based on work with other projects at Fort Bragg, we have a greater understanding of the difficulty in obtaining information about return to duty. Our original intention was to use therapist recommendation about ability to return to duty as the variable (recommended for return to duty or not) as the value we intended to predict in our 3rd aim (using regression). We thought that we would be able to access a brain injury team decision for those patients who were being seen for intensive outpatient services, and PT recommendations for those who are only being seen for single services vs. an intensive program. Our most consistent information about return to duty comes from the self-report a service member provides when they participate in post-testing after they are finished with PT services. It is our plan to use this information as a variable we predict in our Aim 3 analysis, as we don't have reason to suspect that this self-report is inaccurate. We are also using chart review to determine if official notification of approval for return to duty is available in the chart by which we will have an external validation of the service member's self-report.

- ✦ **Actual or anticipated problems or delays and actions or plans to resolve them**
- ✦ COVID 19 had a significant impact on our ability to administer and complete the project in a timely way as data collection was halted in March of 2020. It has resumed in a limited way at Fort Bragg, but not at JBLM. With the temporary halting of PT services/transitions to telehealth, there were subjects who were lost to follow-up because of discontinuing typical PT services. We have used chart review to identify patterns of PT service delivery with the individuals who have been involved in the pre- post-test component of the study. We will use this information to correlate possible therapy intensity with improvements on

self-report and study measures.

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

The tempo of recruitment and testing at Fort Bragg did not necessitate full time coverage, therefore our project manager has reduced her hours (by her choice) to accommodate personal work priorities. Our JBLM research assistant had a baby, and although she trained another Geneva employee to continue with data collection during her maternity leave, the number of subjects recruited during her leave was very limited. When she (Annabell Oh) returned to her position, COVID occurred soon after. We have continued to have both of our Geneva employees work on drafting publications during the time when they were not allowed to collect data, but the total number of hours of work has been reduced across both sites. This has allowed us to reserve funds to continue funding on the project to continue to try to reach our project goals. As a result we have considerable funding in the Geneva subcontract budget we hope to be able to tap in an additional year no cost extension request that is to be submitted shortly.

† **Significant changes in use or care of human subjects, vertebrate animals, 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.** Nothing to report

† **Books or other non-periodical, one-time publications.** Nothing to report

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

ACRM 2019 (American Congress of Rehabilitation Medicine)

McCulloch KL, Cecchini AS, Prim JH. Portable Warrior Test of Tactical Agility (POWAR-TOTAL) Differences in Healthy Control and mTBI Service Members American Congress of Rehabilitation Medicine, Chicago, IL, November 2019

Cecchini AS, Favorov O, Prim JH, McCulloch KL. Service Members with Concussion Improve Performance on a Test of Tactical Agility After Rehabilitation. American Congress of Rehabilitation Medicine, Chicago, IL, November 2019

AMSUS December 2019 Poster Presentation:

Klimp S, Cecchini A, Favorov O, Prim JH, McCulloch KL. Comparison of healthy and concussed servicemembers using POWAR-TOTAL: a test of return to duty readiness following concussion, Washington DC, December 2019

CSM 2020 (American Physical Therapy Association)

Cecchini AS, Prim JH, Favorov O, O'Block LM, McCulloch KL. Test-Retest Reliability of a Return to Duty Performance-Based Assessment: Practice Effects in Healthy Servicemembers, APTA Combined Sections Meeting, Denver CO February 2020

McCulloch KL, Cecchini AS, Prim JH, O'Block LM, Favorov O. Servicemembers with mTBI Improve in Tactical Agility Task Performance after Physical Therapy APTA Combined Sections Meeting, Denver CO February 2020

MHSRS 2020 (Meeting cancelled, abstracts published online)

McCulloch KL, Cecchini AS, O'Block L, Prim J, Oh A, Zhang W. Further development of the portable warrior test of tactical agility: a test of return to duty readiness: Comparison of performance between active duty servicemembers diagnosed with concussion and healthy controls. MHSRS 2020 (invited as poster, meeting cancelled)

Cecchini AS¹, Prim JH², O'Block LM³, Oh A⁴, Wanqing Zhang², McCulloch KL. The portable warrior test of tactical agility (POWAR-TOTAL): service members with concussion improve performance after rehabilitation. MHSRS 2020 (invited as platform, meeting cancelled)

- ✦ **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:	<i>Karen McCulloch</i>
Project Role:	<i>Principal Investigator</i>
Researcher Identifier (e.g. ORCID ID):	<i>0000-0003-4228-0517</i>
Nearest person month worked:	<i>2.4</i>
Contribution to Project:	<i>Dr. McCulloch is the project PI, coordinating the efforts of the research team on the project, troubleshoot project challenges and identify recruitment strategies based on site specific needs. Writing reports and drafting abstracts, coordinating writing efforts and soliciting feedback onr display for clinical use of the measure.</i>
Funding Support:	<i>N/A</i>
Name:	<i>Amy Cecchini</i>
Project Role:	<i>Project Coordinator</i>
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	<i>9</i>
Contribution to Project:	<i>Dr. Cecchini has managed the project at Ft Bragg including recruitment and data collection, established project procedures,</i>

	<i>taken the lead on regulatory efforts, coordinated training of the MAMC staff to ready them for data collection, assisted with report writing, and provide ongoing guidance for Dr. Oh at MAMC.</i>
Funding Support:	
Name:	<i>Annabell Oh</i>
Project Role:	<i>Project Manager</i>
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	<i>5</i>
Contribution to Project:	<i>Dr. Oh has been trained to recruit and collect data at the MAMC site, coordinating efforts with Dr. O'Block. She is assuming responsibility for regulatory efforts at MAMC, and will initiate data collection as soon as we get IRB approval.</i>
Funding Support:	
Name:	<i>Courtney Harrison</i>
Project Role:	<i>Research Assistant</i>
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	<i>3</i>
Contribution to Project:	<i>Ms. Prim has set up the RedCap database, coordinated ongoing research team conference calls and record keeping, and worked with Dr. Favorov on data analyses for poster presentations, assisted with presentations and development of posters.</i>
Funding Support:	
Name:	<i>Oleg Favorov</i>
Project Role:	<i>Co-investigator</i>
Researcher Identifier (e.g. ORCID ID):	

Nearest person month worked:	4.8
Contribution to Project:	<i>Dr. Favorov takes the lead on motion sensor analyses, including supervision of a research assistant who set up the procedures for use of the the cell phone sensors for the project.</i>
Funding Support:	
Name:	<i>Wanqing Zhang</i>
Project Role:	<i>Co-investigator</i>
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	1
Contribution to Project:	<i>Dr. Zhang has worked with RA support on the RedCap database development and has taken primary responsibility for FITBIR data sharing agreement and administration. .</i>
Funding Support:	
Name:	<i>CDR Scott Klimp</i>
Project Role:	<i>Site PI – Fort Bragg</i>
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	1
Contribution to Project:	<i>CDR Klimp works with project staff as the site PI at Ft Bragg to assist with recruitment and involvement of his staff (physical therapy) to identify potential subjects for the study. He meets with Dr. McCulloch quarterly to assure the project is going smoothly.</i>
Funding Support:	
Name:	<i>Lisa O'Block</i>
Project Role:	<i>Site PI - MAMC</i>

Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	1
Contribution to Project:	<i>Dr. O'Block serves as the site PI for MAMC. She initiated the IRB protocol for their site, hired and assisted with training an RA to administer the project. She provides ongoing guidance to the project team related to feasibility and clinical utility.</i>
Funding Support:	
Funding Support:	
Name:	<i>Timothy Challener</i>
Project Role:	<i>Research Assistant</i>
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	1
Contribution to Project:	<i>Mr. Challener is a post-doc working with Dr. Favorov on sensor data collection, offering technical support if difficulties arise with data collection. He has developed interactive screens/guidance for our testers in the field and is also testing smaller sensors to validate them for future applications of the POWAR test.</i>
Funding Support:	

Name:	<i>Olcay Kursun</i>
Project Role:	<i>Consultant</i>
Researcher Identifier (e.g. ORCID ID):	
Nearest person month worked:	<i>1</i>
Contribution to Project:	<i>Dr. Kursun works in collaboration with Dr. Favorov on the analysis of accelerometry/gyroscopic data to develop custom or deep learning algorithms to differentiate those with mTBI from healthy controls.</i>
Funding Support:	

- ✦ **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: Geneva Foundation**
 - ✦ **Location of Organization:** Tacoma, WA
 - ✦ **Partner's contribution to the project** Subcontractor for personnel at Ft Bragg and MAMC
 - ✦ **Financial support;** support provided to Geneva to hire personnel and administer project at local military treatment facilities
 - ✦ **In-kind support Facilities** N/A
 - ✦ **Collaboration** N/A
 - ✦ **Personnel exchanges** N/A
 - ✦ **Organization Name: Fort Bragg – Intrepid Spirit Center**
 - ✦ **Location of Organization:** Fayetteville, NC
 - ✦ **Partner's contribution to the project** local site for subject recruitment and data collection
 - ✦ **Financial support** N/A
 - ✦ **In-kind support** partner has made office space, computer, phone available to project staff, and also provides access to a pool of healthy control subjects through the DVBIC Newcomer's briefing that occurs at Ft Bragg
 - ✦ **Facilities** Data collection takes place in the physical therapy treatment area

during non treatment hours (lunch time, late afternoon, meeting times)

- + **Collaboration** CDR Klimp and physical therapists Shaun Carlson and Michael Krok are collaborators to assist with recruitment, provision of feedback to project staff on testing feasibility and preferences to improve clinical utility.
- + **Personnel exchanges** N/A
- + **Other.**
- + **Organization Name: MAMC**
- + **Location of Organization:** Tacoma WA
- + **Partner's contribution to the project** Provision of site PI and additional physical therapist collaborator, access to former staff of the T2 to assist with translation questions
- + **Financial support** N/A
- + **In-kind support** Partner allows project RA space, laptop computer, that she can use in office space at the Intrepid Spirit Center
- + **Facilities** Partner allows testing to occur in the physical therapy treatment space during non-treatment hours;
- + **Collaboration** Provision of physical therapist (Lisa O'Block, site PI, Holly Roberts) and psychologist collaborations (for translation issues)
- + **Personnel exchanges** N/A
- + **Other.**

8. SPECIAL REPORTING REQUIREMENTS

- + **COLLABORATIVE AWARDS:** N/A
- + **QUAD CHARTS:** *If applicable, the Quad Chart (available on <https://www.usamraa.army.mil>) should be updated and submitted with attachments) Provided on following page.*

PORTable WARrior Test Of Tactical AgiLity (POWAR-TOTAL): A dual-task test to aid return-to-duty (RTD) decision making after military concussion

Focus area: *Sensory systems, military relevance for return to duty assessment*



PI: Karen McCulloch, PT, PhD, NCS

Org: UNC-Chapel Hill/Geneva Foundation **Award Amount:** \$1,000,150

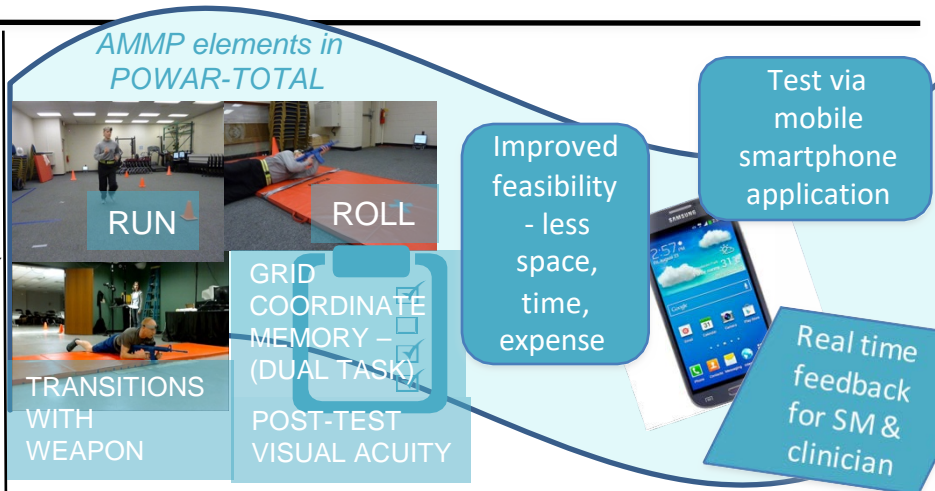
Study/Product Aim(s)

- Compare POWAR TOTAL responses of healthy control participants to those with concussion
- Examine changes in POWAR-TOTAL performance as a result of outpatient intervention at Intrepid Spirit Centers at Fort Bragg and Joint Base Lewis-McChord (JBLM)
- Examine the relationship between POWAR-TOTAL scores and return to duty indicators used in clinical practice.

Approach

Our goal is to assess the performance-based POWAR-TOTAL, that requires tactical mobility skills in a dual-task scenario. We will improve clinical feasibility over similar validated AMMP test components by *requiring less space & time while using less expensive smartphone technology to measure*

movement. This will provide a portable clinical test to inform RTD decision making and provide clinician and SM feedback in real time.



The POWAR-TOTAL uses the *most sensitive elements* from a recently validated dual- and multi-task battery, the Assessment of Military Multitask Performance (AMMP), that challenges cognitive and motor performance simultaneously. This testing approach proved effective in detecting differences between ADSM and SM with symptoms post-concussion.

Goals/Milestones

CY18 Milestones –Preliminary data analysis with first 20 subjects per group indicated need for test-retest reliability analysis with HC subjects (n=10)

Initiated data collection at MAMC as of 11/2018,

Data collected on 60/60 HC, 50/100 mTBI

Obtained no cost extension, In Progress Review

CY19 Goals - Complete data collection, analyze/disseminate results

Finalize means of transition with clinician guidance/assistance.

Comments/Challenges/Issues/Concerns – mTBI numbers at MAMC lagging behind expected. May need to modify Aim 3 to include fewer variables if 100 subjects not obtained in data collection.

CY20 Goals – Have completed data collection with 75 MTBI subjects, 50

Timeline and Cost

Activities	months	1-6	7-12	13-18	19-36
Project infrastructure/procedures		█			
Data collection for Aims 1 & 2			█		
Transition and clinical use plan				█	
Iterative data analysis & dissemination		█			

Estimated Budget (\$1000K)

\$450K

\$550K

post-tested. Manuscript preparation is in process for 2 papers, with plans for 3 additional papers requiring additional data analysis. Have submitted request for additional NCE to accomplish writing/dissemination goals of the project that were slowed by COVID-19 disruptions to project administration.

9. **APPENDICES:** Abstracts presented at meetings in 2019-20

1- Cecchini AS, Favorov O, Prim JH, McCulloch KL. Service Members with Concussion Improve Performance on a Test of Tactical Agility After Rehabilitation. American Congress of Rehabilitation Medicine, Chicago, IL, November 2019 (platform)

Service Members with Concussion Improve Performance on a Test of Tactical Agility After Rehabilitation

Objective: Assess the ability of a performance-based agility task to aid in post-concussion readiness for return to duty assessment of active duty service members (ADSM).

Design: Longitudinal, pre- and post-intervention assessment

Setting: Outpatient clinic on a military base serving ADSM diagnosed with concussion.

Participants (or Animals, Specimens, Cadavers):

13 male subjects: average age of 28.3 years (SD 5.8), 7.6 years (SD 5.7) in service, and 2.5 deployments (SD 2.8).

Interventions: Subjects were seen a median of 6.9 weeks for individualized therapy.

Main Outcome Measure(s): Intake/self-report measures were collected within one week of initial physical therapy evaluation and again after discharge from therapy. Measures included High level Mobility Assessment Test (HiMAT), Sensory Organization Test (SOT), Dynamic Visual Acuity Test (DVAT), and POWAR-TOTAL agility task. POWAR-TOTAL is a military-specific multi-task assessing visual stability, working memory, balance and tactical agility. The agility task includes rapid prone to stand transition, forward and backward running and combat rolls to the right and left while carrying a simulated weapon. Movement is measured with smartphone tri-axial accelerometers and gyroscopes attached at the lumbar and occipital region

Results:

Participants showed statistically significant improvements in HiMAT, SOT, DVAT and the visual stability and movement components of the POWAR-TOTAL task ($p < .05$). Improvements were also noted in self-reported dizziness, sleep, and readiness to deploy, however these improvements did not reach statistical significance ($p=0.11$, 0.12 and 0.12 respectively).

Conclusions: The POWAR-TOTAL task demonstrates functional improvement on a complex, military specific task after physical therapy rehabilitation for impairments associated with concussion. This improvement may serve as an indicator of recovery and of service member readiness for full return to duty.

2- McCulloch KL, Cecchini AS, Prim JH. Portable Warrior Test of Tactical Agility (POWAR-TOTAL) Differences in Healthy Control and mTBI Service Members American Congress of Rehabilitation Medicine, Chicago, IL, November 2019 (poster)

Portable Warrior Test of Tactical Agility (POWAR-TOTAL) Differences in Healthy Control and mTBI Service Members

Objective: To examine differences in active duty service members with mTBI and healthy controls on a tactical agility test, the POWAR-TOTAL.

Design: Case control, cross-sectional.

Setting: Two military treatment facilities with intensive outpatient programs for mTBI.

Participants (or Animals, Specimens, Cadavers): Subjects were all active duty military service member volunteers: 23 individuals with mTBI and age-matched healthy controls drawn from a convenience sample of 50.

Interventions: Individuals participated in single test session in which they completed self-report measures, POWAR-TOTAL, and the High Level Mobility Assessment Test (HiMAT).

Main Outcome Measure(s): The POWAR-TOTAL test is performed while carrying a simulated weapon. The test begins with the service member in a prone position, transition to standing, run forward, transition to prone, combat roll to the right, stand and back pedal to the start position, followed by the same sequence with a combat roll to the left. Multiple trials reduce practice effects and examine differences in single and dual-task performance. The dual-task condition requires remembering a two word, 6 number grid coordinate used in military location descriptions. Performance of the both motor and cognitive tasks are measured in the dual-task condition. The HiMAT, requiring maximum speed mobility tasks was completed according to standard instructions.

Results: 5 subjects with mTBI could not complete all trials of the tests. Those with mTBI differed from age-matched health control performance in cognitive performance in single ($p=.001$), average dual-task conditions ($p=.008$), single task motor ($p=.023$), and average dual-task motor ($p=.044$) performance. HiMAT scores also differed significantly between groups ($p=.001$).

Conclusions: POWAR-TOTAL group differences were significant in cognitive and motor performance. High level mobility tests may aid in return to duty decision making for injured service members with high level mobility or vestibular impairments.

3- AMSUS Poster Presentation:

Klump S, Cecchini A, Favorov O, Prim JH, McCulloch KL. Comparison of healthy and concussed servicemembers using POWAR-TOTAL: a test of return to duty readiness following concussion, Washington DC, December 2019

Purpose: 1- Examine changes in performance of a tactical agility task, POWAR-TOTAL in servicemembers undergoing physical therapy intervention after mTBI. 2- Compare mTBI performance changes to a healthy control group who were tested twice to determine possible practice effects of the test.

Subjects: 16 active duty servicemembers (ADSM) with mTBI referred for physical therapy to address persistent complaints after injury, 10 healthy control (HC) ADSM

Materials and Methods: ADSM with mTBI were tested using the POWAR-TOTAL agility task during the week they began physical therapy and retested at discharge from their therapy course. HC ADSM performed the test twice, in sessions one month apart to approximate the median therapy course for the mTBI group. Movement characteristics were captured using smartphones mounted in the lumbar and occipital areas, allowing 6 components of the complex task to be measured separately (10 ft forward run, combat roll R, prone to stand transition, 10 ft backward and forward run, combat roll L, prone to stand transition). The test protocol includes 5 repetitions of the task. The fastest performance trial from each test session was used for this analysis.

Results: Differences in performance from the first to the second test administration for each group are described in the table.

Phase of POWAR task	HC 1 st test mean (s)	2 nd test difference (s)	HC p-value	BI 1 st test mean (s)	2 nd test difference (s)	BI p-value
Forward run	1.615	-0.17	0.05*	1.8781	-0.159	0.09

Combat roll 1	1.24	-0.01	0.81	1.3125	-0.091	0.03*
Prone to stand	0.92	-0.14	0.18	1.125	-0.269	0.03*
Combined backward and forward run	3.82	-0.345	0.03*	4.3875	-0.419	0.0009*
Combat roll 2	1.275	0.03	0.33	1.3906	-0.088	0.06
Prone to stand	0.955	-0.155	0.22	1.1375	-0.266	0.01*

Conclusions: Healthy control ADSM improved significantly in the speed with which they ran on the second POWAR-TOTAL test, demonstrating a practice effect for those task components. In contrast, ADSM undergoing therapy for mTBI improved in all components of the agility task, including improvements in transitional movements and combat roll maneuvers that did not change in the HC sample. These preliminary results suggest that the use of smartphone aided movement assessment during high level agility tasks may be useful to compare injured to HC task performance.

Clinical Relevance: The transitional movement tasks in the POWAR-TOTAL task appear especially challenging for individuals with mTBI. Physical therapy intervention was associated with improved functional performance of these tasks. Additional analyses of clinical profiles of the treatment group, the focus of therapy, and guidance for POWAR-TOTAL test interpretation will be addressed in the ongoing study.

4- Test-Retest Reliability of a Return to Duty Performance-Based Assessment: Practice Effects in Healthy Servicemembers APTA Combined Sections Meeting 2020

Amy S. Cecchini, PT

Fayetteville, NC

Julianna Prim, MS

Chapel Hill, NC

Oleg Favorov

Chapel Hill, NC

Lisa Marie O'Block, PT, DPT

Department of Defense - United States Army *Lacey, WA*

Karen Leigh McCulloch, PT, MS, PhD, FAPTA

Univ of NC Chapel Hill *Chapel Hill, NC*

Abstract Text:

Purpose/Hypothesis: To assess test-retest reliability of the Portable Warrior Test of Tactical Agility (POWAR-TOTAL), a performance based task that requires rapid position changes similar to military training, in healthy servicemembers, to investigate practice effects associated with the task.

Number of Subjects: 10 Healthy Active Duty Servicemembers (ADSM)

Materials and Methods: ADSM completed the POWAR-TOTAL at two separate timepoints separated by the median time of mTBI physical therapy (~1 month) of a related study. The POWAR-TOTAL is a military-specific dual-task assessing working memory, balance, and tactical agility. The agility task includes a rapid prone to stand transition, forward and backward runs (10 feet) and combat rolls to the right and left, while carrying a simulated weapon. The cognitive component of the POWAR-TOTAL is a working memory task utilizing grid coordinates.

Movement was measured with tri-axial accelerometers and gyroscopes using smartphone technology attached at the lumbar and occipital regions. The time of each component (forward run, combat roll 1, transition to stand, backward run, combat roll 2, transition to stand 2) was analyzed between the two sessions. The number of grid coordinates correct represents the cognitive score. The task was performed 5 times during each test session, the fastest performance trial was used for this analysis.

Results: Improvements in the run and transition components were found between the two testing sessions, with significant differences in duration of the forward ($p=.047$) and backward run ($p=.033$) components. No time

differences were found in the roll components between sessions in either roll 1 ($p=.814$) or roll 2 ($p=.328$). Also both the single ($ICC=.921$) and average dual-task ($ICC=.912$) cognitive components showed high levels of reliability between sessions.

Conclusions: This test-retest reliability analysis showed that healthy control participants improved performance for the running and transition components on the second test. The roll component was the most reliable with minimal practice effects between testing sessions. Given the roll component of the task has been found to be sensitive in differentiating mTBI from healthy control performance, this aspect of the task is especially important.

Clinical Relevance: POWAR-TOTAL targets known vulnerabilities associated with mTBI and is a promising assessment that can aid clinicians with return-to-duty decisions for military servicemembers after mTBI. These results assist in interpretation of POWAR-TOTAL performance changes observed after physical therapy, allowing inference of possible improvements that may be a result of intervention versus those expected with repetition of the test protocol.

References:

- Scherer, M. R., Weightman, M. M., Radomski, M. V., Davidson, L. F., & McCulloch, K. L. (2013). Returning service members to duty following mild traumatic brain injury: exploring the use of dual-task and multitask assessment methods. *Physical therapy*, 93(9), 1254-1267.
- McCulloch, K. L., Goldman, L. T. C., Lowe, L., ... & West, T. A. (2015). Development of clinical recommendations for progressive return to activity after military mild traumatic brain injury: guidance for rehabilitation providers. *Journal of head trauma rehabilitation*, 30(1), 56-67.
- Weightman, M. M., McCulloch, K. L., Radomski, M. V., Finkelstein, M., Cecchini, A. S., Davidson, L. F., ... & Scherer, M. R. (2017). Further development of the assessment of military multitasking performance: iterative reliability testing. *PLoS one*, 12(1), e0169104.
- Scherer, Matthew R., et al. "Measuring soldier performance during the patrol-exertion multitask: preliminary validation of a postconcussive functional return-to-duty metric." *Archives of physical medicine and rehabilitation* 99.2 (2018): S79-S85.
- Prim, J. H., Favorov, O. V., Cecchini, A. S., Scherer, M. R., Weightman, M. M., & McCulloch, K. L. (2019). Clinical Utility and Analysis of the Run-Roll-Aim Task: Informing Return-to-Duty Readiness Decisions in Active-Duty Service Members. *Military medicine*, 184(5-6), e268-e277.

5-Servicemembers with mTBI Improve in Tactical Agility Task Performance after Physical Therapy APTA Combined Sections Meeting 2020

Karen Leigh McCulloch, PT, MS, PhD, FAPTA

Univ of NC Chapel Hill *Chapel Hill, NC*

Amy S. Cecchini, PT

Fayetteville, NC

Julianna Prim, MS

Chapel Hill, NC

Lisa Marie O'Block, PT, DPT

Department of Defense - United States Army *Lacey, WA*

Oleg Favorov

Chapel Hill, NC

Abstract Text:

Purpose/Hypothesis: 1- Examine changes in performance of a tactical agility task, POWAR-TOTAL in service- members undergoing physical therapy intervention after mTBI. 2- Compare mTBI performance changes to a healthy control group who were tested twice to determine possible practice effects of the test.

Number of Subjects: 16 active duty servicemembers (ADSM) with mTBI referred for physical therapy to address persistent complaints after injury, 10 healthy control (HC) ADSM

Materials and Methods: ADSM with mTBI were tested using the POWAR-TOTAL agility task during the week they began physical therapy and retested at discharge from their therapy course. HC ADSM performed the

test twice, in sessions one month apart to approximate the median therapy course for the mTBI group. Movement characteristics were captured using smartphones mounted in the lumbar and occipital areas, allowing 6 components of the complex task to be measured separately (10 ft forward run, combat roll R, prone to stand transition, 10 ft backward and forward run, combat roll L, prone to stand transition). The test protocol includes 5 repetitions of the task. The fastest performance trial from each test session was used for this analysis.

Results: Differences in performance from the first to the second test administration for each group are described in the table.

Phase of POWAR task	HC 1st test mean (s)	2nd test difference (s)	HC p-value	BI 1st test mean (s)	2nd test difference (s)	BI p-value
Forward run	1.615	-0.17	0.05*	1.8781	-0.159	0.09
Combat roll 1	1.24	-0.01	0.81	1.3125	-0.091	0.03*
Prone to stand	0.92	-0.14	0.18	1.125	-0.269	0.03*
Combined backward and forward run	3.82	-0.345	0.03*	4.3875	-0.419	0.0009*
Combat roll 2	1.275	0.03	0.33	1.3906	-0.088	0.06
Prone to stand	0.955	-0.155	0.22	1.1375	-0.266	0.01*

Conclusions: Healthy control ADSM improved significantly in the speed with which they ran on the second POWAR-TOTAL test, demonstrating a practice effect for those task components. In contrast, ADSM undergoing therapy for mTBI improved in all components of the agility task, including improvements in transitional movements and combat roll maneuvers that did not change in the HC sample. These preliminary results suggest that the use of smartphone aided movement assessment during high level agility tasks may be useful to compare injured to HC task performance.

Clinical Relevance: The transitional movement tasks in the POWAR-TOTAL task appear especially challenging for individuals with mTBI. Physical therapy intervention was associated with improved functional performance of these tasks. Additional analyses of clinical profiles of the treatment group, the focus of therapy, and guidance for POWAR-TOTAL test interpretation will be addressed in the ongoing study.

- Weightman MW, McCulloch KL, Radomski MV, Finkelstein M, Cecchini AS, Davidson LF, Heaton KJ, Smith L, Scherer MR. Further Development of the Assessment of Military Multitask Performance: iterative reliability testing. *PLOS One* 2017; 12(1):e016910.
- McCulloch KL, Cecchini AS, Radomski MV, et al. Military-civilian collaborations for mTBI research in an active duty population: lessons learned from the Assessment of Military Multitasking Performance project. *J Head Trauma Rehabil* 2016 (e pub). 2017; 32(1): 70-78.
- Prim JH, Favorov OV, Cecchini AS, Scherer MR, Weightman MM, McCulloch KL. Clinical Utility and Analysis of the Run-Roll-Aim Task: Informing Return-to-Duty Readiness Decisions in Active-Duty Service Members. *Mil Med.* 2019 May 1;184(5-6):e268-e277.
- McCulloch KL, Goldman S, Lowe L, Radomski MV, Reynolds J, Shapiro R, West TA. Development of clinical recommendations for progressive return to activity after military mild traumatic brain injury: guidance for rehabilitation providers. *J Head Trauma Rehabil.* 2015 Jan-Feb;30(1):56-67.
- Scherer MR, Weightman MM, Radomski MV, Davidson LF, McCulloch KL. Returning service members to duty following mild traumatic brain injury: exploring the use of dual-task and multitask assessment methods. *Phys Ther.* 2013 Sep;93(9):1254-67.

6- MHSRS CONFERENCE 2020 (Invited as platform, conference cancelled)

FURTHER DEVELOPMENT OF THE PORTABLE WARRIOR TEST OF TACTICAL AGILITY: A TEST OF RETURN TO DUTY READINESS Comparison of Performance Between Active Duty Service Members Diagnosed With Concussion And Healthy Controls

Karen McCulloch, PhD, PT, NCS¹, Amy Cecchini, DPT², Lisa O'Block, DPT³, Julianna Prim, PhD¹,

Annabell Oh, MS⁴, Wanqing Zhang, PhD¹

¹ Division of Physical Therapy, Department of Allied Health Sciences, School of Medicine UNC-Chapel Hill, Chapel Hill North Carolina, USA

² Geneva Foundation, Ft. Bragg Intrepid Spirit Clinic, Fayetteville, NC, USA

³ Madigan Army Medical Center, Joint Base Lewis McCord, Tacoma, WA, USA

⁴ Geneva Foundation, Joint Base Lewis McCord Intrepid Spirit Clinic, Tacoma, WA, USA

Introduction:

Return-to-duty (RTD) readiness assessment for active duty service members (ADSM) following concussion requires complex clinical considerations of a myriad of impairments. Following a concussive event, many service members present with early deficits in balance, agility, memory, vision and dual or multi-tasking. Many single task assessments are available for clinicians to use when evaluating an individual who has sustained a concussion, however to date, none include military specific skills and none have been fully validated in an active duty population. An important emerging result from the expanding concussion literature is that both exertion and dual tasking may uncover persistent impairments that appear to have recovered to baseline or normal performance when tested alone and at rest in individuals who have been concussed and are being evaluated for return to play, return to work, or return to duty. Persistent impairments under these conditions are particularly relevant to a military population as service members (SM) frequently have uniquely challenging occupational demands and are placed in complex and often dangerous environments where persistent impairments could be unmasked and would have significantly more dire consequences to the individual or the mission. The Portable Warrior Test of Tactical Agility (POWAR-TOTAL) is a performance-based, exertional and dual-task assessment which requires less time, space, and technology than previous laboratory-based RTD assessments. The POWAR-TOTAL demonstrates high external validity, as it is comprised of familiar components to the military population. In order to determine the sensitivity of the POWAR-TOTAL to identify post exertional and dual-task deficits in service members who had been diagnosed with concussion and who were receiving rehabilitation for their persistent symptoms, we compared their performance with their ADSM peers who were fully eligible for deployment.

Objective: To describe the characteristics of concussed ADSM who were referred for physical therapy with the intent to return to duty, to compare these characteristics with a group of service members who have not sustained a concussion in the prior two years and who are concussion symptom free and to compare performance on the POWAR-TOTAL test between these two groups.

Subjects: Sixty-four ADSM diagnosed with concussion within the past two years and 59 ADSM who were concussion free in the same time period and who were on unrestricted active duty and eligible for deployment.

Methods: The POWAR-TOTAL includes a physical, a visual, and a cognitive component. The physical component is a rapidly performed mobility- agility task that includes handling a simulated weapon, and begins with the service member in prone. The tasks involves rapid positions changes, forward and backward running and combat rolling in both directions. Visual acuity and clarity are assessed multiple times during the test to examine vestibular provocation of visual change. The cognitive component consists of a working memory task with the SM retaining an eight character grid coordinate, a familiar type of memory task used in military location descriptions. In the Dual-Task activity, a different grid coordinate is provided and the participant is asked to repeat the coordinate in the correct order immediately after completing the motor task. The Single-Task Motor, Single-Task Cognitive, Dual-Task, and resting and post-exertional vision tasks were repeated over multiple trials to examine differences in single task performance and dual task performance and to reduce practice effects associated with learning a novel task. In addition to the POWAR-TOTAL task, SMs performed the HiMAT, a standardized assessment of higher level mobility tasks, and completed an intake form of self-reported demographics as well as the Neurobehavioral Symptom Inventory (NSI), the Defense

and Veterans Pain Rating Scale (DVPRS) and the PCL-5, a standardized measure of Post- Traumatic Stress.

Results: There were no statistically significant differences ($p < 0.05$) between the groups for age or length of time in service. Service members in the concussed group (CON) had higher scores on the NSI (CON mean 37.97, HC mean 7.88, $p < 0.001$), the PCL-5 (CON mean 28.25, HC mean 6.63, $p < 0.001$) and the DVPRS (CON mean 4.36, HC mean 1.36, $p < 0.001$) than their healthy control peers (HC). The concussed group was more likely to have duty restrictions, such as light duty, working outside their assigned occupational training, or physical training restrictions ($p < 0.001$) and they were more likely to report that they were NOT physically ready to deploy in the next 72 hours ($p < 0.001$). Service members in the concussed group also had lower HiMAT scores than the healthy control group (CON mean 22.63, HC mean 30.63, $p < 0.001$). Finally, with respect to performance on the POWAR-TOTAL task, 5 out of the 64 concussed participants could not complete all of the trials of the POWAR-TOTAL due to developing symptoms significant enough to warrant stopping the test (i.e., dizzy, nauseous, etc.), while 59 out of 59 healthy controls completed all trials of the task. During the single task motor component concussed participants (mean=16s, SD=3.74) were slower than healthy controls (Mean=13.9s, SD=2.04) ($p < 0.001$). Concussed participants (Mean=5.39, SD=1.97) also performed worse in the single task cognitive component compared to healthy controls (Mean=6.95, SD=1.41) ($p < 0.001$). During the dual task conditions, concussed participants were slower (Mean=15.6s, SD=4.3, $p = 0.004$) and scored lower on the cognitive task (Mean=5.08, SD=1.91, $p < 0.001$) when compared to healthy controls (Mean=13.7s, SD=2.1; Mean=6.35, SD=1.38). Concussed participants also scored worse on visual acuity and visual clarity while standing at rest prior to any motor trials, and, for those who were able to perform all 5 agility trials, when standing after completing the agility task compared to the healthy control group (1st vision line $p = 0.014$; 1st vision clarity $p < 0.001$; final vision line $p < 0.001$; and final vision clarity $p < 0.001$).

Conclusions: The POWAR-TOTAL was sensitive to detect differences between concussed and healthy control ADSM. Both the motor and cognitive task components, in both single and dual task conditions, as well as the visual component at rest and after all task trials, demonstrated a robust statistically significant difference between groups. This preliminary analysis supports the value of conducting performance-based assessment when military medical providers are making readiness for RTD decisions. Furthermore, the findings also support the value of incorporating interventions addressing dual-task conditions using relevant tasks and higher level mobility skills that are unique to military occupational demands in preparing for return-to-duty. The POWAR-TOTAL task appears to be a valid, clinically feasible method for evaluating functional skills that are highly relevant to a military population.

7- MHSRS 2020: THE PORTABLE WARRIOR TEST OF TACTICAL AGILITY (POWAR-TOTAL): Service Members with Concussion Improve Performance After Rehabilitation

Cecchini AS¹, Prim JH², O'Block LM³, Oh A⁴, Wanqing Zhang², McCulloch KL²

¹ Geneva Foundation, Ft. Bragg Intrepid Spirit Clinic, Fayetteville, NC, USA

² Division of Physical Therapy, Department of Allied Health Sciences, School of Medicine UNC-Chapel Hill, Chapel Hill North Carolina, USA

³ Madigan Army Medical Center, Joint Base Lewis McCord, Tacoma, WA, USA

⁴ Geneva Foundation, Joint Base Lewis McCord Intrepid Spirit Clinic, Tacoma, WA, USA

Introduction: Individuals who sustain concussion in military service are commonly managed by primary care providers in the acute stage, only seeking additional levels of specialty care if symptoms are persistent. Concussion complaints have been described in clusters of signs and symptoms, however the presentation of active duty service members seen for physical therapy at military treatment facilities is not well studied. Physical Therapists affiliated with Intrepid Spirit Clinics evaluate and treat Active Duty Service Members (ADSM) who have duty-limiting balance and mobility issues or complaints of exertional headache, dizziness, vertigo or cervical pain to improve the SMs

ability to perform the complex and unique tasks associated with military service.

The Portable Warrior Test of Tactical Agility (POWAR-TOTAL) is a complete departure from typical baseline single task balance, mobility, and cognitive assessments used to monitor and assess recovery after a concussion. The overall test attempts to more closely approximate the occupational demands of ADSM without specific adherence to a particular military occupational specialty. Subtasks were developed with military collaborators to include skills that all service members must be able to perform at a high level, such as carrying a weapon, moving and changing positions quickly, accurately locating a target, and remembering specific locations using common military conventions. POWAR-TOTAL is a performance-based, exertional and dual-task assessment that uses smartphone technology in a military-specific multi-task assessing visual stability, working memory, balance and tactical agility.

Objective: To describe the characteristics of concussed ADSM who were referred for physical therapy with the intent to return to duty, to compare characteristics and performance on the POWAR-TOTAL test before and after receiving individualized and/or group Physical Therapy interventions, and to assess the ability of the performance-based POWAR-TOTAL to aid in post-concussion readiness for return to duty assessment.

Subjects: Forty six Active Duty Service Members (ADSM) with an average age of 29.7 years (SD = 6.8), an average time in service of 8.4 years (SD = 6.3) and an average of 5.7 prior concussions (SD = 7.2). 96% of participants were male. Thirty two of the 46 SMs had been deployed with an average of 4 deployments (SD = 2.9) during their time in service. All subjects had sustained a concussion between at least two weeks and no more than two years prior to being enrolled in the study, had been evaluated by a Physical Therapist at the Intrepid Spirit Clinic, and were actively seeking treatment for their persistent signs and symptoms.

Methods: Self-report measures and performance measures were collected within one week of the Physical Therapy initial evaluation and again after discharge from therapy. Measures included the Neurobehavioral Symptom Inventory (NSI), the Defense and Veterans Pain Rating Scale (DVPRS), a measure of Post-Traumatic Stress (PCL-5), the Headache Impact Test (HIT-6), the Dizziness Handicap Inventory (DHI), the Pittsburgh Sleep Quality Index (PSQI), the High level Mobility Assessment Test (HiMAT), the NeuroCom™ Sensory Organization Test (SOT), and the POWAR-TOTAL. The POWAR-TOTAL motor component is a rapidly performed mobility-agility task that includes handling a simulated weapon, and begins with the service member in prone. The motor task includes rapid position changes, forward and backward running, and combat rolling in both directions. Movement is hand timed and measured with tri-axial accelerometers and gyroscopes in cell phones attached at the lumbar and occipital regions. The cognitive component consists of a working memory task with the SM retaining an eight character grid coordinate, a familiar type of memory task used in military location descriptions. The cognitive and motor trials are first performed as single tasks for up to two trials each and then as a dual-task for up to 3 trials. The visual component consists of assessing resting visual using a Snellen Eye Chart. Vision Line and self-reported visual clarity using an 11 point Likert Scale (0=perfectly clear and stable, 10=extremely blurry and / or unstable) are recorded. Vision is assessed multiple times throughout all trials of the task.

Results: When compared to the initial scores, final scores showed significant improvements in all six self-report measures (NSI, PCL, DVPRS, DHI all <0.01; HIT p=0.012; PSQI p=0.017). Final test scores on the HiMAT, the SOT, and most components of the POWAR-TOTAL task (Single and Dual Task Cognitive, Single and Dual Task Motor, and visual acuity tested after performing the single and dual task motor trials) also showed significant improvement when compared to initial scores (p < .01). Baseline acuity and clarity differences were not significant between initial and final testing. A positive response to the question "Do you feel ready to deploy in the next 72 hours" nearly doubled from initial testing to final testing, increasing from 28% of participants to 52% of participants.

Conclusions:

Symptom self-report has been the standard for assessment of recovery from concussion. Clinicians and researchers have been seeking objective measures that may serve to support or to disclaim an individual's own views of whether they are "recovered" from the effects of the concussion as an

indicator of readiness to return to sport, to school, and to work. Objective measures that are able to support individual self-assessment of recovery as well as more evaluate more realistic aspects of daily function in spite of lingering symptoms is vital to ensure safe return to duty for ADSM who may be exposed to imminent danger as part of training or mission demands. The POWAR-TOTAL task is able to capture multiple impairment areas in one test as either single tasks at rest as well as more complex iterations such as dual task and exertional task performance. Overall performance on the POWAR-TOTAL is thus able to capture functional improvement on a unique military specific task when after completing an individualized physical therapy program of care to address impairments associated with concussion. This improvement may serve as a more robust indicator of recovery after concussion and of service member readiness for full return to duty.