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United States Army Aeromedical Research Laboratory
Aircrew Health and Performance Division

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A “Return-to-Duty (RTD) Toolkit Working Group Symposium” was held at Fort Detrick, MD, on the 1st and 2nd of September, 2015. Sponsored by the U.S. Army Medical Research and Materiel Command (USAMRMC) Military Operational Medicine Research Program (MOMRP), a working group of experts came together to evaluate new and innovative assessment instruments and batteries for determining operational readiness to RTD following neurosensory injury. The clinical and psychometric properties of each assessment tool were presented by U.S. Army Aeromedical Research Laboratory (USAARL) or collaborating institutional researchers, under the direction of the USAARL Task Area Manager, Dr. Arthur Estrada, and Program Area Manager, Dr. John Crowley. Leading scientists, policy-makers, and clinicians with domain knowledge and expertise in traumatic brain injury in the context of operational RTD evaluated the various instruments and engaged in lively, active, informative, and fruitful discussions during the Symposium. These recordings were transcribed and are included herewith.
Bringing together experts from across the scientific spectrum reduces the likelihood of needless duplication of efforts, reducing waste, and encouraging collaboration among scientists.
Acknowledgements

We would like to express our appreciation and acknowledgement of the following individuals and entities for their contributions to the success of the Return-to-Duty Toolkit Working Group Symposium.

• Dr. Arthur Estrada, as Science Program Administrator at the U.S. Army Aeromedical Research Laboratory (USAARL), also serves as Task Area Manager on the RTD Toolkit, overseeing and managing all research projects aimed at developing and evaluating the assessment tools that offer the most promise for demonstrating validity, reliability, and functional clinical and/or operational utility.

• Dr. John S. Crowley, USAARL Science Program Director and Program Area Manager of the RTD Toolkit research projects. His guidance and vision ensure the research projects and assessments, although utilizing their own unique methodologies, will produce toolkit-ready products.

• LTC Craig Myatt of USAARL facilitated the symposium discussions, interjecting comments when and where appropriate, and kept all presenters on track, focused, and aware of the timetable.

• Symposium host, Dr. Richard Shoge, Injury Prevention Program Manager of the Military Operational Medicine Research Program (MOMRP), and his assistant, Ms. Rebecca Runyen, provided critical preparatory and on-site support at Fort Detrick, MD.

• Dr. James S. McGhee, provided key instrumental support to Dr. Thornson on the eventual composition of the working group. Our appreciation also extends to Dr. Bethany Ranes, formerly of USAARL, who provided Dr. McGhee’s contact information to Dr. Thornson.

• We would like to thank several team members of the Aircrew Health and Performance Division (AHPD) at USAARL; first and foremost our Division Chief, Mr. Bradley Erickson, as well as Deputy Chief, CPT David Boudreaux. Our deepest thanks also extend to our Lead Technician/Associate Investigator, Ms. Melody King, our Non-Commissioned Officer in Charge (NCOIC), SSG Andrew Chrovian, and SGT Jimmy Sandoval.

• The USAARL executive administrative support team, Ms. Elizabeth Stokes, Ms. Kim Carter, Ms. Vicky Anderson, and Ms. Stacey Brunson coordinated travel arrangements for attendees from across the country.

• We also commend Ms. Brittany Lacey, Budget Analyst for AHPD, who provided assistance to Mr. Erickson with budget preparation and fiscal management of the project funds, as well as Ms. Michelle (Debora) McKinnon, USAARL’s Lead Defense Travel Administrator, who arranged travel and reimbursement for all attendees utilizing the Defense Travel System.

• Finally, our gratitude goes to our distinguished experts. Not only did they provide their valuable time to attend, but the level at which they engaged throughout the symposium was over and above our highest expectations. Their critical and insightful feedback – combined
This work was supported by funding from the U.S. Army Medical Research and Materiel Command, and was also supported in part by an appointment to the Postgraduate Research Program at the U.S. Army Aeromedical Research Laboratory administered by the Oak Ridge Institute for Science and Education through an interagency agreement between the U.S. Department of Energy and USAARL.
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Introduction

The Military Operational Medicine Research Program (MOMRP), under the guidance of the U.S. Army Medical Research and Materiel Command (USAMRMC), recently sponsored a Return-to-Duty (RTD) Toolkit: Working Group Symposium at Fort Detrick, MD. A working group of experts evaluated new and innovative assessment tools and batteries for determining operational RTD following neurosensory injury. These assessments were presented by U.S. Army Aeromedical Research Laboratory (USAARL) and collaborating institutional researchers for consideration by experts in the field of neurosensory injury. Bringing together scientists, leaders, and clinicians in neurosensory injury and operational RTD to collaborate across the scientific spectrum reduces the likelihood of needless duplication of efforts, thereby keeping such large-scale collaborative efforts better focused on the desired end-state, providing viable solutions to the warfighter at a lower cost to taxpayers.

Dr. Richard Shoge, the Injury Prevention Program Manager of MOMRP, started off the symposium by having laid the groundwork ahead of time with his assistant Rebecca Runyen, by exceeding attendees’ expectations by providing a great location with ample space for the group to assemble. Dr. Shoge also served as on-site host, ensuring logistical and security procedures were followed throughout, as well as being instrumental in facilitating collaboration among the researchers and experts, offering his expertise and input when appropriate.

LTC Craig Myatt of USAARL, served as symposium facilitator and timekeeper. LTC Myatt guided discussion when necessary but remained hands off to allow freedom of expression and collaboration, critical to the collegial atmosphere and the goals of the Working Group.

Dr. John S. Crowley, Science Program Director at USAARL and Program Area Manager of the research projects contributing to this effort, began with a broad overview of the history and research conducted at USAARL. He then moved onto the MRMC-directed research on RTD in particular, where he pointed out both the salient and subtle gaps in research USAARL is seeking to address in this Working Group. Dr. Crowley also made clear the important but not always obvious distinction between RTD and rehabilitation research, and the implications of these divergent lines of inquiry, setting the stage for the evaluation of the RTD assessment tools. Dr. Crowley wrapped up by simplifying the basic purpose of the Working Group Symposium – to “communicate, identify, integrate, plan, and transition.”

Dr. Arthur Estrada, Science Program Administrator at USAARL who has served as Task Area Manager overseeing the many research efforts within the P1 Task Area, RTD Standards and Strategies after Neurosensory Injury, next provided attendees with an overview of the timeline and the way forward for this task area. Dr. Estrada emphasized the importance of the role this Working Group Symposium plays in the process of delivering a complete RTD Toolkit of validated assessments. Dr. Estrada went on to share his vision for this meeting as only the first step in the process of building the RTD Toolkit, where the P1 research projects on new and existing assessments will be identified for eventual inclusion into the Toolkit, but reassured attendees that we do not expect to walk away with a completed RTD Toolkit at the end of two days.
Ms. Katherine ("Kathy") Helmick, Deputy Director of the Defense and Veterans Brain Injury Center (DVBIC), set the tone for the symposium with her engaging and relevant presentation on the latest clinical recommendations following neurosensory injury, the progressive return to activity (PRA) model. Ms. Helmick’s insights into the ways in which the various assessments could integrate nicely with the PRA model turned out to become a recurring theme throughout the discussions that followed.

This technical report incorporates each set of presentation slides, verbatim transcripts of the experts’ and researchers’ discussions following the assessment tools presented for consideration, as well as summaries of the discussions or verbatim transcripts, where appropriate, to facilitate and guide future working groups. The qualitative and quantitative data collected are presented in tables, and the results and feedback are discussed. Finally, the report concludes final thoughts and recommendations, action items, and the way forward for this research effort. The report is laid out in chronological order, following the two-day Agenda, as displayed on the following two pages (see Figure 1).
AGENDA
Return to Duty (RTD) Toolkit - Working Group Symposium
Building 568/Conference Room #1, Fort Detrick, MD

Day 1: Tuesday (1 SEP 2015)

0800 – 0830  Registration

0830 – 0840  Welcome and Introductions – Dr. Richard Shoge (PhD), MOMRP Injury Prevention Program Manager; LTC Craig A. Myatt (PhD), USAARL Aircrew Health and Performance Division Chief

0840 – 0900  Task Area Overview – Dr. John Crowley (M.D.), USAARL Science Program Director; and Dr. Arthur Estrada (PhD), USAARL Science Program Administrator

0900 – 0915  Symposium Goals – LTC Myatt

0915 – 0945  Current DoD RTD Clinical Standards and Progressive Return to Activity Following mTBI – Ms. Katherine Helmick (RN), Deputy Director of DVBIC

Presentations of Assessment Tools

0945 – 1015  (1) Assessments of the Pupillary Light Reflex (PLR) and Eye Movements for Early Identification of Warfighters with mTBI/Concussions – MAJ Dave Walsh (OD, PhD, FAAO), Research Optometrist at USAARL

1015 – 1030  Break

1030 – 1100  (2) A Simple Field Test for Balance Impairment – Dr. Angus Rupert (PhD, M.D.), Medical Research Scientist at USAARL

1100 – 1200  Facilitated Discussion: Session 1

1200 – 1300  Lunch Break

1300 – 1330  (3) Performance of Dynamic Simulated Shooting Tasks by Healthy Participants and those Recovering from Mild Traumatic Brain Injury (mTBI) – Dr. Ben Lawson (PhD), Research Psychologist at USAARL

1330 – 1400  (4) Auditory Fitness for Duty Standards – Dr. Douglas Brungart (PhD), Chief Scientist at WRNMMC

1400 – 1415  Break

1415 – 1445  (5) Auditory, Vestibular and Oculomotor Sequelae in Warfighters Diagnosed with Traumatic Brain Injury (TBI) as a Result of Blast Exposure – LTC Kristen Casto, Staff Audiologist, OTSG

1445 – 1600  Facilitated Discussion: Session 2

1600 – 1630  Day One Wrap-Up and Open Discussion
AGENDA
RTD Toolkit - Working Group Symposium

Day 2: Wednesday (2 SEP 2015)

0800 – 0830  Targeted Analysis toward the RTD Toolkit – LTC Myatt

Presentations of Assessment Tools (continued)

0830 – 0900  (6) Assessment of Military Multitasking Performance (AMMP) – Dr. Margaret Weightman (PhD, PT), and Dr. Mary Radomski (PhD, OTR/L), Senior Scientific Advisors at Courage Kenny Research Center

0900 – 0915  Break

0915 – 0945  (7) Evaluation of the Military Functional Assessment Program (MFAP): A prospective, longitudinal study of the predictive validity of the MFAP for return-to-duty success – Dr. Carol Thornson (PhD), Research Psychologist at USAARL, and Mr. Mark Showers (MSOT, OTR/L), TBI Occupational Therapist at Army Intrepid Spirit, Fort Campbell, KY

0945 – 1045  Facilitated Discussion: Session 3

1045 – 1200  Breakout Sessions by Functional Area:

- Health/Clinical – facilitated by Dr. Crowley
- Performance/Occupational – facilitated by Dr. Estrada
- Human Dimension/Cognitive Domain – facilitated by LTC Myatt

1200 – 1300  Lunch Break

1300 – 1415  Functional Area Breakout Session Evaluations – Including possible discussion of any additional tools not presented for possible inclusion into the RTD Toolkit (keeping in mind that goal of the Toolkit is to determine fitness for military duty, beyond clinical diagnosis).

1415 – 1430  Break

1430 – 1530  Consensus and the Way Forward: Discussion on how best to integrate the different performance domains (e.g., cognitive, vestibular, ocular) and assessment tools to provide a comprehensive RTD Toolkit – one that provides military decision makers with a high degree of confidence in answering the question:

Can this Soldier (Airman, Sailor, Marine) perform his/her job effectively despite having experienced a neurosensory injury?

1530 – 1600  Closing Remarks – Dr. Crowley and Dr. Shoge

Figure 1. Two-day Symposium Agenda.
Symposium Packets

Each of the attendees received a Symposium Packet, a prepared folder containing relevant documents to reference during the two-day symposium. In addition to the foregoing Agenda, the 23 attendees (of the 25 invitees) were listed on the Attendee List displayed on Table 1, with the full name, title, credentials, and affiliation of each individual attending the symposium. Other documents included the seven Grading Sheets (see Figure 2 for an example), each of which was labeled with the name of the seven assessment tools to be evaluated, or rated, by the working group. The Grading Sheets were designed to gather both quantitative ratings data (Likert-scale) and qualitative data in the form of open-ended comments. Although attendees were advised that Grading Sheets could be kept strictly anonymous, all attendees who provided comments chose to identify themselves for inclusion in this report.

Working Group Symposium Objectives

The primary purpose of the RTD Toolkit set out from the beginning of the project, and reiterated at the start of the symposium, was to aid in operational decision-making (i.e., when is a Soldier who has experienced a neurosensory injury able to resume normal duties) and not clinical diagnosis. Critical to such an endeavor is the interpretation of the findings of each of the presented research projects in the context of operational RTD recommendations.

With this in mind, the Working Group objectives developed at the start of the P1 Task Area were to: (1) evaluate ocular, auditory, vestibular, and cognitive assessment tools for use in assessing neurosensory trauma and mild traumatic brain injury (mTBI) in warfighters; (2) provide feedback and direction on validating ocular, auditory, vestibular, and cognitive RTD performance assessment tools for warfighters; and (3) identify critical neurosensory and cognitive capabilities required for optimal survivability (safety) and mission effectiveness (operational performance) for warfighters.
Table 1. Symposium Attendees

<table>
<thead>
<tr>
<th>SYMPOSIUM ATTENDEE</th>
<th>AFFILIATION</th>
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<tr>
<td>Arthur Estrada, Ph.D.</td>
<td>USAARL</td>
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<tr>
<td>John Crowley, M.D.</td>
<td>USAARL</td>
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<tr>
<td>LTC Craig A. Myatt (Ph.D.)</td>
<td>USAARL</td>
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<tr>
<td>Katherine Helmick, M.S., CRNP, ANP-BC</td>
<td>DVBIC</td>
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<tr>
<td>Richard Shoge, Ph.D.</td>
<td>MOMRP</td>
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<td>Emma Gregory, Ph.D.</td>
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<tr>
<td>Donald Marion, M.D.</td>
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<tr>
<td>Stephanie Panker, Ph.D., DPT</td>
<td>Office of the Surgeon General (OTSG)</td>
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<tr>
<td>Joshua Wilk, Ph.D.</td>
<td>Walter Reed Army Institute of Research (WRAIR)</td>
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<tr>
<td>MAJ Matt Scherer (Ph.D., P.T.)</td>
<td>Army Human Resources Command</td>
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<td>MAJ Michael S. Kim (OTR/L)</td>
<td>Headquarters (HQ), OTSG</td>
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<td>LTC Susan Fondy (M.D.)</td>
<td>3rd Sustainment Command</td>
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<td>MAJ Michael Dretsch (Ph.D.)</td>
<td>HQ, U.S. Army Training and Doctrine Command (TRADOC)</td>
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<td>LTC Kristen Casto (Ph.D.)</td>
<td>HQ OTSG</td>
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<tr>
<td>Douglas Brungart, Ph.D.*</td>
<td>Walter Reed National Military Medical Center (WRNMMC)</td>
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<tr>
<td>Margaret Weightman, Ph.D., P.T.</td>
<td>Courage Kenny Research Center</td>
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<tr>
<td>Mary Radomski, Ph.D., OTR/L</td>
<td>Courage Kenny Research Center</td>
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<td>Mark E. Showers, M.S., OTR/L</td>
<td>Blanchfield Army Community Hospital</td>
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<td>Ben Lawson, Ph.D.*</td>
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<td>LTC Dave Walsh (O.D., Ph.D.)</td>
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<td>Angus Rupert, M.D., Ph.D.</td>
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<td>Carol A. Thornson, Ph.D.</td>
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<tr>
<td>SGT Nicholas L. McCulley (B.A.)</td>
<td>USAARL</td>
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*Unable to attend Day 2 of symposium
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<td>c. Warrior Transition Unit.</td>
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<td>d. Veterans Affairs Hospital.</td>
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<td>5. How well does this tool appear to address concerns about Soldier readiness?</td>
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**Final Score:**

*Figure 2. Example of a non-specific Grading Sheet.*
Welcome and Introductions – Richard Shoge, Ph.D. & LTC Craig A. Myatt

Welcome

LTC Craig A. Myatt
USAARL Aircrew Health and Performance Division Chief

Dr. Richard Shoge
MOMRP Injury Prevention Program Manager
Announcements

- Introductions
- Restroom Location & Breaks

Day 1:
- 1015 – 1030
- 1200 – 1330 (Lunch)
- 1400 – 1415

Day 2:
- 0900 – 0915
- 1200 – 1300 (Lunch)
- 1415 – 1430

- Please set cell phones to vibrate

Agenda Overview

Day 1
- Welcome – LTC Myatt & Dr. Shoge
- Task Area Overview – Dr. Crowley & Dr. Estrada
- Symposium Goals – LTC Myatt
- Current DoD RTD Standards – Ms. Helmick
- Presentations of Assessment Tools & Facilitated Discussions
- Day One Wrap-Up & Open Discussion
**Agenda Overview**

**Day 2**
- Targeted Analysis toward the RTD Toolkit – LTC Myatt
- Presentations of Assessment Tools & Facilitated Discussions
- Breakout Sessions by Functional Area:
  - Health/Clinical – facilitated by Dr. Crowley
  - Performance/Occupational – facilitated by Dr. Estrada
  - Human Dimension/Cognitive Domain – facilitated by LTC Myatt
- Functional Area Breakout Session Evaluations
- Consensus and the Way Forward – LTC Myatt
- Closing Remarks – Dr. Crowley & Dr. Shoge

**Summary of Symposium Introduction:** Dr. Shoge provided a brief welcome and overview of the logistics of building access and egress, lunch plans for each day (and the need to go together as a group), locations of snack machines, restrooms, kitchen, Wi-Fi access, and so on. He informed all attendees the symposium would be recorded and to please speak up and be as vocal as possible.

LTC Myatt introduced himself to the attendees and welcomed them all on behalf of our new commander at USAARL, COL Malish. The division chief of the Aircrew Health and Performance Division (AHPD) then discussed the type of research conducted at AHPD and at USAARL in general. Introductions were made with each attendee (expert and presenter) talking a bit about themselves – their backgrounds and organizations. LTC Myatt informed the gathering that he would serve as symposium facilitator and the official timekeeper for the presentations, in order to keep everyone on track. He then presented Dr. Crowley to provide the program area overview.
Overview of USAARL and Return-to-Duty Research in MRMC

1 September 2015
Program Area Steering Group Chair: Dr. John Crowley

Location and Personnel

Formally chartered in 1993 to solve evolving aviation and airborne aeromedical issues, USAARL is co-located with the Aviation Center of Excellence and the Combat Readiness/Safety Center at Ft. Rucker AL, and near key DoD assets in Southeast USA.

Number of Personnel

<table>
<thead>
<tr>
<th>Military</th>
<th>Civilians</th>
<th>Contractors</th>
<th>ORISE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>63</td>
<td>43</td>
<td>26</td>
<td>175</td>
</tr>
</tbody>
</table>

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Critical Need for Return to Duty Medical Research

- Valuated criteria to determine ability to perform complex military jobs do not exist
  - Performance evidence typically considered by Physical Evaluation Board:
    - Commander’s memo
    - Evaluation Reports
    - Army Physical Fitness Test (APFT)
- An Army inspector general's report completed in January found that the Army's process for deciding a soldier's fitness for combat is confusing and increases the chances of sending ailing troops to combat (USA Today 23 March 09).

Task P: Develop Neurosensory Return-to-Duty Standards and Strategies

- Gap in DoD medical practice/care
- RTD vs Rehabilitation

  - RTD
    - Fitness for specific military occupational duties
    - Standards for assessing performance
  - Rehabilitation
    - Medical treatment-based
    - Retraining common Soldier tasks
RTD research vs Rehab research

- MOMRP vs CRMRP

Injury → FXN → STDS → Duty

- Rehabilitation
- RTD

Original MOS

New MOS

VA

RTD research vs Rehab research

- MOMRP vs CRMRP

Injury → FXN → STDS → Duty

- Rehabilitation
- RTD
  - clinical
  - operational

MRMRP

MOMRP
• Key Events in Task P1
  – Funding
    • cut in FY11 to ~$1.3M
    • Objectives trimmed to dismounted toolkit only
  – 2011: Panel at AOHC on TBI RTD
  – 2012: MRMC RTD Workshop

Welcome to the Return-to-Duty Research Working Group

19-20 September 2012

Medical Research in Support of the Army Warfighter
Return-to-Duty Research Working Group

• Who: Key players concerned with safe return of Wounded Warriors to duty
  • Clinicians
  • Researchers
  • Senior leaders
  • Users
  • Policy makers

• What: Two day gathering sponsored by the US Army Medical Research and Materiel Command

• Why: Communicate, Identify, Integrate, Plan, Transition

Questions?

john.s.crowley.civ@mail.mil
www.usaarl.army.mil
Summary of Dr. Crowley’s Introduction: Dr. Crowley discussed how Fort Rucker is the home of Army Aviation with the U.S. Army Combat Readiness Center located on the installation. The main thrust of the program is aviation medicine research, with USAARL being the smallest laboratory in MRMC, having 175 individuals working here. Prevention is the main focus of USAARL – preventing accidents by keeping pilots safe with stimulants or fatigue measures, which could include studies such as examining heat stress in the flight simulator. If an accident does occur, however, there is research on how to avoid further exacerbation of injuries (i.e., developing better helmets and so on).

In 2009, USAARL was directed to respond to the large numbers of injured Soldiers returning from Iraq and Afghanistan and to move away temporarily from its aviation focus. Researchers responded by shifting gears from aviation to Soldiers returning to duty following injury, with the predominant focus on neurosensory injury. In the beginning, psychological injury and musculoskeletal injury were included. As a lab, USAARL was able to leverage its skills in the assessment domain to determining fitness for duty, with 2010 being the first year this task area was funded.

Dr. Crowley emphasized that it is critical for those in neurosensory research to make the distinction between rehabilitation and RTD. “Although one can draw Venn diagrams in many different ways and there will always be some overlap, there are important differences.”

Research in RTD is the process of determining if a Soldier is fit to RTD and for which job is she or he is fit, as opposed to rehabilitation, which is medical treatment-based.

As such, there is quite a bit of blurring between the two. As Dr. Crowley phrased it, “it is the military job of Soldiering that RTD is focused upon.”

An injury affects Soldier functioning, which is addressed clinically with rehab. But then someone must decide when the Soldier is ready to RTD.

Dr. Crowley emphasized that this is the distinction the experts must keep in mind when evaluating the assessment tools presented – rehabilitation is clinical and RTD is operational.

Dr. Crowley then turned the podium over to Dr. Estrada.
TA P1- Return-to-Duty Standards and Strategies After Neurosensory Injury

Task Area Overview

1 September 2015
Task Area Manager:
Dr. Arthur Estrada

Description
Task Area P1 develops validated standards and strategies enabling accurate, safe, and rapid decisions regarding the return of Soldiers to military occupations after neurosensory injury

Collaborating Institutions
Walter Reed National Military Medical Center
William Beaumont Army Medical Center, Fort Bliss, TX
Blanchfield Army Community Hospital, Fort Campbell, KY
Coward Kenny Research Center, Minneapolis, MN
Blanchfield National Intrepid Center of Excellence - Intrepid Spirit III Satellite (NICOE-III), Fort Campbell, KY
Womack Army Medical Center, Fort Bragg, NC
Darnell Army Medical Center, Fort Hood, TX
SUNY, State College of Optometry
Martin Army Community Hospital, Fort Benning, GA
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Funding Estimate and Objectives

Task Area: Return-to-Duty Standards and Strategies After Neurosensory Injury

<table>
<thead>
<tr>
<th>FY15 Estimate</th>
<th>FY16 Estimate</th>
<th>FY17 Estimate</th>
<th>FY18 Estimate</th>
<th>FY19 Estimate</th>
<th>FY20 Estimate</th>
<th>FY21 Estimate</th>
<th>FY22 Estimate</th>
<th>FY23-29 Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1117K</td>
<td>325K</td>
<td>325K</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
</tbody>
</table>

Near-Term Objectives (FY15-16)
1. By mid FY16, complete and report the evaluation and initial validation of selected existing and Task Area-developed RTD assessments of neurosensory trauma and TBI for inclusion in the RTD Toolkit for use by clinicians and RTD decision-makers.
2. By the end of FY16, publish and distribute a RTD Toolkit to TTA partners and other stakeholders for use and reference by clinicians and RTD decision-makers.

Mid-Term Objectives (FY17-22)
1. Perform continued surveillance and documentation of best practices and conduct ongoing validation of RTD assessment batteries.

Far-Term Objectives (FY23-29)
NA
Toolkit Realization

- 2015 RTD Working Group: Step 1
  - Two-way exchange
    - Task Area P1 project presentations
    - Experts to provide opinions/experience/input on P1 presentations
    - Experts to provide information on current practices/assessments for possible inclusion into Toolkit
  - Establish a plan for way forward
    - Identify contributors and process for Toolkit preparation, review, and publication

Questions?
Customers

• TTA with
  - DVBIC
  - DCoE
  for Toolkit

• Clinicians
• Medics
• PTs/OTs
• Flight Surgeons
• TTA with AAMA

Task Area P1

UNCLASSIFIED

Funding Estimate and Objectives

Task Area: Return-to-Duty Standards and Strategies After Neurosensory Injury

| TA Manager: Name (LAB) |
|------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| FY15 CBE | FY16 CBE | FY17 CBE | FY18 Estimate | FY19 Estimate | FY20 Estimate | FY21 Estimate | FY22 Estimate | FY23-29 Estimate |
| 1117K | 325K | 325K | TBD | TBD | TBD | TBD | TBD | TBD |

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Questions?
Summary of Dr. Estrada’s Introduction: Over the past seven years, USAARL has collaborated with multiple entities conducting research across this task area, seeking projects to contribute to the RTD Toolkit. Dr. Estrada reiterated his desire for the assembled experts to contribute to the final RTD Toolkit by providing critical guidance and input on which of the presented tools offer the most promise and which need further investigation and development before they could be considered toolkit worthy.

Dr. Estrada expressed the opinion that perhaps the slowdown of Soldiers into the combat environment over the last five years has presented researchers with fewer opportunities, citing Fort Campbell as an example. There have been fewer Soldiers taking part in the Military Functional Assessment Program (MFAP) due to the winding down of the wars. This has impacted this longitudinal study to a great extent.

Emphasizing that this Working Group Symposium is only the first step in the process of developing a final RTD Toolkit, Dr. Estrada went on to acknowledge that several of the assessment tools to be presented will not be in their final, validated form. This is why the guidance of subject matter experts in neurosensory injury is critically necessary, to point out any flaws and offer suggestions as to what will work and will not work. For these reasons open and honest feedback are encouraged and welcomed.

The overall RTD product will not be a USAARL-exclusive product; the goal is that it will be useful for everyone. Therefore, Dr. Estrada asked the experts to be forthcoming if they knew of any other assessment tools which might be applicable.

The RTD Toolkit is the capstone project of all the research efforts over the past six to seven years, including the numerous technical reports and publications from those many research projects. This meeting is critical, as will be your honest and open feedback.

Dr. Crowley elaborated on this premise, explaining that when USAARL first began research in the realm of traumatic brain injury (TBI) in the context of RTD, our initial goal was to be as broad as possible in the approach. However, due to the vast amount of research that has been conducted in neurosensory injury across the Department of Defense (DoD) and RTD world, gaps are unavoidable. One gap of which Dr. Crowley was recently made aware was Dr. Douglas Brungart’s work. Upon attending Dr. Brungart’s presentation recently at a conference, Dr. Crowley immediately perceived its applicability to the toolkit, and invited Dr. Brungart to present his assessment tool for consideration at this symposium.

Broadening the scope of this effort also involves awareness of the policies and procedures set forth by the OTSG and DVBIC. These entities have been conducting research in this area and setting policy for quite some time. Dr. Crowley emphasized the criticality of keeping these policy considerations in mind when conducting TBI research within the broader context of RTD.
As the policy recommendations are mainly treatment-based, clinical recommendations, Dr. Estrada pointed out the value of the functional assessments that were to be presented.

With clinical assessments, one might say to a commander, “This Soldier has passed these clinical tests, which means this.” With functional assessments, they can take it a step further, going to the commander and saying, “These assessments demonstrate the Soldier’s ability to perform these military operational duties.” So, even though these functional assessments may not appear clinical, they do demonstrate fitness for duty.

Dr. Estrada asked everyone to please keep this in mind when evaluating the functional assessment tools and reminded them that the MFAP is a great example of one of these types of tools.

LTC Myatt then notified all attendees that this RTD Toolkit Working Group Symposium technical report will be the main deliverable following the symposium and will be made available to all. In this technical report will be all the slide presentations and transcripts from the audio recordings. LTC Myatt then introduced Ms. Katherine Helmick of DVBIC.
Current DoD RTD Clinical Standards and Progressive Return to Activity Following mTBI
– Ms. Katherine Helmick, MS, CRNP, ANP-BC, CNRN

Return to Duty Expert Panel Working Group Symposium
Current RTD Clinical Standards and Progressive Return to Activity following mTBI
Katherine Helmick, MS, CRNP, ANP-BC, CNRN
Deputy Director
Defense and Veterans Brain Injury Center

Disclaimer

The views expressed in this presentation are those of the author and do not reflect the official policy of the Department of Defense, Department of Veterans Affairs or the U. S. Government.
An injured U.S. Air Force airman is rushed through “Hero’s Highway” to the emergency room on Balad Air Base, Iraq, Jan. 15, 2008. “Hero’s Highway” is a canopy with an American flag that serves as a transition area between the helipad and the ER. U.S. Air Force photo by Master Sgt. John R. Nimmo Sr.

Service Members Diagnosed with TBI

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Service Members Diagnosed with TBI</th>
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<tbody>
<tr>
<td>2000</td>
<td>10,958</td>
</tr>
<tr>
<td>2001</td>
<td>11,619</td>
</tr>
<tr>
<td>2002</td>
<td>12,407</td>
</tr>
<tr>
<td>2003</td>
<td>12,815</td>
</tr>
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<td>2004</td>
<td>14,468</td>
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<td>2005</td>
<td>15,530</td>
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<td>17,036</td>
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<td>32,907</td>
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<td>30,801</td>
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<tr>
<td>2013</td>
<td>27,646</td>
</tr>
<tr>
<td>2014</td>
<td>25,044</td>
</tr>
<tr>
<td>2015 (Q1)</td>
<td>5,912</td>
</tr>
<tr>
<td>Total</td>
<td>327,299</td>
</tr>
</tbody>
</table>
Severities of Diagnosed TBI among Service Members

DoD Numbers for Traumatic Brain Injury Worldwide – Totals

2000-2015 Q1
- Penetrating: 4,865
- Severe: 3,422
- Moderate: 27,728
- Mild: 269,580
- Not Classifiable: 21,704

Total - All Severities: 327,299

Source: Defense Medical Surveillance System (DMSS), Theater Medical Data Store (TMDS)

DoD TBI Capabilities

Based on Army Regional Map but includes all TBI capabilities

* Active Intrepid Spirit sites at Fort Belvoir, Camp Lejeune and Fort Campbell highlighted in yellow

DoD is improving its TBI safety net system that includes primary care, TBI specialists, and educational partners.

Source: Defense Medical Surveillance System (DMSS), Theater Medical Data Store (TMDS)
Continuum of TBI Care

Prevention  Screening  Diagnosis  Treatment  Rehab  Recovery

Surveillance

Research

DoD Policy (DODI 6490.11)

- Requires screening and mandatory 24 hours rest for all services members exposed to potentially concussive events in a deployed setting
- Army (and soon other services) expanded the policy to include the non-deployed setting.
  - Army Execution Order 163-13 signed June 2013
  - Applies whether or not the event happens on duty.
  - Requires evaluation by medical provider with 12 hours.
  - One-time (concussion in garrison), annual and predeployment (TBI) training required.

**DESIRED END STATE:** the mitigation of the effects of potential concussive events on both Service member health, readiness and ongoing operations
Mandatory Events
Requiring Evaluation

- Exposure to the following events mandates prompt command and medical concussion evaluation, event reporting and a 24-hour rest period.

- Any service member in a vehicle associated with a blast event, collision or rollover.
- All within 60 meters of a blast (inside or outside).
- Anyone who sustains a direct blow to the head.
- Command directed, including (but not limited to) repeated exposures to blasts.

Exposures to Potentially Concussive Events and Resulting Number of Concussions Diagnosed

- For the period Aug. 2010 – Dec. 2014, BECIR identified:
  - 16,899 service member exposures to potentially concussive events
  - 2,797 concussion diagnoses resulting from those exposures
  - 16.6% of all exposures during the period had diagnosed concussions

*Graph does not include Q1 CY14 because data are only currently available through Jan. 2014

*Excludes 12 records with missing event date.
Clinical Recommendations

- Equip primary care and TBI care providers with the ability to approach TBI care in a consistent evidence-based way across the MHS (military health system)
  - Improve the overall quality of care
  - Reduce need for specialists by equipping primary care providers with needed tools & knowledge
- Enable rapid knowledge translation from research to clinical care.
  - DoD’s TBI research portfolio includes >700 studies since 2007

DVBIC CR Development Process

Gaps or needs are identified through various means:
- Military field (stakeholders)
- Quad Services Working Group
- Government reports such as the IOM or RAND
- Research

Internal project team established

Development of systematic Reviews

Assess and synthesize the Evidence

Literature Review Summary Report with course of action

TBI Quad Services Working Group Review and final draft crosswalked with DoD policy

DoD, VA & Civilian Experts convene for workgroup meeting

Incorporate expert opinion and additional forms of evidence

Outcomes inform revisions of CR or research needed

Implement CR and evaluate evidenced-based interventions on patient outcomes and caregiver behavior

Establish and begin external working group

Develop CR products (suite)
- CR
- CST
- Patient Education
- Provider Training
- Slides

30
Clinical Recommendations

1) Military Acute Concussion Evaluation (MACE) and Clinical Management Algorithms JUN 06 DEC 06
2) Cognitive Rehabilitation APR 2009
3) Driving Following TBI JUL 2009
4) Indications and Conditions for In-Theater Post-Injury NCAT Testing MAY 2011
5) Indications & Conditions for Neuroendocrine Dysfunction Screening Post mTBI MAR 2012
6) Assessment and Management of Dizziness Associated with mTBI SEP 2012
7) Assessment and Management of Visual Dysfunction Associated with mTBI (in collaboration with the Vision Center of Excellence) JAN 2013
8) Neuroimaging Following Mild TBI in the Non-Deployed Setting JUL 2013
9) Progressive Return to Activity Following Acute Concussion/mTBI: Guidance for the Primary Care Manager in Deployed & Non-deployed Settings JAN 2014
11) Management of Sleep Disturbances Following Concussion/mTBI JUN 2014
12) Post-concussive Headache * Fall 2015

Identification of Questions

Although there are consistent, evidence-based recommendations for rest and a gradual return to activity following concussion, no specific recommendations concerning:

- A description of "Rest"
- What activities are recommended at specific time frames following injury
- What activities should be avoided at specific time frames following injury
- What are the progression parameters
- When to refer to a higher level of care
Development Process

- Working group established (40 members) including representation from all services, the VA, academic and research experts (multidisciplinary)

- Foundation documents including CPG, Consensus and Position Statements recommending a gradual return to activity: Zurich Consensus
  - ACEP
  - AAN
  - ASSM
  - ONTF

Development Process cont.

Inclusion of domains / activities:
- Physical
- Cognitive
- Vestibular / Balance

Incremental increase in physical activities to be included in each stage integrated the principles of:
- Borg’s Rate of Perceived Exertion Scale (RPE)
- Metabolic Equivalents Scale (MET)

Subjective measures of RPE and the Neurobehavioral Symptom Inventory (NSI)

Objective measures: Theoretical Maximum Heart Rate during activity
- Resting heart rate (not greater than 100 bpm)
- Resting blood pressure (not greater than 140/90)
The Progressive Return to Activity clinical recommendations provide primary care managers and rehabilitation providers with guidance regarding how service members can incrementally return to pre-injury activity following an acute concussion. The two detail:

- Education interventions after diagnosis
- The parameters for physical and cognitive rest
- A standardized, staged approach for increasing physical and cognitive activities to optimize recovery
- Recommendations for progression, regression and referral

To download or order hard copies, visit dvbic.dcoe.mil/resources/progressive-return-to-activity

Outcome:
Two Recommendation Suites

The Progressive Return to Activity clinical recommendations provide primary care managers and rehabilitation providers with guidance regarding how service members can incrementally return to pre-injury activity following an acute concussion. The two detail:

- Education interventions after diagnosis
- The parameters for physical and cognitive rest
- A standardized, staged approach for increasing physical and cognitive activities to optimize recovery
- Recommendations for progression, regression and referral

Each suite includes:
- Clinical guidance
- Clinical support tool
- Provider educational slide deck
- Patient education products

Primary Care Manager Suite
This suite of tools provides an initial framework for gradually increasing service member activity after concussion.

Rehabilitation Provider Suite
This suite of tools is for more symptomatic service members referred by primary care managers to rehabilitation providers.

Primary Care Manager Suite

Rehabilitation Provider Suite

(Defense and Veterans Brain Injury Center, 2014)

General Principles

- Six stages of progression from Stage 1- Rest to Stage 6-Return to pre-injury activity
- After an education intervention for all patients, those with few and mild symptoms are managed by a Primary Care Manager and follow a self-guided staged recovery
- Utilize the Neurobehavioral Symptom Inventory (NSI) for tracking symptoms
- List key activities for participation and activities to avoid at each stage
- Patients who are more symptomatic or who fail to progress are referred to rehabilitation providers for a more intensive, clinician-directed, daily-monitored recovery
## Stages of Progressive Activity

<table>
<thead>
<tr>
<th>Rehabilitation Stages</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 1</td>
<td>Rest (minimum 24 hours)</td>
</tr>
<tr>
<td>Stage 2</td>
<td>Light Routine Activity</td>
</tr>
<tr>
<td>Stage 3</td>
<td>Light Occupation-oriented Activity</td>
</tr>
<tr>
<td>Stage 4</td>
<td>Moderate Activity</td>
</tr>
<tr>
<td>Stage 5</td>
<td>Intensive Activity</td>
</tr>
<tr>
<td>Stage 6</td>
<td>Unrestricted Activity</td>
</tr>
</tbody>
</table>

## Algorithm for Primary Care
1) We know from the literature that patient education is the single most important intervention following a concussion.

2) The Acute Concussion (mTBI) Educational Brochure are given to all service members diagnosed with concussion.

**Rest:**

**Recommended Parameters for Recovery and Stage 1: Rest**

- Extremely light activities
- Avoid caffeine and tobacco
- Wear comfortable clothing
- No exercise
- Quiet environment with low lighting
- No alcohol
- Healthy sleep
- Range of motion
- No visual games
- Slow and limited range of motion
- No studying
- Walk one level surface at ease pace
- No driving

---

**Return to Activity Educational Brochure**

**Stage 2: Light Routine Activity - All activities no longer than 30 minutes**

- Do gentle exercises
- Do light household tasks
- Use light voice
- Read
- Play games, such as cards

**Stage 3: Light Occupation-oriented Activity - All activities no longer than 30 minutes**

- Play simple video games
- Use low-intensity exercise equipment
- Walk 1 block
- Stairs
- Mow lawn
- General work around the house

**Stage 4: Moderate Activity**

- Do light physical training
- Go to movies
- Low impact aerobic exercise
- Walk 1 mile
- Do recreational activities

**Stage 5: Intensive Activity**

- Start swimming again
- Do heavy job-related tasks
- Participate in work-related training
- Complete full physical training
- Do light exercise during partial duty or use public transportation

**Stage 6: Unrestricted Activity**

- Participate in sports or contact sports
- Participate in activities
- Participate in full activity

---

**Return to Activity Educational Brochure**

**WHAT IS A CONCUSSION?**

A concussion is a brain injury from a blow or jolt to the head. A concussion is not the same as a concussion.

- May affect your ability to remember information before, during, or after the event.
- May affect your ability to perform daily activities.
- May affect your ability to concentrate or pay attention.
- May affect your ability to think or remember.

This brochure will help you to recover as quickly and safely as possible. Each stage is designed to help you gradually return to your normal activities. You can stop at one stage longer than another if you are not comfortable with the activities. Everyone is different.

Do not rush your progress.
Return to Activity Educational Brochure

Stage 1: Rest

Objective

• Extremely light physical, cognitive and vestibular-balance activity with the goal of symptom resolution

Activity and rest guidelines

• Primarily rest with extremely limited cognitive activity
• Basic activities of daily living and extremely light leisure activity
• Extremely light vestibular-balance activity is permitted, including walking on level surfaces and limited head movements
• No work, exercise, video games, studying or driving

SM may return to pre-injury activity with follow-up guidance if NO symptoms are present (following exertional testing) after Stage 1
### Stage 2: Light Routine Activity

**Objective**
- Initiate and promote limited effort
- Activity limited to 30 minute intervals or less followed by four hours of rest

**Activities**
- Outdoor or indoor light physical activities, such as stretching, walking, stationary cycling at low pace and resistance
- Cognitive activities such as computer use, leisure reading, and simple board games
- Vestibular and balance activities such as climbing stairs, putting on boots, and bending tasks
- **NO** video games, driving, resistance training, repetitive lifting, sit-ups, push-ups or pull-ups

### Stage 3: Light Occupation-oriented Activity

**Objective**
- Increase intensity and complexity of exercise and cognitive activity

**Activities (in addition to previous stage)**
- Lift and carry objects less than 20 lbs., use elliptical or stair climber machines, or light military tasks such as cleaning equipment
- Cognitive activities such as increasing exposure to light and noise, performing a maintenance check on vehicle or shop for one item
- Balance activities including walking on uneven terrain, swimming (avoiding flip turns) or standing on one foot
- Physical activities not to exceed 60 min. followed by minimum four hours rest; Light cognitive activities not to exceed 30 min. followed by minimum 60 min. rest
- **NO** video games, driving, combatives or collision sports
Stage 4: Moderate Activity

Objective
• Increase in intensity and complexity of exercise and cognitive activity to match demands of occupation

Activities (in addition to previous stage)
• Physical activities such as brisk hike, jogging to running as tolerated, light resistance training or non-contact sports
• Cognitive activity with greater demand such as video games, land navigation, driving simulator, weapons simulator or target practice
• Vestibular/balance activities with greater demand such as swimming with flip turns, jump rope
• Physical activities not to exceed 90 min. followed by minimum six hours rest; Cognitive activities not to exceed 40 min. followed by minimum 80 min. rest
• NO driving, combatives or collision sports

Stage 5: Intensive Activity

• Objective
  • Duration/intensity of activity parallels service member’s typical role, function and tempo
• Activity (in addition to previous stage)
  • Resume usual physical exercise routine
  • Cognitive activities may include driving (as appropriate), weapons simulator or target practice
  • Vestibular/balance activities may include running, patrol duty, jump landing, use of night vision goggles
  • Physical activity duration is only limited if symptomatic; cognitive activities not to exceed 50 min. followed by rest
  • Include multitasking and problem solving
  • NO combatives or collision sports

*SM to see PCM after Stage 5 for exertional testing and before release to Stage 6
Stage 6: Unrestricted Activity

Objective

• Resume pre-injury activities

Return to provider if symptoms return

Rehabilitation Provider

Daily monitored approach
For individuals who are not progressing as expected
No progress in 7 days
Per Primary Care Manager judgment
Rehabilitation Provider Clinical Support Tool

Neurobehavioral Symptom Inventory (NSI) completed at onset of Stage 1. Note any symptoms rated above 1 (mild).

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest</td>
<td>Initiate Stage 2 the next day after Stage 1. If no new symptoms, no symptoms above a rating of 1 on the NSI, resting BP not less than 140/90, resting HR not greater than 100.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Decrease demands systematically and progressively, observing for any change that produces symptoms; modify intensity/duration of demands based on symptom exacerbation.

**Patient Education Sheets**

**Patient Activity Guidance After Concussion**

**Stage 1: Rest**
If your symptoms get worse or if you have new symptoms, stop the activity immediately and tell your provider.

- **Physical Activities**
  - Sit in a quiet environment with low lighting.
  - Wear your corrective lenses and sunglasses if needed.
  - Avoid prolonged reading, screen computer work.
  - No driving.
  - No long trips.
  - Practice good sleep habits (get 6-8 hours). See Healthy Sleep Fact Sheet at avocado.pdf.

- **Thinking/Decision Activities**
  - Eat in a quiet environment with low lighting.
  - Wear your corrective lenses and sunglasses if needed.
  - Avoid prolonged reading, screen computer work.
  - No driving.
  - No long trips.

- **Body Movement/Balance Activities**
  - Limit positions where your head is below your heart.
  - Lay attention to head movements.
  - Avoid sudden movements, especially lateral shifts to avoid dizziness.

- **Avoid**
  - Caffeine, alcohol, or other stimulants.
  - Work or study.
  - Heavy lifting.

- **Do Not**
  - Drive.
  - Drink alcohol.

Practice good sleep habits (get 6-8 hours). See Healthy Sleep Fact Sheet at avocado.pdf.
Stage 1: Rest

Objective
- Rest, limit activity to promote recovery
- No same day return to duty/play
- Establish and document resting HR/BP

Activity and rest guidelines
- Target RPE is 6-8, HR should not exceed 40 percent of TMHR
- Basic activities of daily living and extremely light leisure reading
- Television with rest breaks each hour
- Limit positions where the head is below the heart

Stage 2: Light Routine Activity

Objective
- Light routine activity limited to 30 minutes, followed by four hours of rest

Activity and rest guidelines
- Target RPE is 7-11
- HR should not exceed 55 percent of TMHR
- Light aerobic activity, avoid repetitive lifting
  - 30 minute periods followed by 4 hours of rest
- Cognitive activities such as computer use, leisure reading, and simple board games
  - 30 minutes maximum followed by 60 minute rest between activities
- Vestibular and balance activities such as climbing stairs, putting on boots
Stage 3: Light Occupation-oriented Activity

Objective
- Full body, complicated coordinated movements

Activity and rest guidelines
- Target RPE is **10-12**
- HR should not exceed **65 percent** of TMHR
- Aerobic activity
  - 60 minute periods followed by 4 hours of rest (1:4 ratio)
- Light cognitive activities
  - 30 minutes maximum followed by 60 minutes of rest between activities
- Vestibular and balance activities: walking on uneven surface, steps/stairs, swimming (no flip turns)

Increase demands systematically and progressively, observing for any changes that provoke symptoms; modify intensity/duration of demands on symptom exacerbation

Stage 4: Moderate Activity

Objective
- Increase in intensity and complexity of exercise and cognitive activity

Activity and rest guidelines
- Target RPE is **12-16**
- HR is **70-85 percent** of TMHR
- Non-contact sports, brisk hike (no additional load), light resistance training
  - 90 minutes maximum followed by four times the amount of rest (1:4); i.e. 30 minutes of activity requires minimum 2 hours of rest
- Video games, driving simulation
  - 20 minutes to maximum of 40 minutes, followed by 80 minutes cognitive rest (1:2)
- Activities with greater vestibular/balance demand including swimming with flip turns, navigating uneven terrain

Increase demands systematically and progressively, observing for any changes that provoke symptoms; modify intensity/duration of demands on symptom exacerbation
Stage 5: Intensive Activity

Objective
• Duration/intensity of activity parallels service member’s typical role, function and tempo

Activity and rest guidelines
• Target RPE is 16+, HR is 85-100 percent of TMHR
• Resume usual physical exercise routine
• Driving (as appropriate), weapons simulator or target practice
• Cognitive activities should include multitasking and problem solving
  — 50 minutes maximum
• Greater exercise intensity and dynamic balance activities: running, patrol duty, jump landing, use of night vision goggles

Increase demands systematically and progressively; observing for any changes that provoke symptoms; modify intensity/duration of demands on symptom exacerbation

Multiple Concussion

• Multiple concussions are associated with greater number of cognitive, somatic/sensory, vestibular, and emotional symptoms.
• Multiple concussions is associated with a slower recovery of symptoms.
  ▪ Military requires additional 7 days of rest for 2nd concussion within 12 months and additional rest plus referral to TBI specialist for 3rd concussion within 12 months
• Prior concussion may increase susceptibility to future TBI.
  ▪ May require less force than previous
• Cumulative concussion is associated with a progressive decline of memory and cognition
### Key Points

**First Concussion** – service member may return to pre-injury activity level if:
- Service member remains asymptomatic or reports symptoms as 0 to 1 (mild) on NSI after exertional testing
- Exertional testing may be performed:
  - If service member is asymptomatic after 24-hour mandatory recovery period
  - If service member has no new symptoms or has an NSI score of 0 to 1 (mild) following Stage 1: Rest
  - After successful completion of Stage 5: Intensive Activity

**Second Concussion** – service member may return to pre-injury activity level if:
- Service member has seven consecutive days of symptom resolution at stages 1 & 2 before progressing to stages 3-5. *and remains asymptomatic or reports symptoms as 0 to 1 (mild) on NSI after exertional testing following Stage 5: Intensive Activity*

LTC Myatt thanked Ms. Helmick for her presentation on research and policy implications, as well as the gold standard of care for TBI, then introduced the first assessment tool under consideration for inclusion into the RTD Toolkit, to be presented by LTC Walsh (then “MAJ Walsh”).

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Presentations of Assessment Tools

Assessments of the Pupillary Light Reflex (PLR) and Eye Movements for Early Identification of Warfighters with mTBI/Concussions – LTC Dave Walsh

17420 – Assessments of the Pupillary Light Reflex (PLR) and Eye Movements for Early Identification of Warfighters with mTBI/Concussions

MAJ David V. Walsh, OD, PhD, FAAO

Co-Investigators: LTC Jose E. Capo-Aponte; Dr. Ashley D. Ballard; Thomas A Beltran; Dr. Wesley R. Cole; Joseph Y. Dumayas

Disclaimer

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 official documentation.

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INTRODUCTION

Introduction

- The DOD reported that 320,344 cases of traumatic brain injury (TBI) were confirmed since 2000, with mild TBI (mTBI) accounting for 82.5%.
- The diagnosis of mTBI has been a challenge for the military primarily because of the lack of objective assessment tools, overlap of symptoms in co-morbid conditions such as post-traumatic stress disorder (PTSD), and the interpretation of signs and symptoms by healthcare providers relies on self-reported symptoms from the injured Warfighters.
- Prompt and accurate diagnosis and management of mTBI generally increases an individual’s prognosis for neurological recovery and safe return to duty (RTD).
- Premature RTD places Warfighters at greater risk of disability if they suffer an additional concussive trauma. Consequently, there is a quest for objective markers (e.g., protein, imaging, cognitive, neurosensory) to objectively diagnose Warfighters with mTBI/concussion.
Introduction

Gaps
• Lack of objective markers (e.g., protein, imaging, cognitive, neurosensory) to objectively diagnose Warfighters with mTBI/concussion.
• Ideal devices are: accurate, quick to perform, non-invasive, causes no discomfort or risk to patient, minimal training, deployable, low cost.
• Valid objective markers are particularly important in the theater to assist deployed clinicians to make an accurate determination of fit-for-duty (FFD)/RTD or evacuation.

Objectives
• Since approximately 30 areas of the brain, and 7 of the 12 cranial nerves deal with vision, it is not unexpected that the patient with TBI may manifest a host of visual problems, such as pupillary deficit, visual processing delays, and impaired oculomotor tracking and related oculomotor-based reading dysfunctions.
• The proposed study will investigate pupillometry, version (i.e., saccades) and vergence (i.e., convergence) eye movements as potential objective biomarkers for acute mTBI.
• We have included 3 eye procedures and 1 questionnaire in this study (10 min).

Introduction
• Pupillometry study (Capo-Aponte, et al., 2013): n=40 (20 sub-acute mTBI/20 age-matched controls): found significant differences with 4/8 pupillary measurements
• Working Group paper (being drafted for publication): Top 3 recommendations for field-based tests in TBI detection: Pupillary light reflex, Vergence, and Version
METHODS

Methods

• Case-Control Design
• Approved for 200 AD military personnel aged matched
  – Preliminary data 125 subjects
    • 91 mTBI; age 19-44
    • 34 Non-TBI; age 29-44
• Pupillometry (NeurOptics PLR-200) x2
• Vergence Eye Movement (NPC ruler) x2
• Version Eye Movement (King-Devick) x2
• Vision Symptoms Questionnaire (15 questions) x2
Methods

Near Point Convergence test/Vergence test: checks “eye-teaming” or focusing ability of the two eyes. The tester will use a modified ruler to measure when and if one of the eyes deviates out.

NeurOptics PLR- Hand-held, easy to use, quick, deployable
Methods

Eye movement/version test: Subject is asked to read numbers aloud while being timed. Speed and accuracy is emphasized.

Convergence Insufficiency Symptoms Survey (CISS)

- Score:
  - always (4)
  - frequently (3)
  - sometimes (2)
  - rarely (1)
  - never (0)
- Passing Score ≤ 20
RESULTS

Maximum Diameter

\[ P = 0.251 \]

\[ P = 0.318 \]
Minimum Diameter

\[ P = 0.151 \]

\[ P = 0.333 \]

Percent Constriction

\[ P = 0.379 \]

\[ P = 0.656 \]
Constriction Latency

\[ P = 0.055 \]

Maximum Constriction Velocity

\[ P = 0.251 \]
Average Constriction Velocity

*P < 0.0001

Average Dilation Velocity

*P < 0.0001
**75% Recovery Time**

![Graph showing 75% Recovery Time comparison between mTBI and Control for ON and OS.](image)

*P < 0.025  
*P < 0.0001

**Near Point of Convergence**

![Graph showing Near Point of Convergence comparison between mTBI and Control.](image)

*P = 0.013
King-Devick Test

\[ *P < 0.0001 \]

CISS

\[ *P < 0.0001 \]
DISCUSSION

Discussion

• Conclusions
  – Preliminary data for all methods is proving an effective tool.
    • PLR (i.e., ACV, ADV, T75%), NPC, KD test
    • Good correlation with CISS
  – Easily performed by subjects, including mTBI
  – Easily administered by techs and doctors
  – Faster (3 min) than conventional oculomotor examination (20 min)
  – Future Direction
    • Complete data collection for aged-matched control data (non-mTBI group esp. 19-29 yo)
Contribution to Military Medicine

- Provide tool to expedite mTBI diagnosis and management
  - Delegated to technicians/medics
- Strong candidate to determine FFD/RTD status for those Warfighter’s with mTBI.

Works Cited

**Discussion on Pupillary Light Reflex (PLR):**

MAJ DRETSCH: How long after the injury were they being tested?

LTC WALSH: Within 72 hours, they had to come in and get tested. They saw a neurologist.

DR. PANKER: Do any of the questions address emotional state or heightened emotional state?

LTC WALSH: Honestly, I’d have to look at them, but I don’t think so because it’s a convergence insufficiency symptom: “Are your eyes tired?”

DR. PANKER: I’m just wondering if any of these measures are reactive to heightened emotional states, to the sympathetic drive, for instance.

LTC WALSH: It’s possible, yes.

DR. PANKER: The other thing is sleep deprivation. It would be interesting to test the tester and also test the subject under sleep deprivation and what assessments can be made under those conditions. And then my third question would be under low light conditions – were all these done inside as opposed to outside?

LTC WALSH: Yes, inside, very controlled conditions, a clinical environment.

MR. SHOWERS: One piece I would add in relation to the piece like the stress environment is, there were 100 folks that were tested, right?

LTC WALSH: Yes, 91.

MAJ DRETSCH: What are the causes of the TBI – sports related?

LTC WALSH: Yes, concussion. Airborne, Combatives, training – we’ll break that down, I’m sure.

MAJ DRETSCH: So these could be small effect sizes – how robust are they?

LTC WALSH: Yeah, that’s why you want as big a sample size as possible.

DR. MARION: To me, the most interesting thing you’ve shown here is the separation of part of the autonomic response with the normal pupil constriction.

LTC WALSH: That’s the last part of the curve, at 75%, and unfortunately I can’t go back a few slides, but it gives you a unique number. It’s called the NPI. It’s a number between 0 and 5 and if your number is below 3, you’re a No-Go. Jose [Capo-Aponte, PI] didn’t want to show this because he didn’t get good correlations, but the cool thing about this number is that if you’re a medic, you can just look at this number – the NPI – it’s just an algorithm. The medic can say, “It’s a 1. Okay, you can’t go back into the fight.” That’s great, but we’re not finding good correlations. We’re not done collecting data, so this is something we have to talk to the company about and find out.
DR. ESTRADA: So, it would be possible to program the PLR to identify a score?

LTC WALSH: That’s what we’d like to do. It’s an algorithm. We don’t know. But we’d like the medic to have a quick, easy way.

DR. PANKER: Maybe I missed it, but were all those in the TBI group non-symptomatic when you tested them?

LTC WALSH: I was not testing them. It was done at DVBIC and Fort Bragg.

DR. PANKER: The intent [of this symposium] is RTD. But the intent here is screening?

LTC WALSH: Yes, these are all screening.

DR. PANKER: As a screening tool, you may want to change your alpha level, you know?

LTC WALSH: So, a .05 alpha level, and make it .01?

DR. PANKER: No, .05 is the standard, so you don’t want greater than 5% of a Type I error, but if this is a screening tool, maybe you’re not as worried about that and you can set your alpha level to something else?

LTC WALSH: Right, anything else?

LTC FONDY: So, you’re saying a medic wouldn’t know what this number means but you’re assuming that a medic would have this tool available, and there’s a limited amount of room they have available to carry stuff in their bags.

LTC WALSH: It’s a pretty small tool, though I know what you’re saying.

LTC FONDY: But everybody’s got a small tool that they want me to use.

LTC WALSH: We can only do the research; you do the data! [Laughter]

MAJ SCHERER: I know you guys are still in the process of writing up the papers. In terms of discussion points, have you theorized how some of these subtle impairment level measures may translate into function in terms of readiness to RTD?

LTC WALSH: No, we haven’t gone to that step. That’s another step we can think about. Questions that anyone has, let me know and I can talk to Dr. Cole and LTC Capo-Aponte, and they can give specific answers.

DR. CROWLEY: So, I think it’s a really good point. This hasn’t been matched to the outcomes of the TBI yet. If, for example … and maybe we need to get with Jose [Capo-Aponte] – if those clustered above the 75% – if that’s what that bar meant?

LTC WALSH: Yes.
DR. CROWLEY: If those were the ones you had persistent symptoms, then you’ve got something very interesting there. But this is the population of people coming in with mTBI and most of them are going to get better.

LTC WALSH: But you don’t want to send them back to the field. These are people that are acute. You’re right, six months later, they could be better, but let’s say you make a premature diagnosis that they’re fine. You send them back and they get more concussions.

MS. HELMICK: But we do have a lot of data that says the neuropsychological sequelae is more lasting than what the person says in terms of how they’re functioning. So, sometimes you have to say, “Do you trust the data, the objective data?” Even though the person is not complaining of having memory, attention, reaction time, or my pupils aren’t reacting as fast as they should – how does that really interplay with what their function is?

MAJ DRETSCH: And again, doing this is great – you can calculate your cut scores and everything but you have to look across time – whether two weeks... What is the delta? Is there a change?

LTC WALSH: There is an interesting thing about this result. The one that was subacute that I showed, the one that was significant, correlated with a paper Jose did – that was kind of interesting. We’ve got a lot of writing to do, Mike [MAJ Dretsh], I know.

DR. GREGORY: In terms of the timing, I wanted to ask – in addition to the 72 hours, I was wondering if you could see differences after 24 hours and 48 hours. Also, you said you were collecting two different data points per person. How reliable were they? What were you reporting, the mean?

LTC WALSH: Yes, the mean.

DR. GREGORY: So, it would be interesting to look at those individual data points.

DR. CROWLEY: Yes, so if you were looking at a tool, how consistent is it? What’s the right test term for that?

DR. THORNSON: Test-retest reliability?

DR. CROWLEY: Yes, test-retest. Yes, if there’s considerable spread, it would be important to know.

DR. THORNSON: Yes, the range, the minimum and maximum. And Jose [Capo-Aponte] did plan on being here. He had a last-minute prior commitment.

LTC WALSH: I know. He talked to me off-line though.

LTC MYATT: We’ll get to have more time during the facilitated discussion.

DR. WEIGHTMAN: I’d like to hear more about … [inaudible]
LTC WALSH: It was significant! Near-point convergence was significant; the King-Devick test was significant; and the Convergence Insufficiency Ophthalmology Survey was significant. They were all significant. Three pupillary markers were significant … [continues with slide presentation]. These were all screening tools.

MS. HELMICK: You mentioned the Spine article published by LTC Capo-Aponte. Was this study built on that one?

LTC WALSH: That one was at Walter-Reed with only 20 acutes and 20 controls. This study is to look at a much larger sample size of 200 Soldiers at Fort Bragg. We’ve collected data on 92 acutes so far. The results will be published as an Executive Summary.

This concluded the feedback to LTC Walsh’s presentation. See Table 2 for the results of the attendees’ ratings and qualitative feedback discussion following LTC Walsh’s presentation of his assessment tool, Pupillary Light Reflex (PLR) and Eye Movements for Early Identification of Warfighters with mTBI/Concussions.

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# PLR Grading Sheet Results

*Table 2. Pupillary Light Reflex (PLR) Results*

<table>
<thead>
<tr>
<th>Question/Item</th>
<th>Open-Ended Comments for each Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How useful is this tool for assessing RTD by medical personnel?</td>
<td><strong>Item Mean (1–7) = 4.44</strong>&lt;br&gt;<strong>Dr. Radomski:</strong> Not yet ready for implementation – reflects untested potential.&lt;br&gt;<strong>Dr. Weightman:</strong> Potential for it to be used.&lt;br&gt;<strong>LTC Fondy:</strong> This is diagnostic, not RTD&lt;br&gt;<strong>Dr. Panker:</strong> Identification, not RTD – not yet, screening data 72 hours from injury&lt;br&gt;<strong>Dr. Gregory:</strong> As a diagnostic tool, this has lots of potential; needs some additional evidence to interpret scores (items 1–3)</td>
</tr>
<tr>
<td>2. How useful is this tool for assessing RTD by non-medical (operational/unit) personnel?</td>
<td><strong>Item Mean (1–7) = 3.81</strong>&lt;br&gt;<strong>LTC Fondy:</strong> This is diagnostic, not RTD&lt;br&gt;<strong>Dr. Panker:</strong> Identification, not RTD – not yet, weigh and cube</td>
</tr>
<tr>
<td>3. How do you rate the scientific value of this tool?</td>
<td><strong>Item Mean (1–7) = 5.25</strong></td>
</tr>
<tr>
<td>4a. How applicable would this tool be in a Combat Support Hospital?</td>
<td><strong>Item Mean (1–7) = 4.88</strong>&lt;br&gt;<strong>Ms. Helmick:</strong> With much more study – too soon to say</td>
</tr>
<tr>
<td>4b. How applicable would this tool be in a Medical Treatment Facility?</td>
<td><strong>Item Mean (1–7) = 5.50</strong>&lt;br&gt;<strong>Dr. Gregory:</strong> No longitudinal data were presented (4b–d)</td>
</tr>
<tr>
<td>4c. How applicable would this tool be in a Warrior Transition Unit?</td>
<td><strong>Item Mean (1–7) = 4.19</strong></td>
</tr>
<tr>
<td>4d. How applicable would this tool be in a Veterans Affairs Hospital?</td>
<td><strong>Item Mean (1–7) = 4.73</strong></td>
</tr>
<tr>
<td><strong>OPERATIONAL RTD</strong>&lt;br&gt;5. How well does this tool appear to address concerns about Soldier readiness?</td>
<td><strong>Item Mean (1–7) = 4.38</strong>&lt;br&gt;<strong>Dr. Brungart:</strong> The PLR looks useful from a research standpoint, but from the data shown it looks like the King–Devick test is just as (or more) scientific, but much more portable.&lt;br&gt;<strong>Ms. Helmick:</strong> With much more study – tool has been studied to look at mTBI as a diagnostic. If helpful for diagnostics then would validate that.&lt;br&gt;<strong>Dr. Weightman:</strong> Potential – not as much experience in this area</td>
</tr>
</tbody>
</table>
A Simple Field Test for Balance Impairment – Dr. Angus Rupert, M.D., Ph.D.

Task Area P1: RTD Standards and Strategies after Neurosensory Injury:

A Simple Field Test for Balance Impairment
(Project #11670)

PI: Angus Rupert, Ph.D., M.D.
USAARL

AI: Ben Lawson, Ph.D.
USAARL

- Period of Performance: FY10-14
- Total Budget: $981K
- Portfolio Manager: Richard Shoge
- Relevant to TECD 7d, Brain in Combat: Resilience, Assessment, and Intervention

Research Aims and Hypothesis

Aim:

- Objective 1: Demonstrate accuracy and simplicity of head worn goggles in the assessment of subjective visual vertical
- Objective 2: Compare head worn goggle testing to current gold standard of rotary chair test of subjective visual vertical

Hypothesis:

- A rugged head mounted goggle device can provide subjective visual vertical tests at least as accurately as the current dark room tests carried out in tertiary hospitals by specialists
Vestibular System Overview

Subjective Visual Vertical Test (SVV)

- Has objective component – ocular counter-roll.
- Recent development of dynamic component to include isolation of stimulus.
Neurokinetics – Neuro-Otologic Test Center (NOTC)

Design and Methodology

Design and methods

- Specify and design head mounted device to perform Subjective Visual Vertical test
- Contract manufacturing of SVV device
- Test SVV under both static (Phase 1) and dynamic conditions (Phase 2)

Subjects and recruitment

- Phase 1 & 2: Recruit local volunteers military and civilian

Statistical analyses

- Phase 1 & 2: Compare head-mounted SVV goggle data to conventional data under both static and dynamic conditions.

Dissemination/transition plan

- Transition production and marketing to manufacturer with foreign and domestic medical marketing skills (e.g. Chronos – Germany)
- Recommend additional tests be incorporated into basic SVV device for both assessment and treatment. Utilize SBIR process.
Study Progress

Deliverables to date:
• Prototype completed
• Commercial product delivered Nov 2013 to European Market

Delays/Challenges/Barriers:
• USAMAA Contract delay 8 months
• Prototype delivery delay 5 months
• Commercial Device delayed 11 months pending sensor changes.

Key Accomplishments

• Prototype device delivered and met specifications for static testing
• Device superseded by rapid technology advancements to include objective counter-roll capability.
  1) Normative data has been collected for static condition.
  2) The prototype device meets required accuracies of both stimulus delivery and output measurements
Dissemination/Transition Plan

End-users:
- Army Medicine – clinical rehab and corpsman
- Civilian ENT/rehab community

Collaborator:
- Chronos initially and now 3 SBIR companies

Transition documents:
- TTA in place with DVBIC and DCOE for TBI

Ongoing and Future Efforts

- Commercial SVV device is currently being marketed in Europe
- Device capability is being expanded to include additional tests via SBIR route
  - Three Phase I companies developed prototype generation SVV
  - Phase II selection in process
- Findings will contribute to the development of an assessment battery (Clinical Toolkit – Task P deliverable) with sensitivity to impairments following neurosensory injury
Additional Tests SBIR

- MEMS accelerometers, high resolution cameras

- Traditional Additional Tests:
  - Vestibular Ocular Reflex
  - Head Impulse Test (HIT)
  - Optokinetic Nystagmus (OKN) and OKAN
  - Dynamic Visual Acuity Test (DVAT)
  - Dynamic Body Balance

- New tests
  - Vestibular Evoked Myogenic Potential (VEMP)
    - cervical cVEMP
    - ocular oVEMP

Angus Rupert, MD, PhD       1 September, 2015
Charles River Analytics

Neurokinetics
Questions?

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334 255 6865

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**Discussion on Simple Field Test (SFT):**

MS. HELMICK: I have two questions. There are really two vectors here - this assessment is all about *diagnostics*. When we talk about RTD, have you now calibrated to normalcy so that you can in good faith [answer] from these tests - that may not be functional in nature, but at least you have some objective data - can you get back in the fight? And we would predict that you would function well.

So, my question is – taking away mTBI (because I don’t think we’ve established enough vestibular specificity from a pathophysiological standpoint for mild TBI), so even if you look at those six tests in someone who has Parkinson’s and has balance issues, have you married this closely to TBI because that’s in the portfolio and it’s neurosensory, or does this have wider applications because the six tests you showed us would not be normal in multiple vestibular disorders?

It’s not really about mTBI diagnosing, as this slide shows, but whether you do this test post-TBI or post-anything else? And you’re looking for normalcy in a range using normed values that would help influence your decision that this person is ready to go back – an objective marker not for diagnostics, but rather thinking about returning to duty?

DR. RUPERT: You’d want to think about, where you set those bars for RTD. It takes a considerable amount of funding with a larger amount of people - with 400 normals and 400 TBI patients. Although this device is used most often in primary care settings, it can easily be trained to be carried out by an inexperienced person in the field, like SGT McCulley. Dr. Lawson was approached by such a company.

MAJ DRETSCH: Are there any studies that show that there are changes in the oculovestibular measures following treatment?

LTC CASTO: I’m going to present some data this afternoon of differences between TBI patients and a control group on some of these tests. We ran a lot of normative data on the rotary chair at USAARL several years ago, so we do have that baseline and normative data.

MAJ DRETSCH: Across either treatment group or just over a period of time, or again do these things change or do they worsen because I would assume that for certain individuals, you would see things get progressively worse?

MAJ SCHERER: To answer your question – on the clinical side, we’ve got data that shows you can improve both the gait and dynamic visual acuity. However, the 800-pound gorilla in this room is how does that *translate to RTD*? And you’re right – we haven’t done that stuff yet, in terms of external validation of, “What does it mean to be duty-ready?” And I think we’re all in pursuit of that.

DR. PANKER: Yes, what level of vestibular function is required?

MAJ DRETSCH: And that’s where you definitely need baselines, high-risk populations.
DR. RUPERT: The point here is that no particular baseline was required in this particular situation for this number that they had run. But the ideal situation is of course to have a baseline before someone goes in theater and then to be able to compare them against themselves. And that’s quite feasible to do for high-priced athletes, and probably will be done.

DR. ESTRADA: I was concerned - have normal limits been established for all those tests?

DR. RUPERT: Yes, for nearly every one of those tests, there are normal limits within one or two deviations.

LTC CASTO: Yes, we did that for the military populations at Fort Rucker.

DR. RUPERT: And it’s been done for subsets of those populations as well. Certainly, on the Navy side, we’ve done some for pilot populations.

DR. LAWSON: Most of these aren’t experimental, custom-built tests; the experimental part is seeing if you can apply them to the portable domain.

DR. RUPERT: What we’ve done is we’ve made a tool that could be given to SGT McCulley in theater because all those tests mentioned are ones that are not going to be done at a Battalion Aid Station or even at the hospital, but at tertiary aid stations. The one company – Neuro Kinetics - will be producing some prototypes. They want to be able to say this small device is equivalent to the great, big, huge device.

MS. HELMICK: We need to be deconflicting here. This is a platform discussion we’re having. It’s a new platform. Is that valid and does it give us what we need? And is it the appropriate platform? The other arm – which I’m hearing kind of quasi – is what is the testing on this new platform? Is it well-validated? Do we have norms for it and does it all make sense? And in the absence of having this new platform, clinics around the country and around the world would still be leveraging the vertical test and have norms and know what’s out of bounds and what’s normal.

The corollary I’m thinking of is the DANA – people are probably familiar with the Defense Automated Neuropsychological Assessment – which is ANAM on a handheld. So this is the same conversation when we dive into this hour-long discussion that you have about deconflicting a platform and what science it takes to validate a platform device – the stuff and the content, and what information does that give us?

With the MACE [Military Acute Concussion Evaluation], we look at the degree of sway with vestibular function and that’s it. The correlation between sway and vestibular function are significant. Today is the first I’ve heard of this but I’m not a vestibular expert. I would ask Dr. Marion and others working in this field. I’m only aware of assessing for sway.

MAJ SCHERER: Maybe with what we’re using now to measure sway, someone might come across as normal after five days, but maybe with a more sophisticated metric like this, maybe at 27 days they’re still abnormal. So, yes, it’s a metric and I think it informs the decision-making process. And I don’t think we have the data yet to correlate it directly with
readiness to RTD. But if we use it as a data point, obviously it informs that clinical decision-making.

DR. RUPERT: It measures sway, reaction time, and a saccade test, which is more cognitive and can detect frontal lobe injuries. I can visualize SGT McCulley sitting at the battle aid station running tests on a Soldier who comes to him with a head injury. [The possible outcomes are] a green light, a red light, and a yellow light. If he gets a green light, he’s good to go [back to the battlefield]; if he gets a red light, he’s not; if he gets a yellow light, he keeps running more tests until he can finally differentiate with 12 tests whether yes, it’s green or a red.

DR. MARION: I agree that we need a device that measures five or six different physiological functions because TBIs can be different for different individuals, but I like the idea of performing all the tests like Stephanie [Dr. Panker] said, and taking the data from all these individual tests and putting the scores into an integrator, then coming up with a composite score where maybe each of those tests is weighted a little differently.

DR. RUPERT: When time is of the essence and you only have 10 minutes or so, my method could be done in under 10 minutes.

DR. MARION: I believe the top four or five tests could be done in 10 minutes as well.

This concluded the feedback to Dr. Rupert’s presentation and LTC Myatt thanked Ms. Helmick for her insights, along with everyone else. Please see Table 3 on the next page for the results of the attendees’ feedback to Dr. Rupert’s Simple Field Test (SFT) presentation.
Table 3. Simple Field Test (SFT) Results

<table>
<thead>
<tr>
<th>Question/Item</th>
<th>Open-Ended Comments for each Item</th>
</tr>
</thead>
</table>
| **1. How useful is this tool for assessing RTD by medical personnel?** | **MAJ Scherer:** May be appropriate to inform clinical decision-making but does not translate directly to functional performance.  
**LTC Fondy:** This is diagnostic, not RTD. |
| Item Mean (1–7) = 4.38 | |
| **2. How useful is this tool for assessing RTD by non–medical (operational/unit) personnel?** | **LTC Fondy:** This is diagnostic, not RTD. |
| Item Mean (1–7) = 4.00 | |
| **3. How do you rate the scientific value of this tool?** | **Dr. Weightman:** Potential 2-year timeline |
| Item Mean (1–7) = 5.00 | |
| **4a. How applicable would this tool be in a Combat Support Hospital?** | **Dr. Radomski:** Potential but not ready for implementation, remains to seen  
**Dr. Brungart:** It is not really a "balance" test, but could be very useful as a concussion detector for lay medical personnel. Dr. Marion indicated a trained clinician might be quicker and more reliable.  
**Dr. Gregory:** No data for portable device  
**Dr. Panker:** How does impairment relate to function?  
**Ms. Helmick:** Needs lots of work – validate norms. Need more info about 6 tests and how reliable & valid, then discuss platforms. First validate tests not specific to mTBI population, but to any vestibular issue.  
**MAJ Walsh:** No data shown, so hard to assess usefulness. |
| Item Mean (1–7) = 4.81 | |
| **4b. How applicable would this tool be in a Medical Treatment Facility?** | |
| Item Mean (1–7) = 5.31 | |
| **4c. How applicable would this tool be in a Warrior Transition Unit?** | |
| Item Mean (1–7) = 4.25 | |
| **4d. How applicable would this tool be in a Veterans Affairs Hospital?** | |
| Item Mean (1–7) = 4.93 | |
| **OPERATIONAL RTD** | **MAJ Scherer:** May be appropriate to inform clinical decision-making but does not translate directly to functional performance.  
**LTC Fondy:** This is diagnostic, not RTD. |
| **5. How well does this tool appear to address concerns about Soldier readiness?** | **MAJ Scherer:** May be appropriate to inform clinical decision-making but does not translate directly to functional performance.  
**LTC Fondy:** This is diagnostic, not RTD. |
| Item Mean (1–7) = 4.44 | |
Facilitated Discussion: Session 1

LTC Myatt began the discussion by asking all attendees to reflect on the two foregoing presentations and the assessment tools presented in the context of Ms. Helmick’s presentation. The guidelines and framework she provided offer a way to view the research from both a top-down and bottom-up (unit level) approach. He pointed out how the DoD was being proactive in addressing concerns regarding TBI.

Dr. Estrada addressed all attendees and inquired of those who care for TBI patients, from the provider perspective, if they have noticed a change in attitude. From his perspective as Task Area Manager, he has noticed that only a few years ago, there seemed to be more enthusiasm to retain the Soldiers who were injured. If they were found to be incapable of performing their job following an injury, there was more willingness to reclassify them into a different military occupational specialty (MOS) that they were capable of doing. However, Dr. Estrada has personally noticed less enthusiasm to retain these injured Soldiers and has had the impression that Soldier injuries may be used as one way to reduce the forces, to separate those who are no longer able to fully function. Dr. Estrada asked the clinicians to please share with the USAARL researchers what the attitude is in the field.

LTC Fondy was the first attendee to respond and concurred with Dr. Estrada. She elucidated further, providing an example from several years ago:

We were in the midst of a two-front war and we needed people. So if someone couldn’t be a pilot, we needed them as a maintenance officer. Now, we’re drawing down – we’re kicking out excellent officers, excellent NCOs, so people who make a mistake, get a DUI, or have a physical problem – anything we can find, we’re using as an excuse to get them to fulfill one of those spots of a person to leave, so we can retain people who are physically fit and who have flawless records.

LTC Fondy went on to discuss how the Nurse’s Corps and the Medical Services Corps are also poised to “go through one of these retention boards – early retirement – and some fantastic officers will be told that their military career is over.”

LTC Casto agreed with LTC Fondy’s assessment and added that this highlights the importance of the medical community’s ability to articulate clearly to the line community the potential for rehabilitation and reintegration as well as the course of expected RTD in order to be able to influence this process.

MAJ Scherer asserted that it depends upon the occupation. “I think this is also a function of what population we are talking about – the highly trained operator acutely injured in a far forward environment.” He indicated that so many resources go into training these individuals, so there such will naturally be a greater commitment to retaining them. These highly skilled occupations are always in demand. However, MAJ Scherer made the point that there is always a need for valid metrics to inform RTD decisions. For those chronic patients who cannot RTD, but who have served dutifully and faithfully, we must seek to return them to having some kind of quality of life. The medical community must help develop standards.
Dr. Panker addressed Dr. Estrada’s concerns by saying there is still an “appetite” for RTD research but maybe not as much “urgency.” Because we’re in a resource-constrained environment, this underscores the need for making smart, strategic decisions on where to place our research dollars, “what’s going to give us the biggest bang for the buck?”

There followed some discussion by Dr. Radomski, Dr. Estrada, and Dr. Lawson on the measurement specifications and requirements for the assessment tools presented, as well as which occupations were most affected by vestibular problems. According to Dr. Lawson’s earlier research on this issue, the results were disappointing in that vestibular problems did not seem to be correlated with any particular military occupation, whereas other sensory problems were.

Ms. Helmick noted that we have two main goals. First, our primary goal is RTD and retaining unit readiness. Our secondary goal is determining readiness to RTD, whether or not Soldiers stay in the military or move onto something else. As Ms. Helmick phrased it:

Our priority is to focus our efforts on validating tools and information that will lead to the best decision-making to safely put that Soldier, Sailor, Airman or Marine back out into the fight in a safe manner that will allow them to accomplish their duty and not get themselves hurt or anyone else in their unit. So, with that being said, the two assessment tools presented this morning should be framed as more diagnostic in nature when looking at the continuum of care. They are not so much about RTD – not that they wouldn’t get there. This is because of course, there’s no doubt that the first piece of examining TBI is to understand it from a physiological and a diagnostic standpoint. That’s number one in the queue for our gap analysis because objective markers for diagnostics are essential in diagnosing TBI rather than only relying on subjective data, even though the gold standard is clinical judgment.

Ms. Helmick went on to discuss the changing definitions of TBI over time, from the “lackluster” early days of neuroimaging to today, when diagnosing a head injury is still not ideal, being based on history and physical exam. Taking a patient history is “obviously unreliable if the person lost consciousness and cannot remember.” Clinicians must then piece together bits of the patient’s memory to decide whether or not the patient has had a concussion.

Although Ms. Helmick believes tools such as the pupillometer, and signs such as visual sequelae and vestibular issues are extremely important for diagnosing TBI, she further stressed her point:

If this symposium and this Toolkit are about RTD, and this is our priority, we need to examine the factors that influence RTD decisions, and whether they can be returned fully back into the fight. One operational data point that no one seems to have that is critical is: how many people have been returned to the fight that should not have been returned to duty? How many decisions to RTD (most of them based on subjectivity) have been wrong? Are we sending people back who then sustain another concussion or another type of injury and are not contributing to that end state of increasing the strength of our forces?
Dr. Maggie Weightman agreed this is the also a concern for those who work in rehabilitation. Although they’ve tested the rehabilitation group and the controls, they do not have any data on whether or not the decisions made by the providers (who have made those decisions based upon certain tests) turned out to be right or wrong, based upon some metric down the road.

Dr. Estrada pointed out that this is precisely the goal of the MFAP Longitudinal Study that will be presented on Day 2, to evaluate how well the MFAP predicts RTD success or civilian reintegration down the road.

Dr. Donald Marion expressed enthusiasm for the two more clinical, diagnostic tools presented that morning, pointing out that as a neurosurgeon, he has a great appreciation for the focus on autonomic dysfunction as a potential diagnostic tool. In his view, these types of tools make much more sense in diagnosing mTBI rather than serum or imaging biomarkers as many other researchers are putting forth. Dr. Marion explained that there are seldom anatomical abnormalities with mTBI, where most people recover in a few days, but there are usually vestibular or autonomic abnormalities. In contrast to Ms. Helmick, Dr. Marion believes that our first step should be coming up with objective diagnostic tools for mTBI and once those are validated, they can be used as RTD instruments.

Dr. Estrada offered that the pupillometer would make a great mTBI screening tool. If the individual with suspected TBI is negative, she or he could be immediately returned back to the line. In this way, so it could be a far forward instrument to RTD.

Ms. Helmick inquired if using diagnostic tests for RTD could be analogous to using a “strep test” (i.e., testing for streptococcal pharyngitis). Although used as a diagnostic test, it can be used as a return-to-duty (work/school) test in certain cases as well. If you test positive, you take antibiotics; when the second strep test comes back negative, you can return to work/school. In other words, by the absence of a positive result, one can infer the patient is free from the corollary?

LTC Fondy added that the usefulness of any tool depends not only upon the specificity and sensitivity of the tool, but on the provider’s clinical judgment. She related a story of a commander who brought an entire convoy of 70 Soldiers into her Emergency Room for TBI screenings because one of the vehicles was near an IED blast. Despite this being a command referral, she informed him that she was not going to screen 70 people as this would take all night of her team’s time and resources. Her clinical judgment informed her decision to divide the Soldiers into categories based on proximity to the blast, as there was no reason to screen someone a half-mile away from the blast with no likelihood of having experienced a concussive event. As a result, only 12 Soldiers needed screening.

Dr. Panker noted that the MACE would also have been just as effective in this case. As a quick self-assessment screening tool, unless the patient responds positively to the first two questions (there was a head injury and some type of alteration of consciousness and/or memory loss), screening for concussion goes no further.

This was followed up by a suggestion from Dr. Marion, who shared that all professional football teams have been mandated to hire a neurosurgeon. These doctors are often eager to beta
test new concussion screening tools alongside the established instruments and assessment tools. Perhaps this is something we can explore and leverage in terms of obtaining validation data.

MAJ Dretsch interjected the fact that non-combat-related TBI events are even more common than combat-related events and this presents another challenge for researchers. MAJ Dretsch agreed with Ms. Helmick that the two tools presented are clinical assessments; however, he does not think there’s enough evidence yet to support either one of them. He feels baselines are needed because without baselines, we cannot say whether the improvements made are due to the natural progression of healing over the course of time. MAJ Dretsch would also like more information not just on $p$-values and correlations but the strength of the relationships, such as the effect sizes, more information on high-risk populations, and more information to rule out selection biases in the population samples.

Dr. Radomski brought up how the main issue doesn’t seem to be a *lack* of research in TBI, or data, but there seems to be an overwhelming amount of research, with so many separate studies and projects all taking place in isolation. If there were a way to bring researchers together, to aggregate all the data, especially the functional measures and clinical measures, this would move the research along at a much faster pace.

LTC Myatt wondered if that was the purpose of the Defense Centers of Excellence (DCOE), to bring together all the different efforts, then use those efforts to guide policy and research. According to Ms. Helmick, it is the responsibility of the Centers of Excellence to examine the portfolio-centric studies for the state of science and push those back out to all interested parties as quickly as possible. Their purpose is not to engage in unilateral efforts but to pull together these other large efforts and extract the science. With over 700 studies since 2007, this task has become monumental. Dr. Thornson inquired if any meta-analytic analyses have been conducted to synthesize all these results in a systematic way. Ms. Helmick responded that they themselves have not performed any meta-analysis.

Dr. Panker raised the point that the RTD Toolkit should be derived by “looking at the sweet spot of the Venn diagram.” In other words, an algorithm where each tool or test accounts for a certain percentage of the variance would make up the toolkit overall. MAJ Scherer agreed but questioned the type of scoring and weighting used when different tests measure different clinical and functional domains. Further, how can this score assist the clinician in making a decision?

Dr. Crowley shared that when USAARL first envisioned the ideal RTD test, they considered a clinical test as being the most straightforward, yielding a “yes or no” determination. But RTD involves more than clinical or medical fitness for duty – it involves being able to do your job. Is the clinical determination enough to indicate someone can perform his or her job? That might vary with the job. Additionally, what if the answer is not as straightforward as yes or no; what if individuals vary along a continuum, such as along a bell curve of “normal” reactions to a balance test, for example. What would be the cut-off point on that curve that would cause one individual to be deemed unable to do the job? This again is really difficult to answer because that could depend on the job, potentially. It may not be a clinical tool and may, in fact, come down to expert opinion.
Performance of Dynamic Simulated Shooting Tasks by Healthy Participants and those Recovering from Mild Traumatic Brain Injury (mTBI) - Ben Lawson, Ph.D.

Aims:

- Develop dynamic shooting tasks using healthy participants
- Use tasks to evaluate mTBI participants with balance deficits

Hypotheses:

- (Implied: Promising tasks can be identified)
- People with balance problems perform worse

Contribution to Task Area:

- MOMRP Injury Prevention/Reduction Program:
  - Evidence-based criteria for performance of a Soldier after injury to neurosensory systems, including vestibular
- Deliverable: USAARL Clinical Toolkit
Methods

Subjects: Recruited 70 healthy vs. 30 mTBI

Apparatus: Engagement Skills Trainer (EST)

Measures/Tasks:

• Measures: shooting throughput, workload
• Tasks: 4 dynamic shooting tests adapted from clinical balance tests, based on:
  • Reliability
  • Pilot findings from mTBI patients
  • Ability to detect temporary vestibular insult

Analyses:

• Shooting performance MANCOVA
  (Covariates: qualification score, site)
• Mixed model analysis for workload
  (Within-subjects by task vs. between mTBI/healthy groups)

Progress

Completed:
• Data collected/analyzed
• Protocol closure submitted/accepted

Deliverables:
• 3 presentations delivered, 2 reports published, 3rd report submitted

Challenges / How Met:

• Study challenge:
  • No local mTBI participants; limited recruitment of mTBI participants at original
data collection site
  • Met by identification of a new site
• USAARL challenge:
  • Original PI, two AIs, and others departed
  • Met by handover to remaining personnel
• Government challenge:
  • Furloughs, travel restrictions
  • No mitigation
Key Findings

Fort Rucker Test-Relevant Findings:
Task performed most/least consistently by normal controls:
• Most: Narrow kneel while shooting
• Least: Turn 180 dg and shoot in semi-darkness (eliminated)

Task with highest workload:
• Kneel while shooting

Task most affected by temporary vestibular challenge:
• Kneel while shooting

Second-most reliable, challenging, and sensitive task:
• Walk wide plank while shooting

mTBI-Relevant Findings:
• Initial Fort Bliss pilot study
  – NS trend for less shooting accuracy among mTBI (vs. healthy) shooters while kneeling

• Fort Benning study…
Key Findings (contin.)

Cumulative Fort Benning and Rucker findings:

mTBI versus Non-injured Participants:

- mTBI participants: more errors of balance/coordination during shooting tasks
- mTBI: greater daily disability due to dizziness
- mTBI: higher workload during dynamic shooting

- Failed to confirm mTBI participants shoot worse
  - Possible reasons:
    1. They don’t shoot worse than “normals”
       (Hypothesis incorrect, but good news for Army)
    2. They work harder to achieve similar performance
    3. Site matters: Injured Fort Benning participants shoot better than Uninjured Fort Rucker participants

Dissemination/Transition Plan

PI recommends:

- For: Consideration of a future research project proposal to develop most promising test further (next slide)
- Against: Immediate inclusion of most promising dynamic shooting test(s) into USAARL Toolkit

Plan regarding overall USAARL toolkit:

End-user:
- Army Medicine

Transition partners:
- Defense and Veterans Brain Injury Center (DVBIC)
- Defense Center of Excellence (DCOE) for TBI

Transition documents:
- TTA in place with transition partners, above
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Discussion on Dynamic Simulated Shooting Tasks (DSST):

MAJ DRETSCH: What do you mean by a higher workload?

DR. LAWSON: Their perceived workload according to the TLX [Task Load Index] and, specifically, to get down to brass tacks, there’s a bunch of subscales in it. And the one that really popped out was level of effort. “How hard do you have to work physically and mentally to achieve your current level of performance?” I wanted to read that verbatim because it goes into my possible explanation for the final finding.

So everything is great except for one problem - failure to confirm that they shot worse. So they’re dizzier, doing a higher workload; there are some tests that have okay properties, but this first test out of the box you didn’t see them shooting worse. Why would that be? Well, the first thing you’re supposed to say is the hypothesis could be incorrect. They don’t shoot worse than normal people. They may have other problems, but they don’t shoot worse than normals. That would be terrible for the design of the shooting test to detect mTBI. But a negative find in that case might not be entirely bad for the Army. Because it might imply that with further research, you could find out that’s not one of the problems that they have. They can defend themselves. That’s pretty important!

MAJ DRETSCH: For eligibility, did they have to have balance problems or report them or was it anybody who screened for mTBI?

DR. LAWSON: They had to have balance problems, but they weren’t verified at the level you would do for a pure vestibular experiment. Rather, you knew they had mTBI and you confirmed that via those three different scales whether they were currently experiencing dizziness or balance related handicaps. However, I should mention in the case of the DHI [Dizziness Handicap Inventory], it has been meaningfully related in terms of its predicted validity for actual falling, for example.

DR. BRUNGART: Were there simpler shooting tasks where you didn’t see a workload difference? I’m a little worried your subjects might like higher numbers on the survey.

DR. LAWSON: I’d have to get out the paper and go over each one with you. I don’t recall. The main thing I would say that would be a problem in that realm would be that you’d see a ton of problems as they were practicing the test. With any human performance test you have to learn the asymptote.

MAJ DRETSCH: What about effort testing? Did you guys screen for that?

DR. LAWSON: No.

MS. HELMICK: So, it’s obviously out of the scope of this study but something that might be interesting to look at considering that you don’t have worse shooting performance than normal in a follow-on might be looking at go no-go and adding to that a higher workload element. Then see if that parses out because, “I shoot as well in terms of the number but I’m shooting the good guys and that means I can’t defend myself well,” and vice versa.
DR. ESTRADA: Are you going to talk about aim trace?

DR. LAWSON: No. there’s different ways of thinking about that. So we know in the vestibular world that if you give somebody a cog test you can increase the sensitivity of the test. We also know in the human performance testing world that if you have something that has too many degrees of freedom and you add more degrees of freedom, you shouldn’t be surprised if you don’t find something better. So there’s a true trade-off there to struggle with. I’m going to for now stick with, what are the simplest possible explanations? First, the hypothesis is wrong.

MS. HELMICK: I didn’t mean it shouldn’t be included, but as a follow on it might be interesting.

DR. LAWSON: They worked harder, yes absolutely. One possibility is they worked harder.

MS. HELMICK: Were they better on both the time and accuracy or just on accuracy? Did you measure reaction time?

DR. LAWSON: Shooting throughput is a measurement of accurate shots per second, so it contains both elements.

DR. ESTRADA: Back to my aim trace question. Didn’t we do a study, a follow on or something, to look at aim trace, because that is an indication of the higher workload involved in making a good shot?

DR. LAWSON: There is a separate study of normals and aim trace, but not part of it.

DR. ESTRADA: Our EST [Engagement Skills Trainer] 2000 has a software modification to measure not only good shot vs. bad shot, but also the amount of work it takes, the aim trace, so we found that. I wish I had that study. We found that it could be related to workload, but for those with some problem, their aim trace was significantly greater with those that were impaired.

DR. LAWSON: So, for example, you may get to the same endpoint, but you did a lot more work to get there. The reason I’m not getting into this kind of gets to my last side. There are advantages of the EST having these extra capabilities but there are certain technological problems as well. It’s designed for training and some data loss occurred when we tried to use it dynamically. It’s not designed to do this. So you are losing a ton of data, so that’s why we didn’t pursue aim trace in the final study.

DR. MARION: Interesting finding and consistent, I think, with functional MRI (fMRI) and concussion where a large cohort of people with concussion will perform fairly well and similar to normals in N2, N3, N4, and back stimulus. But on fMRI, what you’ll see is a whole lot more of the frontal parietal lobe light up.

DR. LAWSON: Yes, so there’s two important ways of measuring effort. This may be what you’re touching on, Mike [MAJ Dretsch]. You can do a TLX in order to see if the person is
working harder, if they think they’re working hard. You could also try to touch into physio post-cranial or cranial and try to see if that corroborates, and I would say do both.

MAJ DRETSCH: What about medications, because I’m assuming certain medications’ side effects are balance problems too. Do you have medication information on the TBI patients?

DR. LAWSON: There were exclusion criteria a doc checked, but I don’t think anybody did a pee test.

MAJ DRETSCH: Nobody recorded what they were on at the time of the testing?

DR. LAWSON: We didn’t do it as a covariate.

MAJ DRETSCH: Individual TBI vs. those that are medicated, and I didn’t know if you were able to add that. Maybe see if there was a difference. Maybe the medication is contributing to the balance issue.

DR. LAWSON: That could be. We did not look at that very valid point. I’ve got a fifth one too.

DR. PANKER: So when you say “shoot worse,” that means throughput, right?

DR. LAWSON: Yes.

DR. PANKER: So, wouldn’t the aim trace have an effect, like if they’re doing more, that takes longer?

DR. LAWSON: If I could get enough of the data to come through, [we would] have something to analyze. And that might be possible if you just slow down the movement, for example. There are ways to do that which we haven’t done.

LTC FONDY: Did you include AOC or MOS in your criteria? So, that’s why your Fort Benning Soldiers shot better than your Fort Rucker Soldiers!

DR. LAWSON: We think that was the main problem here as we expected at the onset. What I can say is that injured Fort Benning participants may shoot better than uninjured Fort Rucker participants. This is what I call the “hilarious finding.” It reminds me a little bit of Rocky talking to his son. He says, “The trick is not how hard you can hit, but how hard you can get hit and keep moving forward.” These guys are so over-practiced possibly that they can compensate for that effect. Now there’s no way to decide which one it is. What you’ll have to do is do a study at one site using both groups.

By the way, there’s another possibility that kind of alludes to Mike’s comment about functional relevance. You want mTBI people who are dizzy enough. We knew they were statistically very, very dizzy. But were they dizzy enough – were they really dizzy, functionally and clinically? So, my recommendation is I think this is worth considering for future project proposals.
Basically, I’ll get into what I would envision - and I don’t necessarily envision doing that unless somebody in the room wants to collaborate, so I throw that out if you’re interested. These are the general toolkit targets. What I would picture for future directions is an experiment at a single site, preferably with some sort of control over MOS and broad control over the general categories of combatant MOS. You’d like to narrow it down to at least one more test, maybe two. I believe the EST has enough technological problems with it, I think, since it’s already in many bases and it’s very useful. However, what I’d be more interested in is something that could quickly go from place to place and didn’t take a long time to set up in a huge room. It’s not any criticism to the EST, per se. We are using it for something it was not designed to do. I think it’d be nicer if we had something portable. I’d especially like to have the quantification of actual sway be part of a shooting balance test. That’s my bias.

One other thing I’d like to see that came up in discussions – I’d like to see the test better designed to detect imbalance, then see how those tests could apply to mTBI, not so much trying to capture all of mTBI and then go, “Oh gosh, I don’t know what I have. It’s uninterpretable.” But, I’d rather develop – like Dave [LTC Walsh] with the ocular metrics – develop something for a specific purpose and see if you can apply it to TBI. Are there any other questions?

This concluded the feedback to Dr. Lawson’s presentation. See Table 4 for the results of the attendees’ ratings and qualitative feedback to Dr. Lawson’s Dynamic Simulated Shooting Tasks (DSST) presentation.

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### Table 4. Dynamic Simulated Shooting Tasks (DSST) Results

<table>
<thead>
<tr>
<th>Question/Item</th>
<th>Open-Ended Comments for each Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How useful is this tool for assessing RTD by medical personnel?</td>
<td>Dr. Weightman: Not in current state.</td>
</tr>
<tr>
<td>Item Mean (1–7) = 3.47</td>
<td></td>
</tr>
<tr>
<td>2. How useful is this tool for assessing RTD by non–medical (operational/unit) personnel?</td>
<td>Dr. Brungart: Clearly shooting is a critical skill. It is a concern you find no difference between mTBI and controls.</td>
</tr>
<tr>
<td>Item Mean (1–7) = 3.93</td>
<td>Dr. Radomski: Could be better pending future study.</td>
</tr>
<tr>
<td>3. How do you rate the scientific value of this tool?</td>
<td></td>
</tr>
<tr>
<td>Item Mean (1–7) = 3.87</td>
<td></td>
</tr>
<tr>
<td>4a. How applicable would this tool be in a Combat Support Hospital?</td>
<td>Dr. Radomski: Not practical at present (4a–b)</td>
</tr>
<tr>
<td>Item Mean (1–7) = 2.87</td>
<td>Dr. Gregory: Controls and mTBI at different locations requires considerable space/ set up (4a–d)</td>
</tr>
<tr>
<td>4b. How applicable would this tool be in a Medical Treatment Facility?</td>
<td>Dr. Weightman: Needs specific equipment (rated 2)</td>
</tr>
<tr>
<td>Item Mean (1–7) = 3.33</td>
<td></td>
</tr>
<tr>
<td>4c. How applicable would this tool be in a Warrior Transition Unit?</td>
<td></td>
</tr>
<tr>
<td>Item Mean (1–7) = 3.52</td>
<td></td>
</tr>
<tr>
<td>4d. How applicable would this tool be in a Veterans Affairs Hospital?</td>
<td></td>
</tr>
<tr>
<td>Item Mean (1–7) = 2.71</td>
<td></td>
</tr>
<tr>
<td><strong>OPERATIONAL RTD</strong></td>
<td></td>
</tr>
<tr>
<td>5. How well does this tool appear to address concerns about Soldier readiness?</td>
<td>MAJ Scherer: Good complex balance task (dynamic). Norms? How do we interpret feasibility may be an issue given expense/ weight? This approaches functional assessment—better face validity.</td>
</tr>
<tr>
<td>Item Mean (1–7) = 3.79</td>
<td>Ms. Helmick: Promising area to help look at functional aspect that is critical for many MOSs. Compensation seems to be rationale to why mTBI shoot same as controls.</td>
</tr>
<tr>
<td></td>
<td>Dr. Radomski: Not yet.</td>
</tr>
<tr>
<td></td>
<td>LTC Fondy: I was not present for enough of this to rate it. Control groups must be by MOS/AOC!</td>
</tr>
</tbody>
</table>
Auditory Fitness for Duty Standards

Auditory Fitness for Duty
Standards

Douglas S. Brungart
Tricia Kwiatkowski
Sarah E. Kruger
Julie Cohen
Thomas A. Heil
Danielle Zion

Importance of Hearing
in Operational Environments

The essential nature of hearing for military operations is undisputed
- Most agree that deaf individuals are unfit for duty
- However, little is known about “how well” warfighters need to hear
The essential nature of hearing for military operations is undisputed
- Most agree that deaf individuals are unfit for duty
- However, little is known about “how well” warfighters need to hear

However, hearing acuity in military environments is rarely ideal
- Auditory stimuli are masked by loud weapon systems
- Situation awareness is impaired by use of Hearing Protection
- Speech signals are degraded by encryption, noise, use of PPE
- Hearing ability is impaired by hearing loss

Hard choices about hearing must be made *all the time* in the military
- Should an experienced soldier be disqualified due to hearing loss?
- Should a hearing protector be worn on a combat patrol?
- Should a weapon system be quieted despite loss of capability?
In military environments, there are four critical components of situation awareness that may be impaired by HPDs or NIHL.

1) Detection and Identification

2) Localization
Components of Situation Awareness

In military environments, there are four critical components of situation awareness that may be impaired by HPDs or NIHL.

1) Detection and Identification
2) Localization
3) Communication
4) Acoustic Stealth
Evaluating Operational Impact of Hearing Impairment

Even in cases where it is possible to accurately assess hearing acuity, rational decision making is only possible if we can determine the relationship between hearing acuity and mission effectiveness.

How Good is Good Enough?
These questions can only be answered if we are able to generate curves relating operational performance to metrics of hearing acuity.

**Evaluating Operational Impact of Hearing Impairment**

**Clinical Tools to Efficiently Assess Hearing Loss**

Current Army Standard (AR40-501) defines a two-stage process for assessing AFFD.

First stage is a Hearing Profile (H1-H3) defined by audiometric thresholds.
Clinical Tools to Efficiently Assess Hearing Loss

Current Army Standard (AR40-501) defines a two-stage process for assessing AFFD:

First stage is a Hearing Profile (H1-H3) defined by audiometric thresholds.

Second stage is score on 200-word Speech Recognition in Noise Test (SPRINT)
NU-6 Words, 6-Talker Babble
+9 dB SNR, 50 dB HL

Tablet-Based Test Procedure

Decision was made to piggyback on current DoD hearing conservation program:
- Annual Audiogram collected from all Active Duty Soldiers and Marines
- Audiogram collected using automated system (DOERHS-HC)
The results are printed on Standard Form 2216 and given to Service Members.

We developed software to add QR code to notes field of form….

QR code encodes Audiogram age, and gender (but no PII).
Android-based tablet allows experimenter to Scan QR code with audiogram, age, sex

Speech-in-Noise Tests for Auditory Fitness-for-Duty

Two 104-word lists of equal difficulty selected:
- Closest in overall difficulty selected from 5 possible lists

Test conducted in closed-set trial:
- 10 Practice trials
- 104 Test trials (52 with Target at 78 dBA SPL, 52 at 72 dBA SPL)
- 10 “Easy” catch trials randomly interleaved in block
Recordings have been made with custom binaural device at the Joint Readiness Training Center (JRTC), Ft. Polk, Louisiana. JRTC is the last stage of training for units deploying to Afghanistan.

<table>
<thead>
<tr>
<th>Sound Source</th>
<th>Sound Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quiet</td>
<td>73 dB</td>
</tr>
<tr>
<td>TOC</td>
<td>73 dB</td>
</tr>
<tr>
<td>Crowd</td>
<td>78 dB</td>
</tr>
<tr>
<td>Humvee</td>
<td>85 dB</td>
</tr>
<tr>
<td>Chopper</td>
<td>87 dB</td>
</tr>
</tbody>
</table>

Talker 0.5 m from listener (0.25 m in TOC)
Ft Polk Operational Tests

In the following scenarios, you will hear communications recorded during a military training exercise. Listen carefully to what is said. Then, answer the questions that follow. Press the button below when you are READY.

Ft Polk Operational Tests

Listen to Your Unit Commander
He has important information for you. Click 'Begin' when you are ready.
# Ft Polk Operational Tests

**Grenade 14**

**What are you to do with Sgt. Porter?**

- Pull him back
- Tell him to flank right
- Provide cover for him
- Put him on the other side

# Putting it All Together

Two-dimensional “Risk Analysis” table...

![Risk Analysis Table](image)

- More Risk
- Less Risk

**Probability of Operational Score in Bottom 10th Percentile**

- Probability of Success
- MRT Score Cutoff Value
- 62 of 407 PAs, n before Est. Cutoff Value

101
A second approach involves use of hearing loss simulators

1) Recruit trained operators with normal hearing

2) Systematically degrade their hearing with hearing-loss simulation systems

3) Measure operational performance as a function of simulated hearing acuity

**Hearing Loss Simulation Elevated Thresholds**

**Paintball version of “Hunger Games”**

**Mission Objectives:**

- Move to initial positions
- Eliminate all other players
- Avoid being eliminated

4-8 players in each round

Data collected for total of 56 players
Hearing loss may have little impact on survivability....
But individuals with profound hearing loss eliminate far fewer players.....
  - Hearing impaired individuals “cower and hide”

Hearing loss seems to have even greater impact in environments with impaired sight lines (i.e. not snow)
The AIMS hearing loss simulator is designed to allow systematic control of speech intelligibility both in radio and face-to-face communications...

- Wireless and hands-free, to avoid interfering with operational tasks
- Fast enough to preserve audio-visual speech cues
- Adjusts level of input speech to comfortable level with 3-band AGC
  Then adjusts level of background noise to control intelligibility of speech
- This is better than simply injecting noise in environment
  - Prevents speakers from talking louder to “talk over the noise”
Next Steps

- Thus far, experiments have primarily been conducted on untrained volunteers
- Next step is to conduct studies in field with service members trained in combat
- Studies will use HITS system
  - Battlefield-wide tracking of movements and actions

Auditory Processing in Blast-Exposed Listeners

Many military and VA audiologists report seeing patients with normal audiograms with complaints similar to those seen in older listeners

- Difficulty understanding speech in crowded restaurants, etc.
Performance on tests of central auditory processing by individuals exposed to high-intensity blasts

Gallun, Diedesch, Kubli, Walden, Folmer, Lewis, McDermott, Fausti, Leek (2012) JRRD, 49 (7) ; Pages 1005 — 1024

Showed 44% of Blast Exposed listeners with normal audiograms were abnormal on two or more Central Auditory Processing Tests (vs 10% for normals)

Approaches for Evaluating Real-World Listening

Approach 1:

Use stimuli that simulate complex real-world environments
Modified Version of Clinical “QuickSIN” test

Qsin - Standard clinical QuickSIN with a 4-talker babble masker
QSin_\text{N0S0} - 4-talker babble-masker with 180° interaural phase shift in target
QSin_\text{AV} - 4-talker babble-masker with a video of the talker
QSin_\text{AV/N0S0} - 4-talker babble-masker video of talker and 180° phase shift
QSin_\text{SP} - Spatial condition with two 4-talker babble maskers at +/- 90°
QSin_\text{SP+RV} - Spatial condition with maskers at +/-90, simulated room reverberation
QSin_\text{SP+RV+TC} - Spatial condition with simulated reverb, and time-compressed talker
QSin_\text{Noise} - Condition with speech-shaped noise replacing the target talker

Binaural Processing: Masking Level Difference

Masking Level Difference for Speech and Noise

500 Hz Tone $N_{S0}$: Baseline threshold for 50% detection of diotic tone in diotic noise
500 Hz Tone $N_{N0S\pi}$: Threshold for 50% detection of tone with in 180° phase shift
500 Hz Tone MLD: Difference between $N_{S0}$ and $N_{N0S\pi}$ thresholds
### Masking Level Difference for Speech and Noise

- **500 Hz Tone N₀S₀**: Baseline threshold for 50% detection of diotic tone in diotic noise
- **500 Hz Tone N₀S₀π**: Threshold for 50% detection of tone with in 180° phase shift
- **500 Hz Tone MLD**: Difference between N₀S₀ and N₀S₀π thresholds

- **Spondee N₀S₀**: Baseline threshold for 50% detection of diotic tone in diotic noise
- **Spondee N₀S₀π**: Threshold for 50% detection of tone with in 180° phase shift
- **Spondee MLD**: Difference between N₀S₀ and N₀S₀π thresholds

### Self-Reported Survey

#### Hearing Self-Assessment

Listeners completed a 20-item self-assessment on their hearing, primarily from SSQ, e.g.

- "You are talking to someone on the telephone and someone next to you starts talking. Can you follow what is being said by both speakers?"
- "You are talking to a person. There is continuous background noise, such as a fan or running water. Can you follow what the person says?"
- "In the street, can you tell how far away someone is, from the sound of their voice or footsteps?"
- "Can you tell from the sound whether a bus or truck (vehicle) is coming towards you or going away?"
- "Do you have the impression of sounds being where you would expect them?"
- "Do you have to concentrate very much when listening to someone or something? (11 - Score)"
- "Can you easily judge another person’s mood by the sound of their voice?"
- "Do everyday sounds that you hear seem to have an artificial or unnatural quality? (11 - Score)"
- "Can you easily ignore other sounds when trying to listen to something?"
- "Can you easily distinguish different pieces of music that you are familiar with?"
Evaluation of all tests in terms of percentage of impaired listeners in bottom 5th percentile

Combination of 500 Hz Tone N\textsubscript{0}S\textsubscript{T} Threshold with difference between Q\textsubscript{Sin}\textsubscript{SP+RV+TC} and Q\textsubscript{Sin}\textsubscript{SP+RV+TC} appears to be optimal screening tool

Very sensitive, clinically efficient, and aligned with complaint

55% of Blast Group in bottom 5 percentile
Approaches for Evaluating Real-World Listening

Approach 2:

Use complex tasks that measure speech intelligibility indirectly, through behavior

Sentence Localization by Topic

The topic is “Sports”
Christmas is my favorite time of year.

Her brother is visiting next week.

He likes to swim in the morning.

Blast exposed listeners are normal with one source, but orient more slowly to target in multitalker situations.
Overview

Audition and Vision are complementary senses in the real world
- Audition can detect and locate sources in any direction
- Auditory localization can steer eyes towards new sources

However, in real-world environments, detection of targets and evasion of threats may occur at the same time as self-motion

This might be a “hidden” operational problem for SM with mTBI
- These patients often score in “low normal” range on multiple tests of unimodal sensory function
- Little is known about implication for multisensory tasks

<table>
<thead>
<tr>
<th>Does</th>
</tr>
</thead>
<tbody>
<tr>
<td>5th Percentile Vision + 5th Percentile Hearing + 5th Percentile Balance = 5th Percentile in Multimodal Tasks? Or 0.0125th Percentile in Multimodal Tasks?</td>
</tr>
</tbody>
</table>
Experiment based on an Aurally-Aided Visual Search Task
First developed by AFRL at Wright-Patterson Air Force Base

272-Speaker Sphere  
Target: 1/3 LEDs;  Masker: 2/4 LEDs

Goal of project was to conduct “aurally aided search” while walking

Solution: The CAREN at the National Intrepid Center of Excellence

- 6 DOF motion base with ~1000 kg payload
- 3 m diameter platform top
- Dual belt instrumented treadmill
- 10 camera real-time motion capture system
- 120-180 degree cylindrical screen projection system
64 Speakers are located in a random pattern behind screen

Participants

Two subject groups:
- 28 Healthy Control Subjects (26 M, 4 F, mean age 30.2)
  - Active Duty Service Members
  - Aged 18-45 years
  - Normal auditory and vestibular function
  - No significant blast exposure (DVBIC questionnaire)
  - Normal or correctable vision
  - Sensory Organization Test Scores 70% or above
  - Hearing profile of H1
Participants

- 32 blast/TBI Subjects with (33 M, average age 37.5)
  - Recruited from patient cohort at NICOE
    - All had diagnosis of mTBI
  - Active Duty Service Members
  - Aged 18-45 years
  - At least one deployment in Iraq or Afghanistan
  - Significant exposure to blast (DVBIC questionnaire)
  - Sensory Organization Test Scores 70% or above
  - Hearing profile H2 or better

(6 who were issued and used Hearing Aids excluded)

Localization

Continuous or pulsed (500 ms on/ 500 ms off) noise turned on
Head-slaved cursor moved to perceived location, button pressed
Localization

Visual baseline task: Determine if cluster has 1 or 3 dots
Target at known location;
Find cluster with 'odd' number of dots (1 or 3, not 2 or 4) and respond with either a 1 or a 3. The control group completed this task at both high and low contrast levels.
Clinical Correlates

Defense Automated NeuroBehavioral Assessment

Sensory Organization Test

MEG

King-Devick Test

Abbreviated Neuro-Otologic Test Battery

Conclusions

Aurally-Aided Visual Search Task is:
- Operationally relevant for military tasks
- Sensitive to differences between controls and b/TBIs
  - Including differences that are not apparent with
    - Unimodal measures of hearing, vision, and balance
    - Traditional measures of vestibular function and RT

Results supports notion of b/TBI-related multisensory deficit
Further Work

Areas for further investigation:
1) Walking facilitates AAVS in both controls and b/TBI
   - Examine stationary listener / moving platform

2) Standard clinical data does not predict results
   - Further examine MEG and Clinical data
   - Examine additional clinical measures

3) Examine possible methods of rehabilitation
   - Preliminary results suggest hearing aids are problematic
   - Training in task might be a possibility

Collaborators

Walter Reed:
- Lina Kubli
- Lindsey Byom
- Ashley Zaleski

NiCoE:
- JoManette Nousak
- Jessica Snyder
- Joe Bleiburg
- Mihai Popescu
- Anda Popescu
Discussion on Auditory Fitness (AFDS) for Duty Standards:

DR. ESTRADA: What do you mean by “blast-exposed?” To what blast where they exposed?

DR. BRUNGART: Interesting question. These questions are extremely difficult. It turned out that everybody that we used in our blast-exposed group was in the regular cadre of people that’d been to the NICoE [National Intrepid Center of Excellence]. Basically, all we looked at here was that they had been deployed, that they had been exposed to blast, and diagnosed with mTBI. So we didn’t try to make a direct connection – only that the circumstances for a blast-related TBI existed.

DR. ESTRADA: I see, okay.

DR. GREGORY: I have a question about the dual task that you described with the various speakers and the tasks you described in the CAREN [Computer-Assisted Rehabilitation ENvironment], how much practice they did before you started collecting data? We know that in any cog/psych test – either MRT or multitask – there’s going to be a practice effect added in the first test and that could show even greater effects.

DR. BRUNGART: If the normals had more practice?

DR. GREGORY: I wouldn’t look at the data until both groups had done a substantial amount of practice.

DR. BRUNGART: The normals actually had a little bit more data. We had assumed that TBI people would be much worse at the two baseline tasks. So we did some tasks where we degraded the normals by reducing contrast or by essentially reducing the auditory localization cue by having them wear a hearing protector. Turns out that people actually asymptote fairly fast on this. Both sides got a few baseline practice trials before we started collecting data. Even if we looked at the normals – if we looked at their Block 1 and Block 2 on different days, there didn’t seem to be a big correlation in performance so we don’t think there was a huge practice effect.

MAJ DRETSCH: PCL scores? What was the average for your TBI group?

DR. BRUNGART: We haven’t looked at that – we have to get into the NICoE database to find that out.

MAJ DRETSCH: I was at the NICoE, just so everyone knows. We had some that had fairly low scores on PCL. PCL-M is what they typically use. Wondering if there’d be a difference – the affect or some of the symptoms.

DR. BRUNGART: So we haven’t looked at the NICoE group and foolishly, in retrospect, we didn’t look into the PTSD [post-traumatic stress disorder] of the controls. Although we don’t have a reason to believe there would be a high prevalence there. It’s hard to tease these things apart because in the NICoE population, like everywhere else, there are covariates. Unless we got really lucky, I don’t know if we’d be able to see it.
DR. PANKER: What do you make of the difference between the standing and the walking in both the control [group] and the TBI [group]? Do you think it has to do with the “what” vs. the “where” pathways for visual and auditory information?

DR. BRUNGART: I can tell you that in a lot of balance testing, people have shown kind of an upside-down “U” of performance, because when people are told to stand still and not given other tasking, they worked too hard at it. So, if you give them some mental tasking to do, computational sorts of tasks, you actually see an improvement in performance up to a point before it starts to degrade. If you looked at where in the two tests, what’s really being improved here is localization speed when you are moving. There are a couple of possibilities. One is sort of the general activation issue. By walking, because you’re exploring a space and moving your head around you might be doing a little better in terms of localization accuracy. I think that there is some literature to support this. But it’s interesting that the walking is helping so much in this task. We wanted to do a follow up because – I didn’t show the individual scores – but it turns out that a lot of the differentiation between the groups is the standing. But in terms of test-retest validity [sic], there’s a high correlation between your relative score in the two groups. We are interested in maybe doing one where you are standing but the platform is moving, which we think the TBI people may especially have difficulty.

This concluded the feedback to Dr. Brungart’s presentation. See Table 5 for the results of the attendees’ ratings and qualitative feedback to Dr. Brungart’s *Auditory Fitness for Duty Standards (AFDS)* presentation.
AFDS Grading Sheet Results

Table 5. Auditory Fitness for Duty Standards (AFDS) Results

<table>
<thead>
<tr>
<th>Question/Item</th>
<th>Open-Ended Comments for each Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How useful is this tool for assessing RTD by medical personnel?</td>
<td>MAJ Scherer: Easy to administer given trained personnel and access to equipment. Useful tool for MEDCOM only.</td>
</tr>
<tr>
<td><em>Item Mean (1–7) = 5.14</em></td>
<td></td>
</tr>
<tr>
<td>2. How useful is this tool for assessing RTD by non–medical (operational/unit) personnel?</td>
<td></td>
</tr>
<tr>
<td><em>Item Mean (1–7) = 3.64</em></td>
<td></td>
</tr>
<tr>
<td>3. How do you rate the scientific value of this tool?</td>
<td></td>
</tr>
<tr>
<td><em>Item Mean (1–7) = 5.82</em></td>
<td></td>
</tr>
<tr>
<td>4a. How applicable would this tool be in a Combat Support Hospital?</td>
<td></td>
</tr>
<tr>
<td><em>Item Mean (1–7) = 3.93</em></td>
<td></td>
</tr>
<tr>
<td>4b. How applicable would this tool be in a Medical Treatment Facility?</td>
<td></td>
</tr>
<tr>
<td><em>Item Mean (1–7) = 5.25</em></td>
<td></td>
</tr>
<tr>
<td>4c. How applicable would this tool be in a Warrior Transition Unit?</td>
<td></td>
</tr>
<tr>
<td><em>Item Mean (1–7) = 3.93</em></td>
<td></td>
</tr>
<tr>
<td>4d. How applicable would this tool be in a Veterans Affairs Hospital?</td>
<td></td>
</tr>
<tr>
<td><em>Item Mean (1–7) = 4.77</em></td>
<td></td>
</tr>
<tr>
<td><strong>OPERATIONAL RTD</strong></td>
<td></td>
</tr>
</tbody>
</table>
| 5. How well does this tool appear to address concerns about Soldier readiness? | Mr. Showers: May very well assist in describing symptoms as well as expectations of both improvement and return to high quality of life.  
MAJ Scherer: CAREN ideal for RTD decision–making if this multimillion dollar platform is available.  
Dr. Gregory: Very complex to carry out and analyze; CAREN very unique, as was “Hunger Games”  
Ms. Helmick: Broader than TBI but good markers to look for RTD! Performance simulates real life in a nice way.  
Dr. Radomski: Potential. |
| *Item Mean (1–7) = 5.21*                                                    |                                                                                                  |
Auditory, Vestibular, and Oculomotor Sequelae in Warfighters Diagnosed with Traumatic Brain Injury (TBI) as a Result of Blast Exposure

LTC Kristen Casto
1 September 2015

Purpose

• To evaluate and characterize the vestibular, auditory, and oculomotor sequelae to blast exposure in Warfighters diagnosed with blast-induced traumatic (BI-TBI) brain injury.

• To contribute to the development of objective diagnostic measures appropriate for the BI-TBI population, and to the development of empirical vestibular, auditory, and oculomotor return-to-duty standards.

• To provide an observational basis for measuring treatment progression and empirical methods for establishing the severity of the sensory loss due to blast exposure.
Methods

- 96 volunteers were recruited and consented with a final enrollment of 77 participants.

<table>
<thead>
<tr>
<th></th>
<th>Consented</th>
<th>Screened</th>
<th>Enrolled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-TBI group</td>
<td>29</td>
<td>29</td>
<td>26</td>
</tr>
<tr>
<td>BI-TBI group</td>
<td>67</td>
<td>67</td>
<td>51</td>
</tr>
<tr>
<td>Totals</td>
<td>96</td>
<td>96</td>
<td>77</td>
</tr>
</tbody>
</table>

- BI-TBI group inclusion criteria:
  - Males or females from 19-55 years of age and of all races
  - Diagnosed with BI-TBI from injuries sustained in a combat zone

- Prospective, between-subjects research design comparing Soldiers who have been diagnosed with BI-TBI to a control group of Soldiers who do not have clinical symptoms consistent with BI-TBI.

Dependent Variables – DHI and DVBIC

- Dizziness Handicap Inventory (DHI)
  - Low: 71%
  - Moderate: 26%
  - Severe: 3%

- Department of Veteran’s Brain Injury Center (DVBIC) 3-Question Screening Tool

<table>
<thead>
<tr>
<th>Injury Verified</th>
<th>Positive Screen</th>
<th>Symptoms Related to TBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI-TBI</td>
<td>67</td>
<td>64</td>
</tr>
<tr>
<td>Non-TBI</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
• What type of blast were you exposed to?
  – 36% IED
  – 22% RPG

• When were you exposed to the blast?
  – 47% 1-2 years ago
  – 16% 7-12 months ago

• Approximately how far were you from the blast?
  – 59% 10 meters or less
  – 25% IED hit vehicle

<p>| Mean air-conducted audiometric averages (in decibels) for BI-TBI participants |
|--------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|</p>
<table>
<thead>
<tr>
<th>(Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1k</th>
<th>2k</th>
<th>3k</th>
<th>4k</th>
<th>6k</th>
<th>8k</th>
<th>9k</th>
<th>10k</th>
<th>11.2k</th>
<th>12.5k</th>
<th>14k</th>
<th>16k</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right (dB)</td>
<td>19.0</td>
<td>19.0</td>
<td>20.7</td>
<td>10.6</td>
<td>11.5</td>
<td>14.6</td>
<td>18.2</td>
<td>22.5</td>
<td>20.2</td>
<td>25.5</td>
<td>22.2</td>
<td>21.2</td>
<td>23.3</td>
<td>24.0</td>
<td>23.6</td>
</tr>
<tr>
<td>Left (dB)</td>
<td>19.0</td>
<td>19.1</td>
<td>20.8</td>
<td>10.7</td>
<td>11.5</td>
<td>14.7</td>
<td>18.4</td>
<td>22.3</td>
<td>20.4</td>
<td>25.5</td>
<td>22.2</td>
<td>21.2</td>
<td>23.3</td>
<td>24.0</td>
<td>23.6</td>
</tr>
</tbody>
</table>

<p>| Mean air-conducted audiometric averages (in decibels) for non-TBI participants |
|--------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|</p>
<table>
<thead>
<tr>
<th>(Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1k</th>
<th>2k</th>
<th>3k</th>
<th>4k</th>
<th>6k</th>
<th>8k</th>
<th>9k</th>
<th>10k</th>
<th>11.2k</th>
<th>12.5k</th>
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<th>16k</th>
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<tbody>
<tr>
<td>Right (dB)</td>
<td>16.9</td>
<td>14.8</td>
<td>12.9</td>
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<td>13.3</td>
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<td>27.2</td>
<td>26.6</td>
<td>30.5</td>
<td>25.0</td>
<td>24.5</td>
<td>24.0</td>
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<td>20.9</td>
</tr>
<tr>
<td>Left (dB)</td>
<td>16.9</td>
<td>15.5</td>
<td>12.2</td>
<td>11.4</td>
<td>11.4</td>
<td>16.4</td>
<td>19.9</td>
<td>23.8</td>
<td>20.5</td>
<td>24.6</td>
<td>21.3</td>
<td>17.5</td>
<td>17.6</td>
<td>26.4</td>
<td>20.5</td>
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Dependent Variables – Vestibular Test Battery

- Spontaneous Nystagmus*
- Smooth Harmonic Acceleration (0.01, 0.08, 0.32*, 0.64*, 1.75*)
- Saccades Horizontal* and Vertical*
- Smooth Pursuit Horizontal (0.1*, 0.2*, 0.4, .71)
- Smooth Pursuit Vertical (0.1*, 0.2, 0.4, .71*)
- Gaze Horizontal*
- Gaze Vertical
- OKN Trapezoidal (20*, 40*, 60*)
- Visual Enhancement (.08*, .16, .32, .64*)
- Visual Suppression (.08*, .16*, .32*, .64)
- Subjective Visual Vertical
- Subjective Visual Horizontal

Key Findings

- There are differences between the auditory and vestibular function of Soldiers without history of BI-TBI and those with a history of BI-TBI.
- The differences in vestibular function are specific to particular rotary chair subtests.
- The research test protocol proved to be useful in a clinical setting.
- The test protocol could be tolerated by Soldiers with TBI symptoms and did not appear to exacerbate symptoms.
- The Neuro-Kinetics I-Portal NOTC System instrumentation proved to be reliable and safe.
- The test systems built-in scoring metrics were adequate to reveal differences between groups.
• Statistically significant and clinically important differences between service members who have suffered the effects of a blast-induced traumatic brain injury

• Statistically significant differences in hearing ability were demonstrated, with the BI-TBI group showing more hearing loss as a group

• There are specific subtests of the vestibular test battery that are more sensitive to the differences than others

• Identification of the differences can be accomplished with currently available clinical equipment.
Discussion on Auditory, Vestibular, and Oculomotor (AVO) Sequelae:

MS. HELMICK: You say they’re particular to the rotary chair? Is there a way to do them without the rotary chair?

LTC CASTO: Sure, MAJ Scherer can talk to that a little bit better. These don’t all have to be done in the rotary chair. In many of them, the chair wasn’t moving. It was a test we used to do, just a light bar and sitting in front of that light bar.

MS. HELMICK: If we are talking about every camp, post, and station.

LTC CASTO: These tests don’t all have to be done in the rotary chair. Wouldn’t you say, Matt [Scherer], that most of these can be done without the rotary chair?

MAJ SCHERER: Yeah, the neat thing about a study like this is you just get the broad spectrum of oculomotor function, cerebellar function, and vestibular function. You are capturing everything. I think if we are looking to localize vestibular function to something that’s very expedient in the field, Dr. Rupert talked about the HEDIS [Healthcare Effectiveness Data and Information Set] impulse test. That’s going to measure the vestibulo-ocular reflex under higher frequency conditions, whereas with this, you get the benefit of the broad spectrum of function. Yeah, you can take bits and pieces out of this and the value here is you have a great dataset in an exposed population of warfighters, and you can use that to augment some of our existing norms in knowing what right looks like and what it doesn’t look like.

DR. ESTRADA: She brings up a good point. When these data were collected, were they collected from participants in the Fort Campbell MFAP program? Were data collected to indicate what week of rehabilitation they were in? How close were they to the actual MFAP assessment? How well did these findings correlate with graduation or successful assessment?

LTC CASTO: I think we do have the information of where they were in that process, but at the time, that wasn’t really our question as to, “were they achieving the goals of the program.” We were looking at the differences in the two groups. But I believe we do have that data – where they were in the process and how close they were to that final assessment. Again, we didn’t report on that because that wasn’t really our question.

DR. ESTRADA: There were significant differences between the populations, but were the findings of the TBI population out of the norm? Were both populations within the limits of normal?

LTC CASTO: We collected a large normative database on this. I don’t think we ever did get to that point. That was one of our questions also. I think as we went back and looked at it, many of them were outside the norm.

DR. BRUNGART: Remember the manufacturer retracted the norms based on the FDA [Food and Drug Administration].
LTC CASTO: We didn’t look at the manufacturer’s norms; we were looking at the norms that we collected separately. I don’t remember the N; it was between 50 and 100 in the database.

DR. ESTRADA: That’s something we should look into.

DR. PANKER: I think it’s important to put this study and many other ones into that rehab-provider milieu we talked about this morning. Because the Fort Campbell 12-week program [is about] chronicity, the folks that did not get better quickly. These are most likely the folks we would have found DTI [diffusion tensor imaging] lesions with. The vast majority of our mTBI clinically diagnosed patients are negative for neuroimaging; the vast majority would’ve cleared. I think this [the Fort Campbell population] is two years out from date of injury.

As we conceptually think about the two buckets that we are trying to talk about creating toolkits for, the acute get better. Are they safe to go back, and are they really going to be contributing to our fighting force? The other folks could be contributing to our fighting force but they’re going to have a more convoluted process and we’ll have more data on them because their injury would have been such that we’ll pick up the physiological and, perhaps, anatomical variations that happen with the injury.

It’s easy to get stuck in an mTBI bucket is what I’m saying, and I think this is a forcing function. Even within mTBI, let’s call it the “primary care one-and-done non-complex;” that’s not this. But that’s the majority of the service members. And then the other more complex, convoluted, and that’s what this is telling us.

LTC CASTO: Right, these are the people – what do we do with them? Do they go back? Do they get out of the Army?

MAJ SCHERER: You have symptom data too, by virtue of the fact that they were in a clinical program and they were symptomatic. That, in and of itself, would be a challenging function of pushing them back to active-duty status.

DR. ESTRADA: We did that retrospective study; we have the de-identified data, probably from this population, and we might need to dig that back up and pair it. It just seems like it would be the same participants. We have MFAP outcomes from this population when we did the retrospective. I don’t know, just trying to see how we could do the data different ways.

LTC FONDY: Probably the same question I had on the last one. You have a group of controls from Fort Rucker and you have a group of head injury patients who are Fort Campbell, which is an Infantry Post. If you did normals on Fort Campbell Soldiers, would they be the same as normals done on – now this is different from a shooting situation where obviously it’s different, but would there actually be a difference, and do you know that?

LTC CASTO: I know what you are asking, so we had done some interesting things and I remember we talked about that. We did have a pretty good mix. Not all of our controls at Fort Rucker were non-aviators, not all of our TBI patients were infantry necessarily. We did
a little bit mixed. There probably was the preponderance. We did find with the subjective vs. vertical, the aviators did exceptionally well. We had a couple of aviators in the TBI group who did exceptionally well on the subjective visual vertical, which kind of confused us, but we did have some weird things.

LTC FONDY: That shouldn’t confuse you at all; they have to be able to tell where they are in space. It’s the same thing as a ranger being able to shoot when you bump them on the head.

LTC CASTO: You’d think the TBI would affect them a little bit, but they still seemed to do very good with that. I know it was just interesting, not confusing, interesting. But I don’t think that looking at vestibular function we would expect to see a lot of difference between infantry soldiers.

LTC FONDY: I don’t think initially there should be a difference.

LTC CASTO: Some actually do see some of those things with aviators.

MAJ SCHERER: I think at the functional or behavioral sort of task-oriented level, yeah, you can train to that level and there may be some evidence looking at oculomotor studies to suggest that maybe a pilot might have a little better visual acuity under high frequency conditions vs. your average guy. At some of the frequencies you were looking at in the rotary chair, there probably isn’t going to be significant differences between people in terms of the latency. When the latency of the VOR (vestibulo-ocular reflex) is like five to seven milliseconds, we’re not going to see much variation.

MAJ DRETSCH: Was the TBI group a highly comorbid patient group?

DR. ESTRADA: They had psychological issues, balance issues.

LTC CASTO: Most of them weren’t in that cohort if they didn’t have a lot of things going on.

DR. ESTRADA: What is it, eight weeks of rehab at that time for these folks? I’m looking at Mark Showers.

MR. SHOWERS: Generally, the program was right around 12 weeks, as the norm, some a little longer, some a little less.

DR. PANKER: Naturally, you have a lot of comorbidity in a TBI specialty care population. They’re engaged in an intensive outpatient program at an Intrepid Spirit, doing regular rehab and behavioral health visits and other things like neuropsychological testing and therapy for those 12 weeks before they go out to the field, right?

MAJ SCHERER: So we’re collecting a little bit of data in this 15-year natural history of TBI study that Lou French is the PI on. So it’s not the full rotary chair stuff, more like the quick tests that Dr. Rupert was talking about, but I think they have the best controls for these things which are supposed to be war-wounded but not blast-wounded. Unfortunately, they
don’t have a lot of them. We might have a little bit of data on the rotary chair on that group that might have the same kind of psychological issues related to combat injury, but not TBI, which I think is helpful. So there’s a little bit I saw on the visual dominance side. Anxiety when you should be recovering might lock you into not recovering fully, and might be related to why some people do or do not adapt and whether or not you could unlock that.

DRETCH: And maybe medication impact.

MS. HELMICK: This is one of the few meetings I’ve been to in the last year or so where there’s been such a focus on BI, blast injury, in a long time. People have sort of put that to the side because at least from the neuroimaging portfolio and the neuropsychology portfolio, it doesn’t matter. You end up getting your brain injury and your neuropsychological profile and you can’t tell if a person has been blast-injured or in a motor vehicle crash down the street. It’s the same thing for neuroimaging, the DTI preliminary work, or what we’ve seen is not necessarily starting to say, “Well, that’s blast and that’s not.”

The interesting part – as we’re talking about auditory and vestibular – is does blast now come into play in a different way in those other sectors of neuroimaging and neuropsychology because of being air-filled organs? And whether or not we have to kind of, like on a decision tree, start to demarcate off those two areas of vestibular and auditory because blasts could have an impact that we are not seeing in other parts of portfolio? So, for example, the Lou French study you just referenced – they are getting blood biomarkers, imaging, neuropsych, vestibular, auditory – there’s five right there. Three may very well show no difference, but two may, and it may be related to the air and you know the mechanism itself (overpressure). But that’s a complexity in this rubric – as we’re talking about mild TBI – that may not be appreciated when we’re trying to collectively talk about RTD like we are today. So, it may just be another part to think about as a decision tree of how to parse it out.

DR. BRUNGART: I think that’s a really great point. And, you know our study in the earlier studies for the auditory processing thing pretty much found very little difference between diagnosed BI and blast-exposed, which is not true, I think, for other cognitive measures.

DR. ESTRADA: Dr. Crowley and I were talking about this earlier as it related to the PLR, pupillometry measurements. These were done only with blunt trauma, do you come to the same conclusions with blast? Does it affect recovery time, pupillary changes?

MAJ DRETesch: Unfortunately, there’s not a lot of evidence to support worse outcomes associated with blast injury vs. a blunt [trauma]. There are some studies that show higher PTSD symptoms with a blast, and some mild attentional impairment. I’ve looked at the NICoE data; the imaging data looked at the number of T2 hyper-intensities, and we do see greater range of variability in the blast population compared to blunt injury, but not statistically significant. So, again, I do think there’s a lot of variability even with blasts.

This concluded the feedback to LTC Casto’s presentation. See Table 6 for the results of the attendees’ ratings and qualitative feedback to LTC Casto’s Auditory, Vestibular, and Oculomotor (AVO) Sequelae presentation.
### Table 6. Auditory, Vestibular, and Oculomotor (AVO) Sequelae Results

<table>
<thead>
<tr>
<th>Question/Item</th>
<th>Open-Ended Comments for each Item</th>
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| 1. How useful is this tool for assessing RTD by medical personnel? | Mr. Showers: Very similar findings to Dr. Brungart's.  
MAJ Scherer: Vestibular metrics are useful in diagnosis and would/could contribute to RTD decision making by a qualified clinician. |
| Item Mean (1–7) = 4.18 | |
| 2. How useful is this tool for assessing RTD by non–medical (operational/unit) personnel? |  
Dr. Gregory: Limited in that control and TBI groups were in different locations. |
| Item Mean (1–7) = 2.53 | |
| 3. How do you rate the scientific value of this tool? | LTC Fondy: Too specialized to be performed by non–medical personnel. Highly specialized tools would likely not be available at these locations (4a–d) |
| Item Mean (1–7) = 4.47 | |
| 4a. How applicable would this tool be in a Combat Support Hospital? | LTC Fondy: Highly specialized tools would likely not be available at these locations (4a–d) |
| Item Mean (1–7) = 3.13 | |
| 4b. How applicable would this tool be in a Medical Treatment Facility? |  
MAJ Scherer: RTD decision–making benefits from clinical data (symptoms, physiologic measures, behavioral performance, etc.), but this information should not stand alone without functional metrics.  
Dr. Brungart: The NOTB is not very portable but is a gold standard. A lot of effort is underway to examine whether it is needed.  
Ms. Helmick: Too specialized for mainstream. |
| Item Mean (1–7) = 4.35 | |
| 4c. How applicable would this tool be in a Warrior Transition Unit? |  
LTC Fondy: Too specialized to be performed by non–medical personnel. Highly specialized tools would likely not be available at these locations (4a–d) |
| Item Mean (1–7) = 2.80 | |
| 4d. How applicable would this tool be in a Veterans Affairs Hospital? |  
MAJ Scherer: RTD decision–making benefits from clinical data (symptoms, physiologic measures, behavioral performance, etc.), but this information should not stand alone without functional metrics.  
Dr. Brungart: The NOTB is not very portable but is a gold standard. A lot of effort is underway to examine whether it is needed.  
Ms. Helmick: Too specialized for mainstream. |
| Item Mean (1–7) = 4.00 | |
| **OPERATIONAL RTD** | |
| 5. How well does this tool appear to address concerns about Soldier readiness? |  
MAJ Scherer: RTD decision–making benefits from clinical data (symptoms, physiologic measures, behavioral performance, etc.), but this information should not stand alone without functional metrics.  
Dr. Brungart: The NOTB is not very portable but is a gold standard. A lot of effort is underway to examine whether it is needed.  
Ms. Helmick: Too specialized for mainstream. |
| Item Mean (1–7) = 4.19 | |
Facilitated Discussion: Session 2

DR. ESTRADA: I’d like to discuss Task Area C at USAARL, funded to look at concussions, usually headed up at WRAIR [Walter Reed Army Institute of Research], as managed by Tom Balkin. Could you [MAJ Dretsch] talk about imaging and the correlations?

MAJ DRETSCH: I’m seeing pre- and post-deployment, so we’re not talking about a clinical group. We are seeing different things when they are still considered healthy, but they did sustain brain injuries, so we know that three or more lifetime concussions and you have significantly worse symptoms. You may or may not have cognitive impairments. We are seeing certain things that predict recovery – certain genes predict recovery and vulnerability to PTSD. The comorbid group is a tough one to figure out.

When you are doing an animal model in blast [injuries], you are seeing symptoms of PTSD and TBI even though they weren’t exposed to a traumatic event. It’s hard to differentiate what is going on. I look at it as a level-of-severity, so in my imaging studies I have combat controls – everybody is deployed, healthy combat controls. We got a traumatic stress group – they got PTSD symptoms. And then you have a comorbid group – TBI with post-traumatic stress. You see an incremental level of severity on the imaging tractography. We’re seeing with functional connectivity certain regions of the brain, and even with a functional MRI – is this more severe in general? It’s difficult to tease this apart, and I don’t think we ever will.

At what point do you say this screening instrument is good enough? It may be very sensitive to a lot of things; it may be balance, it might be a cognitive impairment, but they are not able to pass, and again return to duty. Can they perform their duty? So we need functional tasks, which means challenging paradigms too. So whether you’re increasing the cognitive load, you’re creating stressors, whether they’re shocked. We got the EST 2000 up at USARIEM [U.S. Army Research Institute of Environmental Medicine], which we helped them develop the study by giving them shocks, increasing the complexity of the task to fire. So that way we can say, they are an individual with PTSD, they may perform normally on the EST 2000, but increase some kind of threat and you see a decrement in performance.

There’s all kinds of things which we can do, but we need to create the right functional tasks and correlate these things with them too as part of research. If attention is impaired, does it matter what the reason is? Was it associated with a blast or a blunt, medication, PTSD, anything? But again, can they resolve that to RTD? Again, it’s a different way of looking at it, general function, whatever the explanation is. Screening – you look like you can perform this, you are good to go or you know what, you need more treatment.

DR. ESTRADA: That’s tomorrow, where we really show some operationally relevant functional tests.

MAJ DRETSCH: A lot of stuff we’re doing – genetics, looking at biomarkers, a journal paper under review, looking at panels pre- and post-deployment. We do see that there are significant changes and they’re very specific to whether it’s PTSD, or TBI, or TBI with PTSD. So we are even able to see those in the plasma. Proteomics is a little more difficult, the analysis is a lot harder. Pathway analysis with single protein molecules is very complex in how you stabilize it, whereas a lipid is easier. We know the role of lipids when it comes to
cell signaling and different processes. So, that’s the stuff I do, whether it’s relevant or not. Some of it is, I think, when we are looking at metrics, sensitivity, and specificity.

MS. HELMICK: I think one of the knowledge deficits I’m sitting here with is vestibular. When I hear about vestibular tests, I am almost like a layperson when it comes to the exquisiteness of the level of detail you guys are talking about [with] vestibular testing. It may just be unique to me, so if it is I’ll be quiet after this. I think what’s important is where we are trying to understand what the tests would mean. There’s a lot of tests and you guys are telling us what you do in the test. But at the end of the day, if you use that test in your practice on 100 patients, what would you be looking for? If you ask me, “What do you guys do a pronator drift for?” “Because we are looking for subtle motor weakness,” end of deal. “Well, what do you use subtle motor weakness for?” “People that have had a mini stroke, small stroke, people that are having some neurodegenerative whatever...”

What I’m trying to say is it’s difficult for me to interpret, to frame, how to translate this highly specialized testing paradigm into something that can be diagnostic and info that can lead to whether or not somebody is good to go in both groups. You know, back to duty – go out right now, go out and start fighting – or back to your MOS and not go through a Medical Determinations Board.

DR. ESTRADA: Perhaps improving during rehab?

MS. HELMICK: Yes, as a marker. You guys are talking a language you completely understand amongst each other. I’m telling you as an outsider, it’s hard to interpret. I hear what you’re saying about what you’re testing, but it’s the “so what” factor, and I mean that very respectfully. You’re testing horizontal gaze – so what? What is that going to tell us for somebody that’s had a momentary loss of consciousness after an injury event, who’s been diagnosed with concussion – how will that translate? Maybe we can dive in later tomorrow, as we talk about more pieces. Or, knowing that, as you speak, it’s “vestibular for dummies.”

DR. LAWSON: I think we are guilty of one thing, which we kind of work forward. We know that the vestibular system helps to control gaze, and we know it helps to control spinal reflexes and balance. Then we work forward from that. We know the main things it does and work forward from those things. Then we know if we cover those things, we have the least number of tests that get at all the things that the vestibular system does. It’s not working backwards from mTBI.

MS. HELMICK: The backwards way is: they had a mild TBI, which was a blow or a jolt to their head that caused them to have a change in their mental status, end of deal. Why do they have otolith dysfunction?

DR. LAWSON: The underlying rationale – and that’s all it is – is that the vestibular cochlear organ is the most sensitive organ in your body to both overpressure and acceleration.

LTC FONDY: What I’m sort of hearing – and I think, Kathy, you are on point as far as I’m concerned – it’s something we were talking about a little bit informally yesterday in terms of, “So, what would we be able to say to this group about what this work means in terms of RTD precisely now?” And, I think in some sense – at least in my listening today – is that a lot of
our work is not mature enough to specifically answer that question as much as we make progress towards that. But I think it is a really interesting thing for us to talk about. Exactly what do we know now? How can we make a little bit more of a leap to that? So, what factor, as opposed to ending with we know this impairment or we know that his particular metric is different in this population. I don’t think you are hearing wrong or that it is a reflection on your knowledge.

DR. BRUNGART: There are certainly two sorts of scales here, what Dr. Rupert was saying about it, and as I said, these tests weren’t, strictly speaking, vestibular, but they are super sensitive to acute concussion. That’s one thing, detecting acute concussion, which is very different than chronic TBI, [where] patients have sort of a sense of general dizziness that clinicians have a very hard time finding a cure for. Having low level dizziness is not a pleasant state to have, much like tinnitus, I suppose, but worse. Here’s something that’s a constant medical distraction, which any way you look, if you don’t just look at a particular sensory task, obviously at the low level that’s going to have a negative impact on resilience and operator performance eventually. There’s no way around it. There are certainly very obvious tests, like the optokinetic reflex is out; you can’t read instruments in a moving vehicle. You can’t read when you are being vibrated around, so there are certainly some low-level obvious implications for some of these vestibular things that would have an impact on performance, so it’s not like they are all completely abstract.

MAJ SCHERER: The other thing too with one of our tests – we don’t measure vestibular output, per se, but one of the tasks we may talk about tomorrow is a run rolling task, which is you running forward. It’s a complex agility task and the participant ends up doing a roll. We aren’t measuring a vestibular output, per se, in the sense that we are measuring his VOR or how fast his eyes move relative to his head, but we had, during the course of the data collection, two or three people who could not do that task. So we know we are stimulating the VOR. We may not know the output, per se, but the bottom line is if they couldn’t do a high-speed roll as part of a combat sequence or simulated combat sequence, then that guy is combat ineffective. We may be talking [about] a couple of different scales here; one is a very specific diagnostic, medical, clinical scale, which may or may not correlate well with function. So, I think we keep coming back to this. We can talk a lot about the clinical metrics and there is absolutely a place for that in the clinic. But we’re all here to talk about function too; that’s obviously going to be in our crosshairs moving forward.

DR. BRUNGART: Another interesting aspect of the vestibular [system] that might be worth noting is that the vestibular [system], I think, is disrupted in a variety of ways all the time; and there is neuroplasticity to let you adapt back to normal function. So, one of the implications of the brain injury may be impairing that ability – that when something happens peripherally to the vestibular system, you are not able to adapt back to normal, which is what usually happens, and that could be PTSD or some other anxiety [disorder].

MAJ SCHERER: And might that account for that sort of chronic state of dizziness that is probably going to result in a non-RTD Soldier?

DR. LAWSON: Yes, about 18% of the people don’t recover months afterwards.
DR. RUPERT: I think, Kathy [Ms. Helmick], that you would really like to have one nice test out there for vestibular and, really, you’ve got 10 possible vestibular sites for injury. You’ve got three canals on each side, plus two otolith organs on each side, so that’s 10 possibilities. If you have something in the vertical canals, you aren’t going to catch it with a horizontal test but you will catch it with a vertical test. That’s why you see several times as many tasks – because you have to try to get at all of these different possible sites of injury.

That’s what I tried to emphasize in that rather cartoonish picture – that it’s a system of systems and there is so much coming in from our skin, muscles, and joints – as well as our visual side – and that’s why there needs to be so many tests, to try and catch where the problem is. Fortunately, on the visual side, there are a lot of global influences – whether it’s frontal lobe, for example, that can be affecting some of those non-vestibular, visual tests, that people classify as vestibular because they happen to be done by people in the ENT world.

MS. HELMICK: Getting back to those two buckets and following on what you were saying, if you look at the gradual, progressive return to activity, you have a primary care provider and for the rehab, the rehab provider is going to get into those nuts and bolts. Those tests that you are talking about are going to get to the fine points. So that’s probably in that one bucket. But you are not going to be able to do all of that at every camp, post, and station, or out in the field when you’re worried about cubing weight and all of that stuff. Which one are you going to hang your hat on, or which two are you going to hang your hat on and assume risk that you are not going to get to all the fine details of the other pieces?

DR. RUPERT: I absolutely agree. That’s why I was saying with the last study from the Kitterman Group, that to try and hang your hat on those four or five tests, and get a go or no-go from that, and if you don’t seem to get a clear indication, then you would consider going on to do other tests. If there’s absolutely no problem on those five tests, then go back. If there is a problem, then you don’t go, and if it’s somewhere in between, then you continue doing more tests until you get to that point.

DR. CROWLEY: That’s a diagnostic battery that would need to be mapped to performance to get where we want to go. I think one of the reasons we tried to do that marksmanship task with the spin-and-shoot was based on what we heard from the VA [Veterans Affairs Office]. Our laboratory showed that aspects of it were sensitive, but it’s not panning out with patients, except for patients that we didn’t really need the tasks to tell they were dizzy. The guys that we really want are those where it’s so subtle that it doesn’t come out; they may not be symptomatic. Perhaps they are concealing it and we want to draw it out in an assessment.

DR. LAWSON: Or they’re not symptomatic when you test them?

DR. CROWLEY: The way that we can then translate that to a performance metric that makes sense to the Army – and that didn’t work, so it’s one of the things we need to discuss and get feedback on – is what if we had them do a modified Romberg while they were walking or whatever? Do we keep pursuing that because it had such great face validity? And tomorrow, we’ll hear about some other tasks that have great face validity from Courage Kenny, but our thinking was to try to leap ahead to something that equaled performance that had a pathophysiological basis and it wasn’t that simple.
DR. BRUNGART: Unfortunately, even if you find some changes that are functionally relevant – and the CAREN study is the example here – the changes are pretty subtle in making a case that the person is going to be operationally unfit based on those changes. I haven’t seen very many convincing cases.

MS. HELMICK: At least for the duration of the tests, as was mentioned earlier. If the workload is increased, maybe you can do that test and you can shoot accurately or have good throughput for five minutes, [but] send somebody out for two days and they peter out.

DR. BRUNGART: I think that’s exactly right. It’s the cumulative disability of dealing with that on a deployed basis is really what the problem is, not whether they can do these tasks.

MAJ DRETSCH: Doing these tasks in a rested state vs. this continuous load of sleep deprivation, a different environment, and other stressors that go with it? I think we’re saying the same thing. How do you bring out that potential underlying deficit? How do you do that?

DR. LAWSON: You make an even bigger MANCOVA [multivariate analysis of covariance].

MAJ DRETSCH: Right, well the hypoxia studies down at USAARL showed interesting findings. The effects are big. There’s a potential difference using measures of attention while you put them in a hypoxic state, starving the brain, taxing the brain because you are taking away some of the oxygen. I don’t know what they are going to find on this one, whether they can replicate it or not, but it still has to translate to some level of functional impairment. This is just symptom reporting.

DR. RUPERT: One slide that Doug [Dr. Brungart] put up – where you basically had auditory acuity and mission success – that’s the same thing we are looking for, vestibular acuity and mission success.

LTC CASTO: That’s exactly the thing we had with hearing. The issue, I can tell a commander, “Your soldier can’t hear 4000 Hertz (Hz) very well.” Okay, so to be able to communicate what that means, your risk assessment code is 50% because he’s not going to be able to hear people when there is background noise, or instructions when there is this type of noise, or whatever specifics to having that clinical tool that predicts operational performance.

DR. BRUNGART: A tricky but important insight in all of these things is the problems we have are not things that impair people’s ability to do their jobs the way they usually do. In the military, accidents and deaths occur when people are absolutely at their limit – almost always. So, we have to be able to sort of predict how these people are going to do when they are in that situation and whether they are more likely to catastrophically fail.

MAJ SCHERER: And the gold standard, as Dr. Crowley put it, is that we are limited during the height of the conflict in terms of our ability to actually execute some of these studies in the deployed setting. That would really be the gold standard if we had a product and wanted to move forward. At this point, part of what we should be thinking about is, okay, now we’ve got the best available evidence after a cumulative ten years of study in this area. What are
we, as a group, going to put forward that we may have to put into practice over the next
decade?

DR. ESTRADA: That is something very interesting. This conversation really stimulates a lot
of thought about things I hadn’t thought about in a while. I imagine that’s happening to
everyone. But Kathy [Helmick] said something a few minutes ago about the DTI effects. It
didn’t matter the source of injury, whether it was blast induced. I got to thinking about the
pupillometry. The entire population was blunt trauma and in separate research, our engineers
are finding that when Soldiers are exposed to a blast wearing eye protection – not goggles,
not sealed – and the blast comes from an angle from the rear, the glasses actually intensify
the blast! It bounces off the lens and goes into the eye socket. I wonder if anybody has
looked at increased eye injury, increased levels of delays in recovery, and things like that.
We might be coming to a conclusion about pupillometry and only looking at half the
population.

DR. CROWLEY: Do you mean are we finding blast-related eye injury?

DR. ESTRADA: I’m asking if the conclusions that were derived from the study using blunt
trauma mTBI and looking at eye metrics, will they be the same if they were blast induced
TBI, where the eye may have taken more of an impact.

DR. CROWLEY: There’s thought that there are blast-related eye injuries showing up
chronically that Dave [Walsh] can talk about more.

LTC WALSH: I don’t think it would really matter, Dr. Estrada, because if you have a
handheld pupillometer, it’s just measuring your response. It doesn’t care if you got it via
blunt or blast. It’s just measuring your response, your autonomic response and says do you
fall within normal ranges. It doesn’t take into account whether it’s blast or blunt.

MS. HELMICK: You could do a stratification study that looked at blast, impact only,
controls, and orthopedic controls, then vary it by time of injury. You could do it immediately
after injury and at certain set points to see if the latency changes. One of the things I was
struck about – we have this clinical recommendation and what we say to providers is, “If
your patient comes in with mTBI already diagnosed and they complain of dizziness, then we
want you to ask these questions and use these questions as a differential to put them in a
vertigo, a disequilibrium, or a lightheaded bucket.” And we treat syncope differently,
syncope’s over to the left; it’s kind of gotten its own set of rules. Right now, our standard of
care for dizziness is that there are some key questions and then, through the answers to those
key questions, you are put into one of those three buckets. And then, after you are put into
vertigo, lightheadedness, or disequilibrium, you have your own assessment tree and your
own individual management tree, depending on one of those three we believe is your top
diagnosis. I recall there is traditionally very little testing, [other than] Dix-Hallpike and
maybe one other, but no devices mentioned, and no vertical gaze. Now that may be because
the stuff we’re talking about in this room is for specialty services and everything I just
mentioned is supposed to be managed in a primary-care setting.
But I think it is important to go back to the big cohort and think about, can you map those four causes of dizziness, a complaint of dizziness, back to the 10 areas that you are talking about that are peripherally associated with the vestibular system? What I mean by mapping this is putting it all together so that it makes cogent sense. And maybe we don’t have those answers yet, but I’m just throwing out there what our clinicians are saying, what we are training our clinicians on day-to-day is not vertical and horizontal gaze and the other big words you guys used. It’s more about those three, that tri-differential, and then trying to treat that in a primary care setting. So think about that.

LTC MYATT: That’s a very good point, and what I hear in the discussion and what Kathy presented earlier, is that among the three sequelae that you presented – physical, vestibular-balance, and cognitive – vestibular is the one where at this point, you’re probably the most concerned about the algorithms for primary care that have been established and you’d like to see something a little bit more definitive.

MS. HELMICK: I think the experts are here because it’s a neurosensory piece and that’s why I’m really highlighting the vestibular, because the vestibular brains are all here. We are concerned about all three, but you’re right, the vestibular is the most “black-holeish” of all three, and the one that the experts are here to untangle and make clear. Because at the end of the day too folks, we need to be able to put it in an outline format, if you will. It has to be, like I said, cogent. These four tests can look at this, whether we are talking about diagnosis, which a lot of you guys talked about early this morning or actual RTD from a clinical tool that translates into how somebody’s going to perform and function in real life.

MAJ SCHERER: Kathy [Helmick], I think if we look at our medical model, to the entry point for that system, perhaps is the PCM [primary care manager]. And, I think if it’s a syncope case, that’s got one clinical pathway, but for the other three, if the provider, the PCM, is interested in getting a definitive diagnosis down to the oculomotor or vestibular system affected, in many cases, he or she will make the referral to audiology, where audiology will do the vestibular function testing and that will be available then in the note.

For the management piece, chances are good that they’re going to refer to a vestibular rehab provider, whether PT or OT, and they will do their own sort of bedside clinical assessment. I think the management is still there. So, what the algorithm currently encompasses is – this is the clinical presentation, and this person is not duty-ready, and so we have to manage that person. I think the treatment pathways and the diagnostic pathways are still there, they just happen at a different level.

MS. HELMICK: But do we have specificity? I think maybe this is the question that’s coming from what you’re saying – do we have specificity? So, in that lightheadedness bucket, you’re going to see the results of your vestibular tests are X, Y, and Z, most likely, and in your vertigo [tests], you’re going to see something different with vestibular testing. Do we have that kind of specificity with the vestibular testing?

DR. RUPERT: I think you’ve got diagnosis and treatment, and you sometimes have to separate those out because very often, the people that end up doing the treatment don’t have a definitive diagnosis. I like to go back to Susan Herdman’s wonderful tree there – how she
goes about treating, which is really, really well done and thought-out over the years. But very often, you don’t end up with a definitive diagnosis for the vestibular-related problem. You only know it’s abnormal.

LTC CASTO: You have the subjective symptoms that put them in that bucket.

DR. LAWSON: You know that some of the symptoms have helped you select the tree.

MS. HELMICK: So, if it doesn’t change that and it doesn’t change your management…

LTC CASTO: Maybe not, but you can still go back to those diagnostic tools to look at objective tests of recovery to pair with those subjective symptoms. I don’t know if that would change the treatment necessarily.

DR. LAWSON: A key issue also is that a clinician can make distinctions between dizziness and vertigo and there’s not a lot of evidence that patients do [make that distinction]. And so, if you really wanted to get at that construct and really know what is going on inside the person’s head, then you would need to have them generate their own descriptors of their state, then analyze those in a formal manner and figure out how they fell out statistically, rather than imposing your own descriptors on them.

MAJ DRETSCH: And I think we’re going to be chasing that rabbit too sometimes, I mean, differences like finding out what the mechanism is underlying the problem or the deficit. So, developing RTD metrics, like if I have the indoor firing range, it doesn’t matter if I have a cognitive impairment or it’s a vestibular issue that’s causing my performance decrement. That’s for the treatment group to be able to figure out – how do we treat this individual? Because it could be both a cognitive impairment and an intentional decrement where I can’t focus; I can’t disengage. Or, it could be that my attention isn’t focused because of my vestibular, my balance issue. It doesn’t matter – my performance is degraded.

MAJ SCHERER: So, you’re not going back to duty under those circumstances?

MAJ DRETSCH: Exactly, that’s what I’m saying! The treatment providers – whether it’s a referral to the NICoE or someplace else to work on it – that’s a separate thing. But, again, these assessments need to say there’s a correlation, but they could be impaired for many different reasons. We’re not talking about specificity; we’re talking about sensitivity and functionality.

DR. ESTRADA: It could be a psychological issue.

MAJ DRETSCH: Absolutely, let it get treated that way.

DR. ESTRADA: We were testing a drug at the time. We put them on the range and one of our subjects broke down, thinking back to shooting in Iraq or Afghanistan, of some experience he had.

DR. LAWSON: I learned not to walk behind them because it really upsets them a lot. I didn’t know that ahead of time.
DR. BRUNGART: One of the tricky things about the whole thing, I think, is that a lot of times the rehabilitation is a little opportunistic. They try some things that don’t work; they try some other things, and eventually something works. To really get at the big answer, if we had some to code in the medical record, in a useful way from a research standpoint, what was tried and what worked. That would certainly eventually give us some insight into what the actual problem was.

MAJ SCHERER: Well, I mean you’re right. Part of the decision-making process is if someone presents to you with true vertigo, you’ve got a pretty easy distinction. Okay, do I do a Dix-Hallpike and determine that it’s BPPB [benign paroxysmal positional vertigo] or if not, maybe it’s an uncompensated vestibulopathy and you’re doing gaze stabilization exercises. But again, that’s for the treatment rehab tree. That person isn’t going to duty right now.

DR. BRUNGART: In fact, a way of diagnosing may be which treatment works. Another thing that’s true – and I think in a lot of places this could be useful – is a lot of times there’s all these tests but there’s clinical judgment that knows what it is. For instance, at the NICOE, PTs are thinking about this – the two different providers see it and they may both have a very common idea about what it is, but they don’t record it, so it’s sort of lost. We always give [assessment] instruments to the individuals [patients, subjects], but rarely do we give them to the team [providers] doing the evaluation. If we actually asked on some kind of Likert scale for the providers to give us some information about what they observed, wouldn’t that make it a lot easier to go back and figure out? The clinical judgment is probably what’s right and all these other tests are secondary, yet we don’t know that.

MS. HELMICK: These tests that you guys described today, are they part of your common milieu? And you have values, whatever you measured in Hz, and all these other words, are they common in your environment, like the back of your hand? There’s no squishiness, it’s like a blood test; potassium is 3.5 to 5.0 and if it’s 5.1, it’s out of range. Do you have that kind of validation to the multiple tests that you showed us?

DR. RUPERT: I think you can say for vestibular tests that individual differences are larger which is why people want to have a baseline, it’s like the old ANAM, people want the baseline.

LTC CASTO: Yes, these tests are available; yes, people do them.

DR. ESTRADA: To that point, your expert panel, your 52 people that you brought together, they agreed on specific tests that they all agreed were the most useful or the most indicative of health?

DR. LAWSON: Yeah, they were trying to make sure to agree upon the capabilities that needed testing and then take a little lighter pass on, “Okay, what specific test?” And I agree that there’s a lot of problems there; however, I would also say that’s probably true for the ultrasound test, for the breast X-ray screening test, for most procedures that have been developed in cardiology. Most of them are around for 10 to 15 years before they started getting truly validated. It’s a problem, but it’s a general problem for any medical test.
MS. HELMICK: I don’t want to scare anybody with the word “validation” because that can take on a life of its own. But it’s more in general – the tests that have been discussed today that test various dynamics that are happening in complex vestibular, auditory, and visual systems – are they commonplace? They’re not piloting – they’re using common practices throughout the rehabilitative world? And they are plug-and-play, if you will, to mTBI, or Parkinson’s, or many, many, many other things – only with the expertise to say “it’s not normal,” if you’re looking at normalcy and not normal? And individual variations exist – age, gender, whatever else – but relatively speaking, we are not talking about validating new instruments and new tests? These are well-established tests?

DR. RUPERT: There would be a couple that are not [validated] to the same extent. Those were two that I mentioned as new tests, the cVEMP [cervical vestibular evoked myogenic potential] and oVEMP [ocular vestibular evoked myogenic potential]. The stuff above that, those have been around forever.

DR. WEIGHTMAN: His are big; they require equipment. But now he’s moving to a field-expedient one.

DR. BRUNGART: Most people would agree on what the test is. One of the trickiest things is this [neuro]plasticity issue. You’ve got 11 inputs or more and you’ll find two people with a peripheral and measurable and clinic dysfunction who are perfectly functional in all ways and show no deficits because people can adapt.

LTC MYATT: You brought up specificity. I think specificity enters into this conversation here. What measure of specificity are we looking for if we’re going to bridge that gap between clinical diagnosis and treatment and then functional performance that further substantiates someone who is categorized as an RTD Soldier or Service member?

MAJ DRETSCH: I was saying we need sensitivity. We need to show some level of capturing a true deficit if there is one. Specificity doesn’t matter as much when it comes to RTD, [except] maybe in certain areas, potentially, when you really identify there’s a specific deficit. But we’re talking about mild TBI and we don’t really know. Because, again, we keep throwing out that no two single TBIs are the same, whether it’s blast, blunt, genetic factors, medication, PTSD, polytrauma, sleep deprivation, skull thickness – how do we narrow it down?

We’re going to spend our whole life chasing that rabbit vs. saying, “this is a functional task that is correlated with some functional ability to do your job.” And again, whether you are impaired from the TBI due to PTSD or it’s more about anatomical changes in the brain, comorbid substance abuse or whatever – and you can pass this test – then to address the specific issues, that’s the clinician, the PT, or whoever else or other specialty there is – an interdisciplinary approach. But we are worried about how do we screen to go back to duty!

LTC MYATT: But the clinical specificity is not necessarily going to carry over directly into the operational specificity that the unit is looking for, so there’s our gap. So how do we bridge that?
DR. LAWSON: There are rules of thumb. If you don’t know anything, you are supposed to balance specificity and sensitivity pretty evenly, right, just going into it? But that’s not going to apply in every case.

MAJ DRETSCH: And again, specificity does depend. Whether I’m using a test of effort, like malingering, it’s the use of it. My cut-offs are going to be different. And again, if I’m more worried about false negatives, then that’s where there’s a huge issue later on. If the magnitude of the injuries is a lot more severe, then I need to shift that. We’re talking about false negative predictive power and a lot of other things. You’re going to have to have a normative database on some to say what number standard deviation, to say this is abnormal, so there’s a lot of major issues.

MS. HELMICK: To your point – in the operational environment, if you have 100 people and 60 of them don’t meet your test, thumbs down, it doesn’t matter that they’re sleep deprived, it means something’s wrong. They might be sleep deprived, they might be hyper vigilant, or whatever. They might have attentional issues or TBI, vestibular, whatever. Are you taking out 60% of your cadre? At that point – to your point – in certain arenas, it makes a big difference. Then you need something more! Everybody’s sleep deprived, so at what level are we going to say the thumbs-up/thumbs-down is not detailed enough, not granular enough – thumbs down, or thumbs way down? We need that level of granularity.

DR. ESTRADA: The standard – are those set up in the MOS guide actually – those skill standards that are required for each MOS?

MAJ DRETSCH: Which we know isn’t necessarily the best. I got injured recently – a torn tendon in my arm and it took me forever [to heal]. I wanted to get treated. I’m like, “What’s going to happen?” If I have a TBI, just because I have symptoms or prior concussion doesn’t mean I’m going to necessarily be referred to this specialty care either. So, like the facilities that you guys are working at – the NICoE and everything else – those are ones where usually they get referred and it’s tough to get in; they’re not just taking everybody that’s been concussed. Besides, we know that people are walking around with prior concussions that are very functional and may have some slight impairment but they have coping mechanisms too.

Where are we really focusing? Is it going to be the ones going through these treatments we are concerned about – the highly comorbid? Or, is it going to be post-deployment? Which do we screen: “Okay, can he pass this?” He could screen positive for being concussed. Nobody has defined that route yet.

DR. ESTRADA: Would it help anybody but me to hear the DVBIC process? When you get an injured Soldier that enters your facility, what RTD criteria do you use?

MS. HELMICK: We don’t have programs. We augment programs that are already existing in the Air Force, the Army, the Navy, [and elsewhere]. We promote the RTD standards that I showed you this morning. Now, how well are they being adhered to – that’s what Emma [Dr. Gregory] and the group are going to be finding out. The three spots are San Diego, [Camp] Pendleton, and [Fort] Bragg.
We’re going to start trying to understand if this is user-friendly – things like that. We should be following the protocols for screening using the MACE tool, and then we have clinical management algorithms that people should be following for how-to, because our biggest problem in mild TBI is symptom management. People have this event, they have some change in their mental status, and temporally related – although not needed for their diagnosis – are symptoms, and they struggle with those symptoms. So, we have paradigms on how to treat, assess, and manage – both from a pharmacological and non-pharmacological standpoint – manage common symptoms that folks complain about.

And we try to empower the primary care provider. Looking at 2010 through 2012 – so a three-year cohort – 66.6% of people in the military health system that seek care for TBI had one or two visits to primary care. So, two-thirds of the mild TBI population seek care in our health system once or twice. And then the group that was about 5% had over 20 visits. So we have, just like Medicare, a few people that use a whole lot of the services and most people who don’t use them very regularly. I think that’s one of the things that as we talk tomorrow, is worth keeping in mind. The vast majority of people had a concussion and now return to the same MOS and want to do so as safely, efficiently, and as fast as they can. And then we have that whole other bucket, which is the chronicity, and can you even stay in the military service? And what can we do to help facilitate that you stay? Are you fit for duty to stay? And the other people managed in primary care get better very quickly and resume their lives, and then those that the majority of people around this table see – the worst of the worst. There are no ED [Emergency Department] physicians here; there’s no primary care [doctor] seeing strep [streptococcal pharyngitis] and everything else – and also, by the way, some concussions. Those are where the vast majority of our TBI encounters occur.

DR. PANKER: What I would say, if you’re talking about the one-or-two-and-done, what the algorithms say is what is our RTD marker? Well, it’s exertional testing. Are we going to fire up your symptoms when we increase your heart rate for a couple of minutes? Maybe that’s where we start and say is that adequate or not? And is that adequate for certain populations and not [for] others? That’s what we have right now. It’s rudimentary. It’s just trying to fire up your symptoms. Now, that’s for the one-and-done. Am I sure that everybody that’s one-and-done, or two-and-done, is actually put on a treadmill for two minutes? I don’t think so, but that’s what the policy is; that’s what the algorithm says to do.

For those that are in ongoing treatment, it does become symptom-driven treatment. Maybe it’s vestibular and they need to do vestibular rehab, or visual rehab; or maybe it’s cognitive rehab-focused, and that’s where you get into the programs like Fort Campbell, Fort Bragg, Fort Carson, Fort Bliss – there are lots of sites that are doing something similar. You try to do the best you can to see if you can manage those symptoms with increasing levels of load and challenge. And then that’s the group you really want to get back to duty. And then there’s the others that are the maybe-we-throw-everything-at-them-trying-to-avoid-an-MEB … that’s kind of a different group as well.

MAJ DRETSCH: So it seems like you try to mitigate the symptoms, like a clinician would, but at the same time making sure there’s an adequate level of functional performance, which seems to be missing. You may take the NSI [Neurobehavioral Symptom Inventory] and say, “Okay, they look normal now; we’ve treated them with medication and everything else and
now they look like they’re normal again in the NSI,” which DVBIC uses a lot. But what about functionally – is it going to have to be a combination of both? You guys are working on the treatment for what’s going on with TBI and saying that’s how you classify them, or send them to the next level for treatment.

DR. PANKER: And how long have they been out of the game? So if they’re one-and-done or okay, they take three days and rest or whatever, and two days – let’s say they’re not in the progressive return-to-activity protocol. They do their exertional testing; they haven’t lost a lot, hopefully, in those one or two days. Whereas somebody who’s been kind of not doing their normal MOS stuff for weeks on end – that might be where you get into your “we need to run them through a battery of exertional tests”… great. But now they’ve lost their marksmanship skills!

SGT McCULLEY: You aren’t going to lose it that quickly.

DR. PANKER: You do decondition pretty quickly with certain things.

SGT McCULLEY: I haven’t been in a lab in probably five and a half years and I could probably walk into a lab and still perform laboratory tests. Marksmanship I could go.

DR. ESTRADA: Nobody bumped you on the head.

SGT McCULLEY: That’s true. I think it takes a little longer than a few weeks to lose your skills. You go to AIT [Advanced Individual Training]; officers learn – they go to college.

DR. PANKER: Twelve weeks, 16 weeks, I mean, we’re talking a couple of months that people may be away – up to six months! There’s a lot of counseling that goes on after a certain point.

DR. ESTRADA: Short-term memory loss is also involved – long term memory loss…

DR. PANKER: But you are right. Some may not degrade and other specific tasks may degrade.

SGT McCULLEY: It depends on the injury.

DR. ESTRADA: It makes me think of a movie that was produced by the Fort Campbell team when it was the WRRC [Warrior Resiliency and Recovery Center]. They showed a really nice video and they have testimonials. Part of the program was teaching them [TBI patients] how to have a little notebook by them because they couldn’t remember appointments and things like that. What I was going to get to was that I had a question for Mark Showers. Do you know if any other NICoE satellite uses anything close to the MFAP? And the reason why I’m asking that is because along with that video, there’s another video on the same CD where Admiral Mullins visited Fort Campbell and he said this is what we need in multiple sites. We need to spread this around – that kind of thing. Is Fort Campbell the only site that uses the MFAP – the specific tests that you guys use?
MR. SHOWERS: Yes, in fairness, we have a lot of inquiry, “How do you do this? What do you do?” So I’ve tried to pare the features down to as portable as I can make them. We’re the only ones who do what we do. It requires so much collaboration with the entire Post. It becomes difficult for other posts to build that camaraderie or togetherness. A lot of times, I think people don’t really like to work with the medical [staff] if you’re the front line. “You guys do what you do, we do what we do.” So that becomes difficult. Now, with that being said, I believe other posts have done bits and pieces.

DR. PANKER: Just to tag onto that, the answer is yes and no, I think. There are lots of RTD efforts going on. They may not all be 12-week programs and they may not all be like “No, let’s really go out in the middle of the wilderness for half a day with high-level providers like OTs.” It’s [the MFAP is] very, very labor-intensive; it’s not exportable as a program. Schofield Barracks has tried to do it, as an example.

So, Schofield Barracks was very interested in having something very close to the Fort Campbell MFAP. They couldn’t do it because you don’t have an NCO sitting at a training hub or whatever out in the woods. They just don’t have that kind of OPTEMPO [operating tempo] to be able to have that uniformed personnel to run you through those tasks. So they honed it down and they have something else, something that can be done within their clinic.

DR. ESTRADA: I know that Dr. Twilley, when we visited the MFAP at the Fort Campbell site, expressed that they had all this data, and they may be collecting the same data at the other sites that may show promise in their programs. Maybe it doesn’t have to be as extensive to be as successful, we don’t know. We are working on that to see if the MFAP, certainly the rehabilitation is successful. I’m talking about the MFAP itself, whether it’s predictive of successful integration and future success in the military. I don’t know that the clinical providers have had the opportunity or experience to do these kind of longitudinal studies to look at their programs like at Schofield Barracks – or are we just doing assessments that are [looking at this]?

MS. HELMICK: Another way to think about organizing this is the way the Army has organized their 48 TBI programs, from a category of one to four (1 – 4). You don’t need every site to be a Fort Campbell – to have 12 weeks of a functional analysis assessment program – but as you start looking at them [as categories], like a Level 1 trauma center … If you are familiar with trauma systems of care, where you have the Level 1’s that are going to take all comers and then a Level 4 is going to be the primary care only, the requirements are smaller, so the capabilities that they offer are much less.

You could striate a system of care, like the Army has done very well, so that you are looking at your hotspots, and you funnel through a referral system. The VA [Veterans Administration] does this well – they have a Level 1 Trauma Center. Ideally, if you are not getting care from the clinics, you start to move up the chain to go to the level of care that has more specialized assets.

The Intrepid Spirits, the IS’s – used to be called Intrepid Satellites. The three that are open now are Fort Campbell, which is very unique and very different from Fort Belvoir and Camp Lejeune. Fort Belvoir and Camp Lejeune take all comers. So they act like a Level 1 because
they take everything. If you have TBI and you’re at Fort Belvoir, you are going to the Intrepid Spirit building over there and we are not going to let primary care touch you. We hear “TBI” and that’s where you are going. It’s the same model at Camp Lejeune. CAPT Tom Johnson, who’s a neurologist, will be your first touch point, he and his team, if you have a TBI at Camp Lejeune. And that’s just a completely different model than Fort Campbell, where you get filtered into a more extensive program. It’s not standardized — it’s capabilities and requirements driven. That might be a little bit loosey-goosey at this point, and we’re hoping to get that a little more tightened up as we march this out more.

DR. PANKER: I think Fort Campbell has made efforts to have a more tiered approach. Yes, primary care — if they’re unsuccessful in primary care, they’re evaluated. Maybe they need the 12-week program, maybe they don’t. Maybe they need TBI light — that’s what Terry James told me.

MR. SHOWERS: We struggled for years trying to figure out, what is that other thing out there? Because we get lots of patients, we get them; we do their evaluations, a couple treatments, out the door.

DR. PANKER: The Commanders and the line at Campbell, they’re like, “Geez, I don’t want my guy sucked in for 12 weeks unless he really needs it.” So there’s got to be some sort of tiered approach.

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Day One Wrap-Up and Open Discussion

The above facilitated discussion did not need any guidance or facilitation, but proceeded smoothly and unassisted, extending into the open discussion timeframe, where LTC Myatt attempted to broaden the discussion by interjecting some questions.

LTC MYATT: You know the things that you mention, Dr. Panker, about the labor costs and how expensive it is to take something similar to what Fort Campbell has and implement it somewhere else?

If you all put on your acquisition hats and think of programs of record, then you ask yourself, “Is this a medical problem? Is this a medical challenge to fill the gap? Or is it an Army-wide thing?” And you accept, perhaps, that it’s medical.

Then if we’re going to use Kathy’s two-by-two, we’re essentially providing solutions to those outside the medical community when we resolve these issues for ourselves. And, right now, there is no program of record that really embraces RTD, so I would ask you, do we have that capability? Do we have the capacity, the capability within the AMEDD [U.S. Army Medical Department], and with the support that we have from DoD to establish a program of record, will that allow us to fill this capability gap?

MAJ DRETSCH: What is the cost benefit of this? Let’s put it out there because, again is it going to make that much of a difference, where we’re going to be a much more effective force? I’m thinking human dimension; I’m thinking TRADOC [U.S. Army Training and Doctrine Command], FORCECOM [U.S. Coast Guard Force Readiness Command], everything. What is the real impact this it’s going to have? Is this trying to figure out some kind of RTD metric other than what’s being done clinically? Are we really going to say, “Hey, all right you guys, we’re going to get you to this place now; we’re going to send you all back?” Or, whether you use an RTD metric or not, clinically you’re evaluated and deemed fit-for-duty based off of one clinician, then that’s good enough – I don’t know.

LTC MYATT: You mention the human dimension. If we are looking at this as an Army-wide problem within the medical community, the human dimension is a good link. So, imagine if we, on the medical side, get it right all the time and the line units are saying, “You got it right. You got it right with that soldier you kept in your rehab program; you got it right with that soldier you returned to my unit; you got it right.” So, if our scorecard was 100%, we got it right. Then we would be demonstrating that we really do have our finger on the pulse in this regard, and the research that we’re investing in right now would reap some benefit, with some secondary and tertiary consequences. It would contribute to a strategic effort.

MAJ DRETSCH: Has there been research done saying that individuals that have prior concussions, a history of concussions, are bringing down the mission – or that they cause various mishaps? I don’t know if it could go there.

DR. ESTRADA: We did that unit cohesion study that Amanda Kelley led. The hypothesis was when teammates learned that you had a TBI and had gone through rehabilitation – that
you were going to be treated differently; you were going to be thought to be an impairment to the unit mission. It turns out it wasn’t.

DR. CROWLEY: But that was just looking at bias. You said that as if that is something that’s been looked at.

MS. HELMICK: We’re getting signals from downrange, where commanders are, if I can be blunt, pretty sick of this TBI hysteria. And not just commanders in the theater environment, we are also getting signals from our sports athletics trainers and sports groups. They feel as though the TBI concussion discussions have taken away from musculoskeletal and other key injuries. So, the signals we’re getting form boots-on-the-ground is, “This is not truly as much of an occupational hazard as you guys have led us to believe,” and “We are diverting time and attention long enough on this issue and need to get back to some other business.”

Those are two examples of some recent signals that we’ve received. But I don’t think that we necessarily have the surveillance data to follow the second concussion within 12 months or the third concussion within 12 months. The statistics we are shown are one-time lifetime incidents. There may be second and third concussions that are nowhere in those statistics. So, we don’t have a good way of necessarily following those out, and those are the people that we really need to focus on for these types of tests.

DR. MARION: That raises one of two issues that I think we haven’t touched on very much. The long-term effects of a concussion are a reasonable thing to think about in this discussion. The other thing is, the more we drill down into very specific vestibular tests or these other physiological tests, the more we risk missing a physiologic system that is impaired. Things like memory for example, this is based on sensory abnormalities. We’re not talking about memory problems – memory problems are certainly another sequelae of concussion.

DR. ESTRADA: I think you’ll find some memory in the AAMP, and I think in the MFAP too, that use different military functions to tap into that.

SGT McCULLEY: What you just said about beating this TBI like a dead horse – you said a 12-week rehab program? To me, that’s overkill. You’ve been on the sidelines for football. I played football for 10 years. At one point when I first got into college football, I had three concussions in three months and I’m fine.

I will say – I think I was a freshman at the time – I did notice that I was slower to respond in class. I did have slurred speech. That was stuff that I was able to notice. And what I asked Don [Dr. Marion] earlier is, “At what point do you just ask the Soldier, ‘Hey, are you okay?’ Or, or at what point does the Soldier say, ‘I’m okay to go back and do what I was doing,’ or ‘I’m not okay.’?”

So, if I’m a Soldier, I’m a Soldier. I had a TBI, whether it was mild, severe, moderate, barely noticeable … I should be able to come up and say, “Hey I feel like I can return to my job.” Then, that’s where the intense battery of tests comes in and says, “Okay, we’re going to make sure you can go back to your job,” instead of stretching it out 12 weeks to be over-sure, which is great – you want to protect our brains. You want to protect the investment the
Army has made. But, at some point, the Soldier should be able to say, “Hey doc, I’m okay,” and then you confirm it. And also, you touched on malingering. You have people that say, “I’m not okay,” and how do you know?

DR. ESTRADA: That’s why I asked how long you could stay in Phase 3. There are some malingerers.

MAJ DRETSCH: You do get selection bias, but that’s what effort testing various forms is for, but it’s a tough one.

DR. PANKER: And to follow up with Don’s [Dr. Marion] point, that’s where maybe some of the neurocognitive testing comes into play, where there’s that mismatch where the soldier says, “Hey, I’m fine,” but their neurocognitive assessments say, “Uh, maybe not so fine,” or vice versa, where they say, “No way, no way!” That’s where the education piece comes in.

SGT McCULLEY: That Soldier needs to be educated, but no one’s mentioned how about we ask the Soldier. I get that some say they are good to go, “Put me back in,” and they’re not. And some are going to say, “I’m not okay,” and they’re fine. But these soldiers need to be educated to say, “Hey, I’m okay.” To get back to my story earlier, I knew I wasn’t okay. I wasn’t going to jump right back into practice; I wanted to sit out of practice a couple of days.

MAJ DRETSCH: Say you had a concussion yesterday, and now we’re getting ready to deploy. Now the question is to you – this is the risk. If you have another concussion, you could be in a lot worse of a place. Again, this is the impact of multiple concussions and this is what may happen. Then, at what point do we entrust individuals to say, “All right, you’re right. I don’t want any more concussions.” Or say, “I don’t care. I’ll do it.”

DR. THORNSON: Isn’t risk-taking a part [symptom] of it [TBI]?

SGT McCULLEY: You’re in the Army. That’s an occupational hazard.

DR. THORNSON: Isn’t that one of the symptoms of mild TBI – frontal lobe [involvement] and lack of judgment?

LTC MYATT: Yes, certainly executive function [is involved].

MAJ DRETSCH: Everybody’s job is to make sure you have quality of life too, right? That’s the fine balance, and again, we know there’s risks. If we go to war, there’s risks.

DR. CROWLEY: With the scenario you just described, it’s totally different. You could be 100% normal to every test we do but still be at an increased risk if you are re-injured. That, then becomes a probability question. What’s the probability of getting re-injured?

MAJ DRETSCH: There’s an increased risk of combat of concussions in certain environments, in certain training environments, and again how do you mitigate that when you know that individual already has a couple concussions in their medical record?
LTC MYATT: With these discussions, I didn’t have to facilitate. When we finished our last presentation, this group phenomenally just began to converse. The discussion has been spontaneous and I regret that I have to bring it to an end right now.

We do have Day 2, so please come back. I think we lose a person tomorrow who can’t make it back to be with us. But this is the ideal kind of discussion we need to have and as we’re wrapping it up I want to thank Dr. Lawson, Dr. Rupert, LTC Walsh, Dr. Brungart, and LTC Casto for their presentations. Please give them a round of applause.

I don’t think the spontaneous discussions we’ve had here occurred independent of their influence and what they brought to us with their discussions. That having been said, tomorrow we’re going to be challenged to focus the discussion in a way that’s going to work for us. And one way that we will have a better idea of the way the discussion’s going to for work for us tomorrow is for you to complete the Grading Sheets for the three presentations that were done this afternoon. Some folks completed the Grading Sheets from this morning’s presentations, but did not turn them into SGT McCulley or me. We’ve got a stack next to the door. Some of us will be reviewing them tonight and I noticed from those that were turned in this morning, there were some written comments. Those comments will facilitate discussion tomorrow. One of the things we’re going to do tomorrow will be to have breakout sessions where we prescribe three different groups.

MS. HELMICK: For patients, maybe there are batteries related to emotional agitation or whatever?

DR. THORNSON: We use the Quality of Life scale for those who do not RTD in our assessments. Obviously, things like depression or PTSD do affect your quality of life, so we do kind of address those.

LTC MYATT: The issues that SGT McCulley presented here certainly remind us that we have to take the science and make it relevant and practical. And we really do need to look at the long-term consequences of what we’re trying to do with our applied research efforts through this particular body of research that we’re committed to support. Thank you very much for bringing that up, SGT McCulley. I’m going to turn this over to Dr. Crowley and Art [Dr. Estrada].

DR. CROWLEY: Adjourned.
Targeted Analysis toward the RTD Toolkit – LTC Myatt

LTC Myatt began Day 2 by thanking the attendees for the following day’s discussions and reminded all of the Day 2 Agenda ahead. LTC Myatt presented Dr. Margaret (Maggie) Weightman of Courage Kenny Rehabilitation Institute. Although Dr. Weightman gave the presentation, two of her collaborators were part of the Working Group Symposium, Dr. Mary Radomski, also of Courage Kenny (and listed as coauthor), and MAJ Matthew Scherer of USAHC. It should also be noted that there were several videos of the various experiments incorporated throughout the slide presentation which, for obvious reasons, cannot be incorporated into this technical report.

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Presentation of Assessment Tools (Day 2)

Assessment of Military Multitasking Performance (AMMP) – Margaret Weightman, Ph.D., P.T. & Dr. Mary Radomski, Ph.D., OTR/L

AMMP Team Members

• Leslie Davidson PhD, OTR/L; Riverbend Therapeutics LLC
• Marsha Finkelstein, MS; CKRC
• Kristin Heaton PhD; USARIEM
• Karen McCulloch PT, PhD, University of North Carolina-Chapel Hill
• CPT Laurel Smith, MA, OTR/L; USARIEM

• CAPT Henry McMillan PT, DPT; Womack PI, Fort Bragg
• Amy Cecchini PT, MA; Research Coordinator, Fort Bragg
• Caroline Cleveland BA; Research Assistant, Fort Bragg
Background

• Lack of performance based assessments in rehabilitation medicine
• Novelty of what the AMMP is trying to do...on many fronts
• Clinical feasibility important...cost of equipment, space, time to set up and administration time.

Warrior Training and Job Demands
## Study Measures—Theoretical Framework

<table>
<thead>
<tr>
<th>Multitasks</th>
<th>Cognitive Executive Function, Memory, Attention, Reaction Time</th>
<th>Sensorimotor Eye tracking, Scanning, Vestibular, Balance</th>
<th>Physical Exertion, Bend/Lift, Manual Speed, Agility</th>
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<tbody>
<tr>
<td>CQ Duty</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Run-Roll-Aim</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patrol-Exertion</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dual-Tasks</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Illinois Agility</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load Magazine/Radio Chatter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISAW Grid</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Neurobehavioral Tests
- Tower of Hanoi, WRAT Reading, CTMT, NAB Digits/Number & Letters, TOMM, DVAT, SRT

## Background & Development Process

**Multistep process...**

- **Stakeholder Inquiry**
- **Expert Consultation**
- **Stakeholder Summit**
AMMP—Hybrid Model
Dual-task and Multitask Paradigms

Functional assessment measure using dual-task and multitask methods that is sensitive to duty-limiting sensorimotor, vestibular, and cognitive deficits in concussed Soldiers

<table>
<thead>
<tr>
<th>Dual-task</th>
<th>Multitasking</th>
</tr>
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<tr>
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</tr>
</tbody>
</table>

AMMP Dual Tasks

<table>
<thead>
<tr>
<th>Dual Tasks</th>
<th>Illinois Agility Test - Word List</th>
<th>Load Magazine-Monitor Radio Chatter</th>
<th>Instrumented Stand &amp; Walk (ISAW)-Grid Coordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Working memory</td>
<td>• Attention allocation</td>
<td>• Balance</td>
</tr>
<tr>
<td></td>
<td>• Physical exertion</td>
<td>• Processing speed</td>
<td>• Memory</td>
</tr>
<tr>
<td></td>
<td>• High level balance</td>
<td>• Manual dexterity</td>
<td>• Attention</td>
</tr>
<tr>
<td></td>
<td>• Obstacle avoidance</td>
<td>• Auditory processing</td>
<td>Mancini et al. (2012)</td>
</tr>
</tbody>
</table>
AMMP Multitasks

- Divided & alternating attention
- Visual attention & scanning
- Auditory & visual processing
- Physical exertion
- Reaction time

Patrol/Exertion
- High level balance
- Vestibular function
- Dynamic visual search
- Response inhibition
- Prospective memory

Run-Roll-Aim
- Executive function
- Memory
- Scanning
- Manual speed

CQ Duty Task

Project Aims Initial AMMP Validation
USAMRMC Funding 2012-2015

Aim 1: Refine a set of AMMP dual-tasks and multitasks; specify test administration procedures

Aim 2: Evaluate inter-rater reliability (IRR) in Healthy Control and Service Members with mTBI

Aim 3: Evaluate convergent/discriminant validity using correlation

Aim 4: Evaluate known groups validity
**AMMP Task Refinement Process**

**Interrater Reliability**

**Study Phases-task revisions**

**Phase Ia**—USARIEM 20 HC; 9 tasks

**Phase Ib**—USARIEM, 12 HC; 2 tasks

**Phase IIa**—Fort Bragg 12 mTBI & 1 HC; 6 tasks

**Phase IIb**—Fort Bragg, 7 mTBI; 6 tasks

**Phase III**—Fort Bragg, 35 mTBI & 53 HC; 6 tasks

Multitasks (A-bag, Duty Roster, Pack-ship) dropped for poor IRR, difficulty observing all task components, large test burden—salient components revised into CQ Duty. Step Initiation-Stroop Dual-task-dropped for lower face validity, equipment issues.

Subjects were inconsistent on SALUTE report components, varied based on judgment/experience/rank of SM. Revised to be standardized post patrol questions in place of SALUTE report.
Design and Subject Demographics
Fort Bragg

**Design:** Convenience sample case-control measurement study involving test construction & evaluation using target population (mTBI) from TBI pipeline at WAMC & healthy control (HC)

### DEMOGRAPHICS

<table>
<thead>
<tr>
<th></th>
<th>HC N=54</th>
<th>mTBI N=54</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years) Median (Range)</td>
<td>30(19-42)</td>
<td>25.5(19-42)</td>
<td>0.007*</td>
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<td>Sex Female OR Percent</td>
<td>10(18.4%)</td>
<td>3(5.6%)</td>
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<td>Caucasian OR Percent</td>
<td>28(51.9%)</td>
<td>33(61.1%)</td>
<td>0.023*</td>
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<tr>
<td>College Degree or higher OR Percent</td>
<td>26(48.2%)</td>
<td>10(18.6%)</td>
<td>0.008*</td>
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<tr>
<td>Service Time (years) Median (Range)</td>
<td>8.2(0.3-23.3)</td>
<td>3.6(0.8-23.0)</td>
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<td>Primary MOS Category</td>
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<tr>
<td>Force Sustainment Operation</td>
<td>27(50.0%)</td>
<td>21(38.9%)</td>
<td>0.012*</td>
</tr>
<tr>
<td>OPS Support</td>
<td>9(16.7%)</td>
<td>2(3.7%)</td>
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<tr>
<td></td>
<td>18(33.3%)</td>
<td>31(57.4%)</td>
<td></td>
</tr>
<tr>
<td>PTSD checklist</td>
<td>19(36.5%)</td>
<td>8(15.1%)</td>
<td>-0.001*</td>
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<tr>
<td>WRAT Reading (standardized)</td>
<td>101(76.134)</td>
<td>101(76.134)</td>
<td>0.007*</td>
</tr>
<tr>
<td>Deployed to Iraq/ Afghanistan</td>
<td>39(72.2%)</td>
<td>38(70.4%)</td>
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<tr>
<td>Hearing issue</td>
<td>23(42.6%)</td>
<td>47(87.0%)</td>
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<tr>
<td>Ready to RTD 7</td>
<td>49(90.7%)</td>
<td>27(50.0%)</td>
<td>&lt;0.001*</td>
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</tbody>
</table>

**AMMP Tasks—Dual Tasks**

Functional assessment measure using dual-task and multitask methods that is sensitive to duty-limiting sensorimotor, vestibular, and cognitive deficits in concussed Soldiers

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</tbody>
</table>
Instrumented Stand and Walk-Grid Coordinates

- Target - balance, memory, attention
- Grid Coordinates – 8 digit
- ISAW:
  - 30 Second stand
  - 7 meter walk
  - 180 degree turn

ISAW-Grid

<table>
<thead>
<tr>
<th>ISAW-Grid</th>
<th>Scoring Reliability</th>
<th>Known Groups Analysis*</th>
<th>Correlations to Standard Neurocognitive tests</th>
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<tbody>
<tr>
<td></td>
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<td>ICC (95% CI), n, p-value</td>
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<tr>
<td>Metrics</td>
<td></td>
<td></td>
<td>Tower of Hanoi # moves</td>
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<td></td>
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<td>ICC (95% CI)</td>
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<td></td>
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<td>ICC (95% CI)</td>
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<tr>
<td>Grid</td>
<td></td>
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<td>0.97 (0.92-1)</td>
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<tr>
<td>coordinates</td>
<td>Single</td>
<td>Dual</td>
<td>Single</td>
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<td></td>
<td>7.0 [1.5]</td>
<td>7.0 [1.5]</td>
<td>12.0 [2.1]</td>
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<tr>
<td></td>
<td>5.9 [2.3]</td>
<td>6 [1-8]</td>
<td>6.6 [1.8]</td>
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<td>Walk time</td>
<td>T-test</td>
<td>0.04 [-0.16, 0.24]</td>
<td>n=99 p=0.697</td>
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<tr>
<td></td>
<td>n=91 p=0.805</td>
<td>0.04 [-0.16, 0.24]</td>
<td>n=99 p=0.697</td>
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<tr>
<td>Walk time</td>
<td>Single</td>
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<td>0.206</td>
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<td>0.04 [-0.17, 0.24]</td>
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</tbody>
</table>

*Known groups analysis with Mann-Whitney U unless otherwise noted.
Instrumented Stand and Walk -Instrumentation

• The Instrumented Stand and Walk (ISAW) test (Mobility Lab, APDM INC, Portland OR) wireless Opal™ movement monitors which contain 3D angular rate sensor, 3D accelerometer, gyroscope

• Monitors affixed to
  – lumbar area
  – lateral ankles

http://www.apdm.com

ISAW TURNING DYNAMICS-
Single Task Condition

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group statistics</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>Turn duration (secs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mTBI</td>
<td>Mean (SD)</td>
<td>&lt;0.001 (T-test)</td>
</tr>
<tr>
<td>HC</td>
<td>1.88 (0.39)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.57 (0.32)</td>
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</tr>
<tr>
<td>Turn Peak velocity (°/sec)</td>
<td></td>
<td>&lt;0.001 (T-test)</td>
</tr>
<tr>
<td>mTBI</td>
<td>Mean (SD)</td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td>198.3 (37.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>235.0 (50.9)</td>
<td></td>
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</tbody>
</table>

Healthy Control SM (HC) n= 64 (including 20 HC from USARIEM MTBI “non-duty ready” SM (mTBI) n= 43

**Similar findings in Dual-task condition; awaiting results
Distinguished HC vs. mTBI participants ($p=0.003$)

**HC: Mean (STD):**
- 225.7 (45.1)
- ID 83: 338 deg/s

**mTBI: Mean (STD):**
- 192.1 (35.3)
- ID 57: 167 deg/s

---

**Illinois Agility Test-Word List**

- Working memory
- Physical exertion
- High level balance
- Obstacle avoidance

*Getchell (1979)*
### Illinois Agility Test-Word List

- **Targets**
  - Working memory
  - Physical exertion
  - High level balance
  - Obstacle avoidance
- **Scaled “packing list”**
  - number recalled in ST condition
- **3 conditions**
  - No instruction NI
  - “Remember the words” Cog
  - “As fast as you can” Mob

---

### Illinois Agility-Word List

<table>
<thead>
<tr>
<th>Metrics</th>
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<td>Fort Bragg</td>
<td>HC</td>
<td>mTBI</td>
</tr>
<tr>
<td>n = 23</td>
<td>Mean (SD)</td>
<td>Median (Range)</td>
<td>p-value</td>
</tr>
<tr>
<td>18 mTBI, 5 HC</td>
<td>n = 50</td>
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<tr>
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<td>Median (Range)</td>
<td>ICC (95% CI), n, p-value</td>
</tr>
<tr>
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</tr>
<tr>
<td>Words correct</td>
<td>1.0 (1-1)</td>
<td>5.5(0.8)</td>
<td>5.6(0.8)</td>
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<tr>
<td></td>
<td></td>
<td>6(4-7)</td>
<td>6(4-7)</td>
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</tr>
<tr>
<td>Time (secs)</td>
<td>0.99 (0.98-0.99)</td>
<td>19.8(2.3)</td>
<td>19.9(2.3)</td>
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<tr>
<td>Single task</td>
<td></td>
<td>19.1(16.1-26.1)</td>
<td>19.1(16.1-25.0)</td>
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<tr>
<td>Word errors</td>
<td>1.0 (1-1)</td>
<td>1.7(1.2)</td>
<td>1.8(1.2)</td>
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<td>2(0-5)</td>
<td>1(0-5)</td>
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<td></td>
</tr>
<tr>
<td>Words correct</td>
<td>1.0 (1-1)</td>
<td>4.5(1.0)</td>
<td>4.3(1.0)</td>
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<td>5(2-6)</td>
<td>4(2-6)</td>
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</tr>
<tr>
<td>Time (secs)</td>
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<td>18.8(1.9)</td>
<td>18.9(1.6-23.9)</td>
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<tr>
<td>Dual-Cognitive</td>
<td></td>
<td>18.4(15.5-23.9)</td>
<td>18.9(15.2-26.0)</td>
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<tr>
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<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Word errors</td>
<td>0.996 (0.987-1)</td>
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<td>1.0(1.3)</td>
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<td>1(0-4)</td>
<td>1(0-5)</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Known groups analysis with Mann-Whitney U tests, unless otherwise noted.
Load Magazine-Radio Chatter

- Targets
  - Attention allocation
  - Processing speed
  - Manual dexterity
  - Auditory processing
- Load M16 dummy rounds
- Respond to Keywords
  - Monitor 2 speakers

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Fort Bragg</th>
<th>Scored Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC</td>
<td>n = 24</td>
<td>18 mTBI, 6 HC</td>
</tr>
<tr>
<td>mTBI</td>
<td>n = 51</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Load Magazine-Radio Chatter</td>
<td></td>
<td>Median (Range)</td>
</tr>
<tr>
<td>ICC</td>
<td>(95% CI)</td>
<td>p-value</td>
</tr>
<tr>
<td></td>
<td>n = 24</td>
<td>T-test</td>
</tr>
<tr>
<td>Rounds loaded</td>
<td>Not evaluated</td>
<td>55.4(7(9.9)</td>
</tr>
<tr>
<td>Single</td>
<td></td>
<td>58(32.7)</td>
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<tr>
<td></td>
<td></td>
<td>53(7(8.6)</td>
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<td>54(3(9.4)</td>
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<tr>
<td></td>
<td></td>
<td>0.337</td>
</tr>
<tr>
<td>Rounds loaded</td>
<td>Not evaluated</td>
<td>51.8(0.3)</td>
</tr>
<tr>
<td>Dual</td>
<td></td>
<td>51(60-72)</td>
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<td>49(51-81)</td>
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<tr>
<td></td>
<td></td>
<td>0.16</td>
</tr>
<tr>
<td>Rounds difference</td>
<td>Not evaluated</td>
<td>3.7(6.0)</td>
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<tr>
<td>Single-Dual</td>
<td></td>
<td>4(13-19)</td>
</tr>
<tr>
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<td>4.4(6.8)</td>
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<td>0.730</td>
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<td>(0.993-1)</td>
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<tr>
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<td>7.7(1.9)</td>
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<tr>
<td></td>
<td></td>
<td>7(2.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.797</td>
</tr>
<tr>
<td></td>
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<td>-0.07 (-0.27, 0.14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n=92 p=0.508</td>
</tr>
<tr>
<td>Single Task Errors</td>
<td>0.995</td>
<td>(0.986-1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.2(1.4)</td>
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<tr>
<td></td>
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<td>2.7(3.8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.797</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.09 (-0.12, 0.29)</td>
</tr>
<tr>
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<td>n=92 p=0.385</td>
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<td>-0.11 (-0.29, 0.1)</td>
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<tr>
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<td></td>
<td>n=102 p=0.318</td>
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<tr>
<td>Dual Task Correct</td>
<td>0.978</td>
<td>(0.968-0.999)</td>
</tr>
<tr>
<td></td>
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<td>7.7(1.6)</td>
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<td>7(2.1)</td>
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<td>0.014</td>
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<td>-0.14 (-0.31, 0.07)</td>
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<td>n=92 p=0.197</td>
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<td>Dual Task Errors</td>
<td>0.947</td>
<td>(0.869-1)</td>
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<tr>
<td></td>
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<td>2.2(2.6)</td>
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<tr>
<td></td>
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<td>3.4(2.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.17 (-0.03, 0.36)</td>
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<tr>
<td></td>
<td></td>
<td>n=92 p=0.102</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-0.35 (-0.51, -0.17)</td>
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<tr>
<td></td>
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<td>n=102, p&lt;0.001*</td>
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<tr>
<td>Correct difference Single-Dual</td>
<td>*</td>
<td>-0.06(2.2)</td>
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<td>0(6-8)</td>
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<td>0.05</td>
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<td></td>
<td>0.04 (-0.17, 0.24)</td>
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<tr>
<td></td>
<td></td>
<td>n=92 p=0.711</td>
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<td></td>
<td>-0.14 (-0.32, 0.06)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n=102 p=0.17</td>
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</tbody>
</table>

*R Known groups analysis with Mann-Whitney U unless otherwise noted

Scoring Reliability

<table>
<thead>
<tr>
<th>Known Groups Analysis*</th>
<th>Correlations to Standard Neurocognitive tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC</td>
<td>mTBI</td>
</tr>
<tr>
<td>ICC (95% CI)</td>
<td>p-value</td>
</tr>
<tr>
<td>Tower of Hanoi # moves</td>
<td>WRAT Reading (IQ)</td>
</tr>
</tbody>
</table>

* Known groups analysis with Mann-Whitney U unless otherwise noted
AMMP Tasks—Multitasks

Functional assessment measure using dual-task and multitask methods that is sensitive to duty-limiting sensorimotor, vestibular, and cognitive deficits in concussed Soldiers

<table>
<thead>
<tr>
<th>Dual-task</th>
<th>Multitasking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires simultaneous performance of a cognitive and a motor task.</td>
<td>Ability to concurrently process and perform two or more alternating tasks.</td>
</tr>
<tr>
<td>Measured as a “cost” relative to performance of each activity in a single condition. Assumes limited and shareable human process capabilities.</td>
<td>Further characterized by task “Interleaving” and “attention modulation”.</td>
</tr>
</tbody>
</table>

Charge of Quarters Duty (CQ Duty)

- **Targets**
  - Executive function
  - Memory
  - Scanning
  - Manual speed
- **Unstructured task**
  - develop and implement a plan
- **Prospective memory task**
- **4 work areas, rules, motivation**
CQ Duty

*Reliability between scorers achieved
*Two CQD metrics appear to distinguish between groups

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Scoring Reliability</th>
<th>Known Groups Analysis</th>
<th>Correlations to Standard Neurocognitive tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ICC (95% CI), n, p-value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tower of Hanoi # moves</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>WRAT Reading (IQ)</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>Task Performance</td>
<td>0.88 (0.76-0.97)</td>
<td>n=49 34 (2.8) 35 (29.38)</td>
<td>n=33 32.6 (3.9) 34 (21.37)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total visits</td>
<td>0.98 (0.97-0.99)</td>
<td>n=50 11.86 (3.8) 11.6 (-22)</td>
<td>n=51 14.4 (5.3) 13 (7-30)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completion time</td>
<td>0.998 (0.994-1)</td>
<td>n=50 18.6 (4.5) 18.0 (11.7-30.8)</td>
<td>n=51 20.1 (4.9) 19.3 (13.1-37.0)</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>Total # Rule Breaks&gt;3</td>
<td>0.91 (0.75-1)</td>
<td>n=49 7 (14.3%)</td>
<td>n=33 5 (15.2%)</td>
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</tr>
</tbody>
</table>

Run-Roll-Aim

- Targets
  - High level balance
  - Vestibular function (roll)
  - Dynamic visual search
  - Response inhibition
  - Prospective memory

- Trip wire, 3-5 sec rush, roll
- Stroop task, view numbers through scope
### Run Roll Aim

37 HC and 37 BI subjects in such 300-dimensional feature space (in which each subject is represented by a point), all 74 subjects were projected onto a 2-dimensional plane, which was chosen by PLS-DA (Partial Least Squares – Discriminative Analysis) algorithm so as to maximize the spatial separation of HC and BI subjects. This projection is shown in Figure 1, revealing prominent and distinct clustering of the two groups.

---

#### Table: Scoring, Reliability, Known Groups Analysis*, Correlations to Standard Neurocognitive tests

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Fort Bragg</th>
<th>HC</th>
<th>mTBI</th>
<th>ICC (95% CI), n, p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roll</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aim</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total time (seconds)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Trial 1 correct</td>
<td>0.999</td>
<td>(0.997-1)</td>
<td>13.5(0.70)</td>
<td>13.2(1.0)</td>
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<tr>
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</tr>
<tr>
<td>Trial 1 errors</td>
<td>0.96</td>
<td>(0.91-1)</td>
<td>2.0(1.1)</td>
<td>2.0(1.1)</td>
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<tr>
<td>Total time (4 trials)</td>
<td>*</td>
<td></td>
<td>2.9(0.59)</td>
<td>3.0(0.57)</td>
</tr>
<tr>
<td>Total correct (4 trials)</td>
<td>*</td>
<td></td>
<td>4.9(4.6)</td>
<td>5.4(4.4)</td>
</tr>
<tr>
<td>Total errors (4 trials)</td>
<td>0.64</td>
<td>(0.13-0.92)</td>
<td>4.9(4.6)</td>
<td>5.4(4.4)</td>
</tr>
</tbody>
</table>

*Known groups analysis with Mann-Whitney U unless otherwise noted.

---

#### Plot: Principal Component Analysis

The PCA plot shows a clear separation between HC and BI subjects along the first two principal components. HC subjects are predominantly on the left side, while BI subjects are mainly on the right side, indicating distinct patterns of performance across the tasks.

---

### Run Roll Aim--Multitask

In the context of the multitask scenario, the performance metrics for each subject were analyzed. The data suggests that HC subjects generally perform better than BI subjects across various metrics, indicating a significant difference in neurocognitive function. This is further supported by the reliability and known groups analysis, which show consistent patterns across the tasks.

---

All data points were derived from a comprehensive study conducted at the COURAGE KENNY REHABILITATION INSTITUTE, utilizing advanced analytical tools to assess and compare the neurocognitive performance of healthy controls and patients with BI.

---

170
Linear Support Vector Machine (SVM) was trained to discriminate between HC and BI subjects using their 300-feature vectors as inputs. The discriminative performance of SVM was cross-validated using the leave-one-out approach. 31 out of 37 BI subjects (84%) were correctly classified by SVM as such, and 23 out of 37 HC subjects (62%) were also classified correctly. The distributions of SVM scores of BI and HC populations are plotted in Figure 2, showing significant shift of the BI distribution relative to the HC distribution.

The ROC curve of the BI and HC distributions is plotted in Figure 3. Area under the ROC curve (AUC) is 0.804.
Patrol-Exertion

• Divided & alternating attention
• Visual attention & scanning
• Auditory & visual processing
• Physical exertion
• Reaction time

Patrol-Exertion

• Targets
  • Divided & alternating attention
  • Visual attention & scanning
  • Auditory & visual processing
  • Physical exertion
  • Reaction time
• Exercise 65-85% APMHR ~ 12 minutes
• Monitor/during video IED markers, post patrol questions
• Reaction time, essentially randomly throughout
### Feasibility of Tasks

- Administration time (instructions and testing)
- Set up/take down time
- Cost of equipment (range of <$100 to $8,000)
- Testing space
- Storage Space

<table>
<thead>
<tr>
<th>AMMPP TASK ADMINISTRATION TIME (MINUTES)</th>
<th>Healthy Controls Median(range)</th>
<th>mTBI Median(range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CQ Duty (44,30)</td>
<td>27(12-40)</td>
<td>28.5(18-45)</td>
</tr>
<tr>
<td>ISAW-Grid (47,29)</td>
<td>16(10-42)</td>
<td>17(13-28)</td>
</tr>
<tr>
<td>Load Mag-Radio Chatter (43,29)</td>
<td>21(14-37)</td>
<td>21(16-32)</td>
</tr>
<tr>
<td>Run-Roll-Aim (40,27)</td>
<td>13(6-30)</td>
<td>14(5-31)</td>
</tr>
<tr>
<td>Patrol-Exertion (47,28)</td>
<td>23(18-30)</td>
<td>25(10-35)</td>
</tr>
<tr>
<td>Agility-Word List (48,23)</td>
<td>12(7-38)</td>
<td>13(8-17)</td>
</tr>
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</table>
Logistic Regression--prediction

<table>
<thead>
<tr>
<th>Healthy Control</th>
<th>mTBI</th>
<th>Percent Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy Control</td>
<td>38</td>
<td>5</td>
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<tr>
<td>mTBI</td>
<td>9</td>
<td>21</td>
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<table>
<thead>
<tr>
<th>B</th>
<th>SE</th>
<th>df</th>
<th>Sig</th>
<th>Exp(B)</th>
<th>95%CI Lower</th>
<th>95%CI Upper</th>
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</thead>
<tbody>
<tr>
<td>CQ Duty-Visits</td>
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<td>.072</td>
<td>1</td>
<td>.021</td>
<td>1.180</td>
<td>1.026</td>
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<td>GRID Coordinates</td>
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<td>.169</td>
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<td>.077</td>
<td>.742</td>
<td>.533</td>
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<td>Patrol Reaction Time (end)</td>
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<td>.106</td>
<td>1.004</td>
<td>.999</td>
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<td>.012</td>
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<td>1.934</td>
<td>1</td>
<td>.063</td>
<td>.027</td>
<td></td>
</tr>
</tbody>
</table>

Decision tree (CHAID):

[Decision tree diagram]
Overall Comments

• Physical metrics in general did not distinguish know groups, as we measured them,
• The physical on top of the cognitive, allowed the cognitive to bubble to the surface.
• Rolling (RRA) caused a problem, our metrics didn’t capture

• Physical metrics in general did not distinguish know groups, as we measured them, not surprising in population of Warrior athletes who typically reserved full effort for physical tasks (not primary domain of impairment)
• The physical on top of the cognitive, allowed the cognitive to bubble to the surface.
• Rolling (RRA) caused a problem, our metrics didn’t capture
• Collecting a limited dataset of neurocognitive (WRAT reading/reaction time) in addition to specific symptom related outcome measures related to the mechanism of provocation in test tasks could prove a feasible clinical (i.e., field expedient) assessment pathway in the absence of full instrumentation
  - RRA rolling provoke activity limiting function in a subgroup of patients
  - Post activity changes in vision from PATROL task discriminated between groups
  - Simple and within task reaction time measures discriminated between groups within the PATROL task
  - These types of localized but highly sensitive findings could be useful in building a refined test battery to inform duty readiness within the constraints of clinical time spans
Overall findings
Lessons learned

- Functional (clinical) metrics within physical performance domain were limited in their utility to discriminate HC from sub-acute mTBI groups without instrumentation and/or including symptom report or neurocog metrics.
- There is likely an optimal balance of symptom report, impairment and functional metrics that can be modeled to optimally discriminate between ready and non-duty ready personnel.
- Future research should explore use of sensitive test components identified with the battery to flag non-duty ready personnel from RTD.

Future research directions for AMMP

- I think we need to further evaluate whether or not there are essential domains of functioning/vulnerabilities that are not appropriately evaluated in the subset of AMMP test tasks that show between group differences. (like vestibular function).
- Collection of normative data on healthy controls (ultimately would want to establish cut-points for definite “gos” and “No gos” (we might not be so precise about SMs in the in-between area).
- Determine whether single test-task metrics or a composite of metrics (spider plot, predictive modeling?) would best predict readiness for duty.
- Ultimately, would need to test between-group differences with the population of interest (that is, SM post mTBI but who look “fine” but are still symptomatic – not those still receiving rehabilitation)?
- If it is to be used to measure progress for RTD, we need to evaluate responsiveness to change and/or need for alternate forms.
### Future Research Directions (continued)

- A longitudinal study exploring the predictive validity of the AMMP, an abbreviated AMMP (including symptom reports/ select neurocognitive data points) or specific test tasks within the battery would be useful for end users.

- Statistical analysis that incorporates multiple domains of functioning (logistic regression) likely a valuable tool to normalize contributions of multiple factors to the overall variance ~ strong ecological validity in otherwise high functioning population.

### For those who are keeping score…

- WHAT DID WE FIND???
Discussion on AMMP:

DR. ESTRADA: How did they [the study participants] determine if they were ready to return to duty?

DR. WEIGTHMAN: We asked them a question, “If you were asked to deploy in the next 72 hours, do you feel you’re ready?”

[Following the first video, “Instrumented Standing and Walking – Grid Coordinates Test”]

DR. RUPERT: Are they [the participants] trying to just remember that [task] during the period of time? They don’t have to spit that out at the same time as they’re walking?

DR. WEIGTHMAN: No, they wait until the end after it’s completed.

DR. CROWLEY: What were the clinical metrics you used?

DR. WEIGTHMAN: We used accelerometers on several of these things.

DR. GREGORY: For the selection tasks, what were the results?

DR. WEIGTHMAN: The results were different across the tasks. And they were reliable through all the trials here.

LTC WALSH: What is your p-level? What are your standards?

DR. WEIGTHMAN: We set it at .05 with most of the people in this early set of development.

MAJ DRETSCH: What is the single task?

DR. WEIGTHMAN: They load M16 dummy rounds. That’s the motor task. And then, the cognitive test is how many words they got right and how many words they got wrong.

DR. ESTRADA: So, as long as you are doing one task alone, you don’t differentiate the population?

DR. WEIGTHMAN: Only the cognitive component of the dual task.

DR. PANKER: One quick question – if you had to choose the top two tasks, which two would you choose? Knowing there’s going be gaps and you are not capturing everybody?

MAJ SCHERER: We’ve had talks amongst [each other], what’s the best way to administer these? The answer may be driven by the amount of time you have. It isn’t necessarily a whole battery that you’re administering. From a clinical standpoint, these are additional data points.

DR. WEIGTHMAN: I would say dual tasks; I would argue that you give them a different cognitive task.
FONDY: I’m looking for something different that I can use to make an RTD determination, and not these overwhelmingly complex tools still being researched.

Dr. ESTRADA: What about pupillometry? Can that make the RTD determination?

DR. PANKER: Now you’re talking about diagnostics vs. operational RTD again. All these tests don’t take 24 hours.

MS. HELMICK: Maybe what we need is a decision tree for abnormal vs. normal, a clinical assessment tool and RTD, that has Yes/No answers. If no, then refer up.

This concluded the feedback to Dr. Weightman’s presentation. See Table 7 for the results of the attendees’ ratings and qualitative feedback to Dr. Weigthman’s and Dr. Radomski’s Assessment of Military Multitasking Performance (AMMP).

This space is intentionally blank.
AMMP Grading Sheet Results

Table 7. Assessment of Military Multitasking Performance (AMMP) Results

<table>
<thead>
<tr>
<th>Question/Item</th>
<th>Open-Ended Comments for each Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How useful is this tool for assessing RTD by medical personnel?</td>
<td>Item Mean (1–7) = 5.10</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>2. How useful is this tool for assessing RTD by non–medical (operational/unit) personnel?</td>
<td>Item Mean (1–7) = 3.40</td>
</tr>
<tr>
<td>3. How do you rate the scientific value of this tool?</td>
<td>Dr. Gregory: Dual task approach has lots of potential. Need to look at large mTBI sample with 7 acute, subacute and chronic populations.</td>
</tr>
<tr>
<td></td>
<td>Item Mean (1–7) = 4.40</td>
</tr>
<tr>
<td>4a. How applicable would this tool be in a Combat Support Hospital?</td>
<td>Dr. Panker: Parts of it</td>
</tr>
<tr>
<td></td>
<td>Item Mean (1–7) = 2.90</td>
</tr>
<tr>
<td>4b. How applicable would this tool be in a Medical Treatment Facility?</td>
<td>MAJ Walsh: Great videos!! If you have the right specialists performing the tests, then this can be a useful tool in WTU's.</td>
</tr>
<tr>
<td></td>
<td>Item Mean (1–7) = 4.60</td>
</tr>
<tr>
<td>4c. How applicable would this tool be in a Warrior Transition Unit?</td>
<td>Dr. Panker: Too late</td>
</tr>
<tr>
<td></td>
<td>Item Mean (1–7) = 3.90</td>
</tr>
<tr>
<td>4d. How applicable would this tool be in a Veterans Affairs Hospital?</td>
<td>Ms. Helmick: Has much potential – needs refinement; need to define normals and abnormals (for any reason).</td>
</tr>
<tr>
<td></td>
<td>Item Mean (1–7) = 4.00</td>
</tr>
</tbody>
</table>

OPERATIONAL RTD

5. How well does this tool appear to address concerns about Soldier readiness? | Item Mean (1–7) = 4.80 |
|                                                                           | Ms. Helmick: Has much potential – needs refinement; need to define normals and abnormals (for any reason). |
Evaluation of the Military Functional Assessment Program (MFAP): A prospective, longitudinal study of the predictive validity of the MFAP for RTD success – Carol Thornson, Ph.D. & Mark Showers, M.S., OTR/L

Medical Research and Materiel Command
U.S. Army Aeromedical Research Laboratory
Fort Rucker, Alabama

Evaluation of the Military Functional Assessment Program (MFAP): A Prospective, Longitudinal Study of the Predictive Validity of the MFAP for RTD Success

Mark Showers, M.S.
NICoE-ISIII
http://www.campbell.amodl.army.mil/

Carol A. Thornson, Ph.D.
http://www.usaarl.army.mil
https://orise.orau.gov

Approved for public release; distribution unlimited

Military Functional Assessment Program
UNCLASSIFIED

A Ready & Resilient Force

Military Functional Assessment Program (MFAP)

Culmination of the 12-Week Rehabilitation Program

National Intrepid Center of Excellence-Intrepid Spirit-III (NICoE-ISIII)

To Support the Fighting Force
MFAP

- Provides quantifiable data to verify Soldier meets RTD requirements
- Uses a multidisciplinary approach
  - Occupational Therapy
  - Physical Therapy
  - Behavioral Health
  - Active Duty/Operations SME (NCOIC)
- Completed in 5 Days (2 tasks/day + both EST’s)
- Structured observation of performance on tasks for which a standard already exists
- Functions as a final stage in TBI/PTSD Rehabilitation Program

MFAP Ratings Process

- Four professionals rate MFAP task performance according to behavioral anchored ratings scales (5-point) within their fields of specialization:
  - Non-commissioned officer (NCO) rates according to military performance standards
  - Occupational Therapist (OT) rates global and cognitive functioning
  - Physical therapist (PT) rates physical strength, agility, and balance
  - Mental health counselor (MH) rates anxiety and psychological functioning
- All raters collaborate on the final RTD determination (yes/no)
Review of Tactical Combat Casualty Care (TCCC)

Didactic review via PowerPoint presentation and discussion.

Practical Exercise:
- Hemorrhage control
- Sucking chest wound
- Open and maintain airway
- 9-line Medevac request
- Low physical impact

Warrior Tasks/Battle Drills

Tasks completed at stations:
- Don gas mask and MOPP gear
- CASEVAC with combat litter
- Physically demanding tasks (3-5 second rushes, log rolls, pushups, sit-ups, react to fire)
- Drill and Ceremony
  - Facing movements
  - Forward march
  - Column L/R
  - Rear march
- High physical impact
HEAT instructors present brief class on rollover safety. Soldiers complete 3 rollover drills:
1. Basic egress
2. Egress with limited visibility
3. Egress out the turret
On final egress, Soldiers extract casualty and provide TCCC and call up a 9-line Medevac request.
High physical impact

High Ropes Adventure Course

- Team Building
- Communication
- Leadership
- Response to Stress
- Problem Solving
- Safety
- Moderate physical impact
Review of Land Navigation

Classroom-style presentation of basic land navigation skills:
- Use of protractor
- Use of compass
- Identifying terrain features
- Identifying topographical symbols on a map

Practical exercise involves utilizing 8-digit grid coordinates to locate 3 specific locations on a map and determining the distance and azimuth between them.

Zero and Qualify with M-4 Rifle

Soldiers demonstrate understanding of basic marksmanship skills
- Steady position
- Aiming
- Breath control
- Trigger squeeze

Identify parts of weapon, perform functions check, and clear weapon

Must zero and qualify with two or less trials to pass

Low physical impact
Judgmental Shooting Scenarios

Soldiers work as a team to complete 5-7 "collective" scenarios and 5-10 "shoot/no-shoot" scenarios. Must demonstrate adequate:
- Visual/visuoperceptual skills
- Communication with team
- Judgment/respect of ROE
- Weapon safety
- Low physical impact

Land Navigation

Soldiers complete 3-5 point land navigation course (max distance between points of 350 meters).
- Basic map reading skills
- Use of pace count
- Use of terrain association
- Visual scanning
- Problem-solving
- Cognitive flexibility
- Moderate physical impact
Virtual Convoy Operator Trainer (VCOT)

Complete three combat scenarios embedded with selected entities:
- IEDs
- RPGs
- Non-combatants
- Friendly forces

Must demonstrate:
- Appropriate use of radio
- SITREPs
- Visual scanning
- Safety/judgment
- Topographical orientation
- Teamwork
- Low physical impact

Medical Skills Training: ‘Care Under Fire’

Soldiers complete 3 care-under-fire scenarios of escalating psychological demand and cognitive complexity.

Soldiers must demonstrate appropriate:
- Evaluation of a casualty
- Hemorrhage control
- Management of open chest wound
- Airway management
- Stress management
- 9-line Medevac Request
- Moderate physical impact
Tactical Simulation/IED Lane

- Soldiers perform a dismounted patrol in a squad-sized element and are armed with paintball guns
- Perform a dismounted patrol in a squad-sized element and are armed with paintball guns
- The mission is to keep from being ‘mortally’ wounded while evaluating, treating, and evacuating a casualty while encountering an ambush and ‘IED’ attack.
- High physical impact

 Soldiers must evaluate and treat any casualties they encounter that necessitate completing their mission
Soldiers must react to simulated IED blast and small arms fire.

Soldiers must evacuate all casualties to a casualty collection point... all while maintaining security and fire superiority.
The MFAP seeks to go above and beyond traditional clinical tests in answering:

**Is this Soldier medically FIT to RTD?**

To answer:

**Does this Soldier demonstrate OPERATIONAL READINESS?**

---

**Study 1: Preliminary Assessment of the Construct Validity of the MFAP Using Archival Clinical Data**

- Using de-identified archival clinical records \((N = 79)\), this 2013 study (led by Dr. Art Estrada) explored the relationships between:
  - 14 traditional **clinical assessments** (cognitive, vestibular, and mental health/behavioral assessments used at Ft. Campbell)
  - Subjective ratings of **MFAP task performance ratings**:
    - Global Level of Independence (LOI) score (mean rating across raters on all MFAP tasks)
    - Means across MFAP Tasks by individual raters (NCO, OT, MH, PT)
    - Means of individual MFAP tasks assigned across raters
  - **RTD determination (yes/no)**

---
Methodology

Clinical assessments examined:

<table>
<thead>
<tr>
<th>PT</th>
<th>OT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory Organization Test (SOT) – pre/post</td>
<td></td>
</tr>
<tr>
<td>Dizziness Handicap Inventory (DHI) – pre/post</td>
<td></td>
</tr>
<tr>
<td>Dynamic Visual Acuity (LV) – pre/post</td>
<td></td>
</tr>
<tr>
<td>Comprehensive Trail Making Test – pre/post</td>
<td></td>
</tr>
<tr>
<td>Self-Reported Occupational Performance – pre/post</td>
<td></td>
</tr>
<tr>
<td>Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) – pre/post</td>
<td></td>
</tr>
<tr>
<td>PTSD Checklist Military Version (PCL-M)</td>
<td></td>
</tr>
<tr>
<td>Beck’s Depression Inventory – pre/post</td>
<td></td>
</tr>
<tr>
<td>Beck’s Anxiety Inventories – pre/post</td>
<td></td>
</tr>
<tr>
<td>Patient Health Questionnaire (PHQ)</td>
<td></td>
</tr>
<tr>
<td>Military Acute Concussion Evaluation (MACE)</td>
<td></td>
</tr>
<tr>
<td>Epworth Sleepiness Scale (ESS)</td>
<td></td>
</tr>
<tr>
<td>Alcohol Use Disorders Identification Test (AUDIT)</td>
<td></td>
</tr>
<tr>
<td>MH</td>
<td>Other</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Takeaways from Tech Report

- Statistically significant ($p < .05$) correlations were found for all 14 assessments and global rating scores of MFAP task performance, providing initial support for convergent validity between the MFAP ratings and clinical assessments.

- Findings by Raters/Tasks:
  - NCO- and OT-rated MFAP task performance on 7/10 tasks were significantly correlated ($p < .05$) with the clinical assessments.
  - The MFAP task that had the most significant correlations ($p < .05$) with the clinical assessments was the VCOT (Virtual Convoy Operator Trainer), with 19.
  - MH-rated MFAP task performance was significantly correlated ($p < .05$) with the greatest number of clinical assessments (29).
Takeaways from Tech Report

- 18% of those who completed the MFAP (72) failed – they were not recommended for RTD.
  
  The MFAP tasks with the **highest failure rates > 10%** were:
  
  - Land Navigation Prep Class (16.7%)
  - Land Navigation (21.42%)
  - Virtual Convoy Operator Training (14.1%)
  - Engagement Skills Trainer (EST) - Qualify (30%)
  - Mass Casualty Scenario (MCS) (16.9%)
  - Tactical Mission Scenario (TMS) (10.14%)

More Takeaways

The foregoing MFAP tasks with the highest failure rates were significantly correlated with the following clinical assessments:

- Patient Health Questionnaire (PHQ) – *depression scale*
- Dizziness Handicap Inventory (DHI)
- Sensory Orientation Test (SOT)
- Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) - *currently using NAB*
- PCL-M (PTSD Checklist-Military version)
- Dynamic Visual Acuity (DVA (left and right))
- Military Acute Concussion Evaluation (MACE)
- Canadian Occupational Performance Measure (COPM)
Conclusions/Limitations

- Initial support for the construct (convergent) validity of the MFAP
- However, using de-identified archival data, no follow-up was possible to evaluate RTD success, necessitating the need for …

Longitudinal Study

Evaluation of the MFAP: A Prospective, Longitudinal Study of the Predictive Validity of the MFAP for RTD Success

- Confirm construct validity findings of the archival study by demonstrating convergent validity between subjective ratings of performance on MFAP tasks and clinical assessments scores using a new sample of MFAP participants
- Extend the archival study findings by examining the degree to which MFAP scores predict RTD success (or reintegration into civilian life) 6 and 12 months following program completion
Baseline Data ➔ Follow-Up Data

<table>
<thead>
<tr>
<th>NCoE</th>
<th>Clinical Assessment Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>PT</td>
<td>Sensory Organization Test (SOT) - pre/post</td>
</tr>
<tr>
<td>OT</td>
<td>Dizziness Handicap Inventory (DHI)</td>
</tr>
<tr>
<td>MH &amp; Intake</td>
<td>Dynamic Visual Acuity (L/R) - pre/post</td>
</tr>
<tr>
<td></td>
<td>Neuropsychological Assist Battery-ATTN - pre/post</td>
</tr>
<tr>
<td></td>
<td>Canadian Occupational Performance Measure (COPM)</td>
</tr>
<tr>
<td></td>
<td>PTSD Checklist – Military version (PCL-M)</td>
</tr>
<tr>
<td></td>
<td>Epworth Sleepiness Scale (ESS)</td>
</tr>
<tr>
<td></td>
<td>Military Acute Concussion Evaluation (MACE)</td>
</tr>
<tr>
<td></td>
<td>Alcohol Use Disorders Identification Test (AUDIT)</td>
</tr>
<tr>
<td></td>
<td>Patient Health Questionnaire (PHQ) - depression</td>
</tr>
<tr>
<td></td>
<td>MFAP Performance Data</td>
</tr>
<tr>
<td></td>
<td>MFAP Task Performance Ratings* from Clinicians &amp; NCO</td>
</tr>
<tr>
<td></td>
<td>Percentage of Tasks Passed (0-100)</td>
</tr>
<tr>
<td></td>
<td>RTD? (Y/N)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USAARL</th>
<th>DHI</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>COPM</td>
</tr>
<tr>
<td></td>
<td>PCL-M</td>
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<tr>
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<td>AUDIT</td>
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<td>ESS</td>
</tr>
<tr>
<td></td>
<td>PHQ</td>
</tr>
<tr>
<td></td>
<td>QLS*</td>
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</table>

Follow-Up Performance Data

<table>
<thead>
<tr>
<th>NICoE</th>
<th>Promotion Points – how many?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard Weapons Scorecard</td>
</tr>
<tr>
<td></td>
<td>Performance/Event-Related Counseling</td>
</tr>
<tr>
<td></td>
<td>Officer Evaluation Report (OER)</td>
</tr>
<tr>
<td></td>
<td>Weapon Scorecard - Known Distance Course</td>
</tr>
<tr>
<td></td>
<td>Weapon Scorecard - Scaled Target Course</td>
</tr>
<tr>
<td></td>
<td>Weapon Scorecard - Combat Field Fire</td>
</tr>
</tbody>
</table>

*Quality of Life Scale for those who do not RTD

Data Collection (ongoing since Feb. 2014)

Baseline Data Collection: Clinical Assessments & MFAP Data

- 34 Soldiers have been recruited/consented
  - Demographic and clinical assessments N=34
  - MFAP Task Performance Data, RTD Determinations N=29

Follow-up Data Collection: Assessments & Performance Data

- Of the 24 participants due for 6-month follow-up, data have been collected from 50% N=12
- Of the 15 participants due for 12-month follow-up, data have been collected from 20% N=3

Power analysis indicates complete longitudinal data are needed for N=39

May be necessary to recruit up to 60 to allow for further attrition
**Demographic Data (N=34)**

### Demographic Data (N=34)

#### Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>32</td>
<td>94.1</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>5.9</td>
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<tr>
<td>Total</td>
<td>34</td>
<td>100.0</td>
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</tbody>
</table>

#### Age

<table>
<thead>
<tr>
<th>Age</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
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<tbody>
<tr>
<td>Age</td>
<td>34</td>
<td>19</td>
<td>41</td>
<td>28.24</td>
<td>5.72</td>
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</table>

#### Rank

<table>
<thead>
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<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>E3</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>E4</td>
<td>16</td>
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<tr>
<td>E5</td>
<td>10</td>
<td>29.4</td>
</tr>
<tr>
<td>E6</td>
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<td>14.7</td>
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<tr>
<td>E7</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>E8</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>100.0</td>
</tr>
</tbody>
</table>

**Mean = 27.93 of N=29**
Demographic Data (N = 34)

Enlisted Rank

N=29: E4 (14), E5 (7), E6 (5)

Infantry (11), Maintenance (91), Unit/Petroleum/Logistical Supply Specialists (92), Ordnance (89), Transport (88), ENT (68), Military Intelligence (35), Fire Support Specialist (35), Artillery (13)
Preliminary Results (N = 29)

- MFAP Correlations:
  - The DHI was significantly and negatively correlated with the decision to RTD, $r = -.41, p < .05$ (N=28)
  - Being of a higher Rank was associated with higher overall (global) MFAP Task Performance Ratings ($r = .43, p < .05$)
  - MFAP Task Performance Ratings, as expected, were significantly correlated with the decision to RTD ($r = .66, p < .01$

Preliminary Results

- MFAP Correlations between Raters (N=29):
  - OT Ratings of MFAP Task Performance correlated significantly with the three other Raters ($p < .01$)
    - PT ($r = .52$)
    - MH ($r = .69$)
    - NCO ($r = .82$)
  - MH Ratings of MFAP Task Performance correlated significantly ($p < .01$) with all three - in addition to OT Ratings:
    - PT Ratings ($r = .49$)
    - NCO Ratings ($r = .54$)
## Preliminary Results

### Individual Rater Scores and MFAP Outcomes (N=29):

<table>
<thead>
<tr>
<th>Individual Raters (Clinicians/NCOIC)</th>
<th>Global MFAP Task Performance Rating</th>
<th>% of Tasks Passed</th>
<th>RTD Determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCO (Military Rater) Scores</td>
<td>.86**</td>
<td>.88**</td>
<td>.68**</td>
</tr>
<tr>
<td>Occupational Therapist (OTR/L) Scores</td>
<td>.95**</td>
<td>.80**</td>
<td>.69**</td>
</tr>
<tr>
<td>Physical Therapist (DPT) Scores</td>
<td>.67**</td>
<td>.44**</td>
<td>.27ns</td>
</tr>
<tr>
<td>Mental Health Counselor Scores</td>
<td>.81**</td>
<td>.54*</td>
<td>.42*</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level (2-tailed).  
**Correlation is significant at the 0.01 level (2-tailed).  

### MFAP Task Scores and MFAP Outcomes (N=29):

<table>
<thead>
<tr>
<th>MFAP Task</th>
<th>Global MFAP Task Performance Rating</th>
<th>% of Tasks Passed</th>
<th>RTD Determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tactical Combat Casualty Care Score</td>
<td>.23</td>
<td>.11</td>
<td>.21</td>
</tr>
<tr>
<td>Warrior Tasks and Battle Drills Score</td>
<td>.47†</td>
<td>.25</td>
<td>.31</td>
</tr>
<tr>
<td>HMMWV Egress Assistance Trainer Score</td>
<td>.62†</td>
<td>.46</td>
<td>.39†</td>
</tr>
<tr>
<td>Virtual Convoy Operator Trainer Score</td>
<td>.66**</td>
<td>.47†</td>
<td>.22</td>
</tr>
<tr>
<td>High Ropes Course Score</td>
<td>.44‡</td>
<td>.43</td>
<td>.33</td>
</tr>
<tr>
<td>Land Navigation Prep Class Score</td>
<td>.65**</td>
<td>.53</td>
<td>.49**</td>
</tr>
<tr>
<td>Land Navigation Score</td>
<td>.70**</td>
<td>.63</td>
<td>.47</td>
</tr>
<tr>
<td>Engagement Skills Trainer - Quality Score</td>
<td>.40†</td>
<td>.45</td>
<td>.32</td>
</tr>
<tr>
<td>Engagement Skills Trainer- Judgmental Scenarios Score</td>
<td>.24**</td>
<td>.67</td>
<td>.66**</td>
</tr>
<tr>
<td>Mass Casualty Medical Trainer Scenarios Score</td>
<td>.74**</td>
<td>.70</td>
<td>.56**</td>
</tr>
<tr>
<td>Mass Casualty Tactical Mission Scenarios Score</td>
<td>.69**</td>
<td>.59</td>
<td>.41</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level (2-tailed).  
†Correlation is significant at the 0.05 level (2-tailed).  
‡Correlation is significant at the 0.001 level (2-tailed).
Conclusions

- Study is ongoing and data collection is still underway - more results to follow!
  - To assess the inter-rater reliability of the military (NCO) ratings of Soldiers during the MFAP. The goal is to determine the portability of this program to other locations and branches of service.
  - The study will assist in evaluating the usefulness of NCO ratings in guiding clinicians and policymaker decisions as to when Soldiers are fully able (cognitively and otherwise) to RTD following neurosensory injury.
  - The study will be conducted at USAARL recruiting NCO participants from the Fort Rucker area.

Acknowledgements

- First and foremost, this research would not be possible without the Soldiers, who provide meaning and purpose to our research.
- Many thanks to the previous investigators who designed and initiated this project, as well as conducting the archival study (Drs. Art Estrada, Amanda Kelley, and Bethany Ranes).
- Much appreciation to the AHPD team for their support, and for LTC Myatt and Brad Erickson for leading and coordinating the team (special thanks to Jared Basso for his help).
- The caring clinicians and staff at NICoE Intrepid Spirit Satellite III at Fort Campbell go above and beyond for the Soldiers, in particular my co-PI, Mark Showers, also the Sandra Cannon (MHC), Tamera Moreland (DPT), SGT Mark Harris, and Liz Lee, SLP.
- This work was supported by funding from the U.S. Army Medical Research and Materiel Command, and was also supported in part by an appointment to the Postgraduate Research Participation Program at the U.S. Army Aeromedical Research Laboratory administered by the Oak Ridge Institute for Science and Education through an interagency agreement between the U.S. Department of Energy and USAARL.
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Discussion on MFAP:

DR. WILK: Can you say a little bit about how you selected these different [MFAP] tasks?

DR. THORNSON: We found in the technical report [written on the archival study], that they were selected based on the Soldier’s common tasks [The Soldier’s Manual of Common Tasks] – the 11 tasks that mostly closely matched the Neuropsychological Assessment Battery (NAB).

DR. CROWLEY: Who designed it, and how did this come to be?

MR. SHOWERS: It was a team approach.

DR. PANKER: There are a lot of them [tasks in The Soldier’s Manual of Common Tasks], so how did you select these?

DR. THORNSON: These are the ones that were most amenable to actually assessing what was needed. I would need to get back to you on exactly how they were selected though.

MAJ DRETSCH: You are not using it to assess, you’re basically helping them through it. So they are assessed, but it’s not like somebody there saying you look like you’re going through trouble…

DR. ESTRADA: No, they are assessed. We’ve looked at inter-rater reliability.

MAJ SCHERER: What was your finding for the reliability on this?

DR. THORNSON: Well, you can’t really look at inter-rater reliability, because they each have a different scale. Like we were saying, behavioral health is looking at one thing, like the psychological [components], and OT is looking at the cognitive components, so you can’t really look at inter-rater reliability in that way. Let me just show you what we’ve found so far – everything is pretty much preliminary.

DR. ESTRADA: I do want to say that I remember looking at a lot of these data and I don’t ever remember the ropes being evaluated. Retrospective, there were no scores. Anyway, it might just be that they are scoring them now.

DR. THORNSON: It’s only evaluated by mental health and PT. It’s mostly team-building.

MAJ DRETSCH: What is the sequence these assessments are done?

DR. THORNSON: Mostly at intake.

DR. PANKER: You had said that it was done on intake. That was one of the four you had mentioned. But how is it correlated? You had the success and failures basically on this RTD battery, if you want to call it that. So, you had successes and failures, so your failures were significantly correlated with the MACE how?

DR. THORNSON: Well, with the score, those that passed and those that failed.
DR. PANKER: I know, so failure, but the MACE is not a pass/fail. It’s a three part evaluation. So it’s…

MAJ DRETSCH: Probably the total score could be used.

DR. ESTRADA: Yes, it was.

DR. THORNSON: I don’t think they used the total. I think it was out of 30. Anyway, that was in the results they reported. We didn’t get to the longitudinal study yet.

DR. PANKER: You’re talking about the cognitive portion.

DR. THORNSON: Yes, the cognitive portion. This is the archival study, like I said, I’m just going by the tech report. I don’t have the data so I can’t dig into it.

MAJ DRETSCH: How are they correlated? Because you got a binary, binominal outcome variable, pass or fail, and then you have continuous variables. So was it a binary logistic regression or …?

DR. THORNSON: I think she did a logistic. I’ve got to dig into this, like I said.

DR. ESTRADA: I’m sure it’s in the tech report.

DR. PANKER: Isn’t there a way to get some of the very basic data, like if they made their promotion on time? So you can’t go through DMDC [Defense Manpower Data Center] or something?

DR. THORNSON: No, you can’t.

DR. ESTRADA: That’s privileged, I think. They are very protective.

DR. PANKER: The people that you … the 12 and the 3 – are those folks that are RTD and people that are going through it?

DR. CROWLEY: They have passed, so not necessarily.

DR. PANKER: So, you can’t reach them through their demographics?

DR. THORNSON: No, not if they provide a “mail.mil” email address and then get out. We’ve tried everything to reach them, to track them down for follow-up.

DR. PANKER: So these people are people you generally can’t reach or they are out [of the military]?

LTC MYATT: They haven’t been reached by the contact information that was provided to the researchers and we can’t track where they are in the system.

MAJ SCHERER: I think that’s your key right there. We’ve talked about how do we validate anything? What’s their UIC [unit identification code] at 6 and 12 months, that confirms
they are still on Active Duty? You probably could crosscheck and see if some of those UIC’s have redeployed and whether or not they were among them? Can you look at APFT [Army Physical Fitness Test] scores or something along those lines? This is the hardest question – of all this stuff, that is the hardest part – the follow-up!

DR. THORNSON: Yes, that’s very true.

MAJ DRETSCH: It’s also what does it mean? There has to be something above and greater than not having treatment. You have to show something of value. Right now, I’m really just evaluating the program, because they don’t pass the first time, right? Then they keep training up to try to pass the battery?

MR. SHOWERS: Folks that didn’t pass, they didn’t return-to-duty. One of the issues that were so helpful was that’s okay. We’ve got you within this normal range where you can still be very functional.

DR. CROWLEY: In this study, not the pilot study, but the N of 34, all of them passed, right?

DR. THORNSON: We only have MFAP data on 29, but demographics and clinical assessment data on all 34. All 29 passed so far. But with the RTD measure being dichotomous, Yes/No, you can’t really correlate that. Being of higher rank was associated with higher MFAP ratings.

MS. HELMICK: That’s interesting. I was just sitting here thinking that basic training is where people do this [these tasks/military exercises]. So, if you ask people about basic CPR skills or basic first aid skills that you learn as you enter the military, the closer you are to that time [when you learn these skills], i.e. the lower rank you are, there may be greater recall.

DR. THORNSON: You would think so, like recency effects, but that’s not what we found.

MS. HELMICK: When’s the last time you guys have done this – you guys in uniform – when’s the last time you’ve done this stuff, four years, six years? [Laughter amongst attendees]

DR. THORNSON: Okay, I’m getting the “Stop Sign” again [from LTC Myatt], so I have to wind it up. This is really interesting – the correlations between the different raters – this isn’t really inter-rater reliability but you can look at the relationships between the raters...

MAJ DRETSCH: Are the raters normally there? So they have all worked together? They aren’t objective raters, right?

DR. THORNSON: They are being objective. I have observed them and that’s what I thought at first – they’re going to be biased because they are invested, but they are objective. They have a grading sheet with exactly what they are looking at. Their primary goal – speaking as a psychologist, as a scientist – their primary goal is, “Would I want this person with me if I were in battle?” This is what goes through their minds.
DR. PANKER: But, obviously, having Tammy do the PT assessments when she has been working for 12 weeks is different than having the Blanchfield PT come out when Tammy has been working with them.

DR. THORNSON: She still does the same [objective] assessments: “Do this, do that.”

DR. PANKER: There’s a potential for it. Tammy is great, but there is a potential for it.

DR. THORNSON: That was my initial thought before I went up there, because I’m always thinking “bias,” but I mean, she has them do the, what is it [demonstrates test]?

DR. PANKER: Pronator?

DR. THORNSON: Yes. So, if you look at the global ratings across tasks [pointing at slide] – how much weight went into the global score for each task …

DR. WEIGHTMAN: So you’re saying the engagement skills trainer (EST), that’s that shooting thing?

DR. THORNSON: Yes, the judgmental shooting scenarios.

DR. WEIGHTMAN: And then the mass casualty medical trainer correlated the most with their total score?

DR. THORNSON: Right! Those tasks requiring frontal lobe/cognitive judgment [carried the most weight].

Basically, the study is ongoing; the data collection is still underway, and there is a separate study examining NCO inter-rater reliability ratings.

DR. ESTRADA: I think what is going to help out here is this. Of course at Fort Campbell, the OTs, the PTs, and the mental health folks – they help to evaluate the performance of these people that are ready to be determined fit or unfit for duty. What Carol [Dr. Thornson] is proposing with this NCO study, is to ask, “Is it possible to use NCOs instead of the OTs and the PTs – those clinicians have already said this person has passed every clinical assessment – and we think we can return this person to duty, ”

I think what Carol [Dr. Thornson] is proposing here – don’t let me speak for you – is a separate study to see whether NCOs can be used for this purpose of determining fitness for duty once those clinicians say these people are ready to move on. The purpose is so that this program could be exported to other locations and you wouldn’t need the resources of these clinicians to do the military functional assessment.

MAJ DRETSCHE: I guess you need to have healthy people go through it too, and see how they are rated. You can’t be objective if you know the people going through the program and you have to see if the controls are rated the same way as the patients.
DR. THORNSON: Yes, I mean, that’s the only thing. Originally we were going to look at a control group and have controls run through it, but the logistical constraints …

MAJ DRETSCH: And there are many designs you could try to address some of these issues. Now what kind of value will this provide to a commander that’s meaningful? Should it be for TBI only? No, I think it’s something that is a basic standard. So, again, should it be other types of injuries? So if I went to PT for a bum knee, I should still be able to pass these things.

DR. PANKER: Just to piggy back on that a little bit. Generalized ability is always a big issue. You can do X, Y, or Z in the clinic, great. Does that generalize to a real world task? I think that’s part of the real beauty of what this brings to the table. It’s, perhaps, a look at that generalized ability. I think it would be really interesting to combine forces, perhaps, as a way ahead. Look at the stuff that Maggie, Mary, and Matt have done; maybe combine that somehow, some way shape or form in a more real world scenario. Generalize that endurance piece or what have you, to see if that bears out.

But I do agree that there’s a lot of subjectivity, a lot of, “Okay, everybody, is this thumbs up or a thumbs down for this person?” I think it does give the individual Soldier a sense of accomplishment and a sense of, “Hey, I really can do it! The therapist told me and I’m out here on the ropes and shooting,” or whatever, and “I really can do it!” But is there another way to build that confidence that is perhaps exportable, cheaper, rather than having very high-level, highly skilled people out there in the woods with six individuals for five days? From a programmatic standpoint, it’s staggering and certainly not exportable.

MS. HELMICK: But maybe there are ways to link what Maggie presented here – have those kinds of clinic-based assessments that predict that real world outcomes – with all of these focused, impairment-based measures. Think about that and what percentage of self-reported function should go into the RTD Toolkit and the gradual return to activity model, and how should that pie be sliced? Maybe there is more of a functional slice. We need to synthesize these studies. Longitudinal studies [like the MFAP] are the holy grail in terms of what matters. We need to find a way to do predictive studies or find the right subjects so that we can get the follow-up results we need.

This concluded the feedback to Dr. Thornson’s and Mr. Showers’ presentation. See Table 8 for the results of the attendees’ ratings and qualitative feedback the Military Functional Assessment Program (MFAP) presentation.
### MFAP Grading Sheet Results

**Table 8. Military Functional Assessment Program (MFAP) Results**

<table>
<thead>
<tr>
<th>Question/Item</th>
<th>Open-Ended Comments for each Item</th>
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<tbody>
<tr>
<td><strong>1. How useful is this tool for assessing RTD by medical personnel?</strong></td>
<td><strong>Dr. Weightman:</strong> [Rated as 7, with the caveat] – If at an MTF with this equipment.</td>
</tr>
<tr>
<td><em>Item Mean (1–7) = 4.67</em></td>
<td></td>
</tr>
</tbody>
</table>
| **2. How useful is this tool for assessing RTD by non–medical (operational/unit) personnel?** | **Dr. Weightman:** Needs more psychometrics.  
**MAJ Scherer:** Face validity is very strong. Norms feasibility is a challenge given expense and time to administer. Very strong approximation of real world requirements. Predictive validity research key with COPM 6 and 12 months as a measure of successful RTD or reintegration – could be greatly augmented by 1) APFT performance, 2) Unit of assignment/UIC assignment at 6 and 12 months. If 80% RTD, is the MFAP a sufficiently rigorous assessment tool? |
| *Item Mean (1–7) = 3.08* | |
| **3. How do you rate the scientific value of this tool?** | **Dr. Weightman:** Needs more psychometrics.  
**MAJ Scherer:** Face validity is very strong. Norms feasibility is a challenge given expense and time to administer. Very strong approximation of real world requirements. Predictive validity research key with COPM 6 and 12 months as a measure of successful RTD or reintegration – could be greatly augmented by 1) APFT performance, 2) Unit of assignment/UIC assignment at 6 and 12 months. If 80% RTD, is the MFAP a sufficiently rigorous assessment tool?  
**MAJ Walsh:** Need the right specialists (OT, PT, MH, etc.) to assess these tasks. |
| *Item Mean (1–7) = 3.33* | |
| **4a. How applicable would this tool be in a Combat Support Hospital?** | **Dr. Weightman:** With equipment  
**Dr. Radomski:** Specific sites only |
| *Item Mean (1–7) = 2.00* | |
| **4b. How applicable would this tool be in a Medical Treatment Facility?** | **Dr. Weightman:** With equipment  
**Dr. Radomski:** Specific sites only |
| *Item Mean (1–7) = 3.09* | |
| **4c. How applicable would this tool be in a Warrior Transition Unit?** | **Ms. Helmick:** Specialized population – useful for about 5% of the military population.  
**MAJ Walsh:** Need the right specialists (OT, PT, MH, etc.) to assess these tasks. |
| *Item Mean (1–7) = 3.92* | |
| **4d. How applicable would this tool be in a Veterans Affairs Hospital?** | **Dr. Weightman:** Yes, an adaptation to more civilian tests  
**Dr. Radomski:** Too late |
| *Item Mean (1–7) = 2.70* | |
| **OPERATIONAL RTD** | **Ms. Helmick:** What happens for 18% who fail? Is this the tip of the spear of the population? Longitudinal study is important.  
**MAJ Walsh:** Not sure about how successful the ones who "passed" would be when back in their unit. I will see with the follow–up data. |
| **5. How well does this tool appear to address concerns about Soldier readiness?** | **Dr. Weightman:** [Rated as 7, with the caveat] – If at an MTF with this equipment. |
| *Item Mean (1–7) = 4.67* | |
Facilitated Discussion: Session 3

DR. ESTRADA: I’ve thought about this just this morning. We’ve almost done this in isolation. We met in 2012 and we brought all the RTD programs together. Then we all broke apart and concentrated on our own projects and after three years we’re at this point. We have some things to work with, but we’re not done. And I know that Richard [Dr. Shoge] and the PAD-3 want a product right away, and they’d love to brag about it, but it doesn’t appear that we’re at the finish line just yet.

But I love what you [Kathy Helmick] said – what we talked about this morning. We need a coordinated effort here. It might be OTSG, or it might be DIVBIC that coordinates this for us and at some point, says this tri-fold is great for this bucket for this period – for this phase from 1 to 72 hours or something. And, our vision of a toolkit three years ago was, I think, more ambitious than we can deliver at this point. Maybe we need to rethink this product that we’re trying to get out to the field. We need a context to work toward the goal. How are we going to achieve the goal we want, if we don’t even know the framework in which we’re working? Or do we want to continue having every post have its own program? Because I don’t see a commonality right now across the United States Army or the military. Maybe the MACE is standard and that’s not mandated. I mean you mentioned it yesterday.

MS. HELMICK: It is, by policy.

DR. PANKER: In the Army, we evaluate it in inspections, that it is being used. Are there gaps? Obviously, [there are].

MS. HELMICK: But it is a Service policy, that’s the difference. The Army is ahead with a Garrison TBI policy. None of the other Services have it codified. The big DoD one, the one I described yesterday, is in a theater-deployed environment. But what we are missing is a broad DoD TBI policy worldwide-no-matter-where-you-are-standard-of-care. And that’s also where some of the pieces that Stephanie [Panker] brought up yesterday [fall], between the brochure and the RTD. It’s because we don’t have any policy DoD-wide to stand on to say that “everybody will have 24 hours of rest after they’ve had a concussion in a nondeployed environment.” We do in a deployed environment, absolutely.

DR. PANKER: But I think if we know a little bit of what “right” looks like, we can proceed with a way-ahead down those general paths. I like to look at it as a continuum, so there’s the forward-deployed, “I don’t need any special stuff, maybe the medic can do it,” test – maybe it’s the 85% solution – or just the deployed solution, or just the one-two-and-done solution, and then build from there. When you get to more impairment, longer rehab times, those unit buckets, the people who are going through 12-week or the 6-week, or the intensive outpatient program or whatever, that build onto more rehab where you get into more specific tools for impairments, then you really want to look at guiding treatment as well as tracking recovery and RTD. So I see it as that kind of continuum.

Before we break into our breakouts, I did want mention that the Marine Corps representative for TBI could not be here, but he did write an email to us that basically said that their primary focus, from the Marine Corps standpoint for RTD, is that first piece I mentioned – out on the battlefield, out on the athletic field, the quick and dirty, no special equipment.
And, there’s going to be risks associated. There’s going to be people that are going to be returned that shouldn’t be. There’s going to be people that are probably going to be held back that should be, but that is really where the Marine Corps wants their focus for RTD to be. So even though we don’t have an over-wide DoD policy, there’s certainly appetite and interest from the different Services to help move this forward.

DR. WEIGHTMAN: That’s the point that our team is really focused on, what product are they after – is it functional performance? Is the goal to follow rehabilitation to show responsiveness to change, to show that rehabilitation made a difference, to show that they passed? What does a healthy control look like on our military clinical measures or the functional gate assessment or something like that, but is that the product that’s wanted? Is it both products? We tried to answer it all with this humongous six-task thing. We only tested it on one group, but what’s the answer? There’s no major conflict [overseas] right now, so there’s ways some of this stuff could be tested on West Point plebes who are concussed all the time in their sports. Then you could follow up. Some of our tasks could be tested. They don’t really require major military skills.

The other issue is what is the real standard for returning firearms and whatever? Do our tests/tasks correlate with those things? How would SGT McCulley make a decision that his Private, or whoever, was okay to be with them on his patrols? Would he make sure that he knew how to stop bleeding? What are the rules that Army has for go/no-go? We spent a lot of time years ago with that Soldiers Manual of Common Tasks, trying to figure out what we could test, but there is nothing actually able to test, but the go/no-go. You can’t reliably measure any of those of things because it depends on donning your MOPP [Mission Oriented Protective Posture] gear; [it] depends on when you went into the military, answering a SALUTE [size, activity, location, unit, time, equipment] report; it depends on if you were deployed or not; doing a nine-line MEDEVAC [medical evacuation]; [and] depends on, you know, you get the little card – there’s not a task that we can reliably measure as therapists.

MS. HELMICK: One key section that’s missing, talking about moving forward, that I would be concerned about having a lot of knowledge deficits in, besides vestibular stuff, is decision gate from MRMC. As we start talking about piloting stuff, acquisitions, getting things out, analysis alternatives – that whole process that has to occur before either the U.S. Army or the U.S. Government is going to widely pilot beyond a site. That’s an area that, particularly for DIVBIC, we have very, very little experience in. It would be inefficiency without bringing those experts to the table to figure out how to facilitate some of this.

So, as we talk about future planning, I just want to acknowledge upfront, that even though we are in MRMC Command right now, we really have a huge deficit in the “how to.” If you want to order 55 things, whatever it is, or the neuro-optics – or some of the companies you guys have been working with – we would have no road map on how to get that properly facilitated.

DR. PANKER: We’re doing capabilities developments that include setting the stage. I know there’s this big chunk in the middle that you’re talking about as we define our required capabilities that is included in there.
DR. CROWLEY: The point is that this whole acquisition process that Kathy [Helmick] referred to as “decision gate,” which is the way MRMC produces stuff and puts it through the acquisition cycle, requires a requirement that really should exist before the research is done.

But, often when we see a need, we’re sometimes a little ahead of the requirement, especially the details of the requirement. What should this RTD thing look like? Does it have a certain cost and so forth? After seeing what’s out there now, we may be closer to the point where we go to MEDCOM [U.S. Army Medical Command] and gear them toward creating that requirement. But that’s something to think about. Susan [LTC Fondy], you had a comment?

LTC FONDY: Creating the requirement would be good, but for me, producing something end users can use, that will help me. I see stuff that very high-level people in concentrated groups produce – I see tools being developed for use in the future but I don’t see something useful now like a tool that answers are they good to go.

DR. THORNSON: Were you looking for something that would resolve these issues with the toolkit?

LTC FONDY: Yeah, I was hoping for something – a toolkit that will give you a “good to go” – something you could use in Afghanistan maybe. Like, here’s your toolkit and if you do these four tests, the majority of them will be good to go.

DR. WEIGHTMAN: From the rehabilitation side, that’s where we were kind of pushing.

MAJ SCHERER: From the DoD staff mentioned, you’ve got physical/occupational therapists that are at that level, that can, theoretically at least. When we were initially constructing our body of tests/tasks to operationalize it – that was the level at which some of the tests we were proposing might be administered. So I agree.

Obviously, it’s a holy grail to say that we have this small confined battery of tests that will reliably, validly, predict readiness for RTD. We are all finding that because we’re branching into the range of the functional. From our standpoint, we may have rethought things and said, “How we can inform that RTD decision or that provider who has to make the call and decrease the risk associated with returning them?” Maybe it isn’t a black/white, yes/no, go/no-go solution that we can provide, because at the end of the day, it still will come down to a judgment call by the provider who has to return them to duty.

However, perhaps it’s better to have made that decision being informed by, in addition to, clinical impairment level measures and functional measures that have face validity to the warfighter, and the provider who has to make that call. There are a lot of different expectations around the table to what “right” looks like.

MAJ DRETSCH: I do think that this is pretty big, the RTD toolbox. So we are really identifying where it can be used. It’s like the NIH [National Institute of Health] toolbox, not everybody can use the NIH toolbox, and it’s got to be set for goals or target specific areas along the continuing natural history of TBI. If we come out of this with a couple of tools that can be implemented for rehabilitation purposes or a more general purpose.
DR. ESTRADA: Far forward – where these things can be used. I keep going back to the commander who referred his whole unit. We could look at point of injury. For some cases, where she [LTC Fondy] had the whole convoy show up, some tools like the pupillometer might be able to discriminate at that point. There’s some [concussions] that might be more severe and at that point, in this continuum of care, they [the clinicians] could move to the next level of assessment, and so on.

DR. PANKER: Let me just break in a moment. Now you’re talking about a screening tool for potential diagnostic use, as opposed to RTD. I know there will be some overlap there. In the situation within the convoy, everyone is taking a knee for 24 hours. And all of those people are being re-evaluated for 24 hours. By policy, that is what happens.

LTC FONDY: No. People within the range of the blast are being held out for 24 hours.

DR. PANKER: Correct, but if it’s Command-directed, and it’s one of the potentially concussive events, then everyone takes a knee for 24 hours in a deployed setting.

LTC FONDY: Right, but if a young CPT comes to me saying he wants them all evaluated, as a commander, you could assist him into not making an irrational decision.

DR. PANKER: I understand your point about educating the young leader. But if a whole convoy comes in because they’ve been exposed within 50 meters, or they’ve had a vehicle rollover, or they are Command-directed – let’s say 10 people are Command-directed and 50 people were within range – all of those people, by [orders of] the DoD, whether diagnosed or not, get 24 hours of “take a knee” and re-evaluation. The point I’m really making is about the screening tool. Do we want to focus on the overlap with the screening tool, regardless of the number of people screened? So you bring people in because of the event, driven by protocol and policy. A commander can always override that based on necessity, but once people get in, are you going to use a pupil test or a vestibular test as a screening tool when you know that they are taking a knee anyways? They will have the MACE as an evaluation. The first two questions, nobody knows, but the rest will continue the MACE. You will get your 24 hours and educational brochure, so at that point maybe that’s when the RTD decision comes into play – at those 24 hours.

DR. ESTRADA: Some of these discrete tools, even far forward, are about how to discriminate and move them forward to a higher level of care. I’m just saying, let’s not throw out the discrete tools as RTD tools.

MAJ SCHERER: I think the importance then is to cross-validate. If you want to hang your hat on a clinical impairment-level metric as an RTD decision-making tool, let’s validate it with something that has face validity from the warfighter standpoint that is [also] functional.

DR. THORNSON: That’s what we’re trying to do with the MFAP.

MAJ DRETSCH: If you were normal before, you’ve had something happen to you medically. If I can show that happened to you, I don’t need to show you that you can still do your job. Because you could do it before and it turns out you are biomarker negative.
MAJ SCHERER: So what if my sway is so imperceptible that I can get back into the fight, and it’s not clinically normal the way it was before? And I may, by all outward appearances, be able to get back into the fight and apparently do my job. But what if it is significant?

DR. ESTRADA: If that condition still is in doubt, maybe it’s 51 meters, then those subjective visual vertical and other tests that imply imbalance could be used as an RTD tool. You would then retain that person under medical care and if they passed everything, there would be a deficit that is very small. If you didn’t detect it with those tests, then the clinician would need to have more confidence in returning that person to duty.

MS. HELMICK: I think it has to do with the abnormal vs. the normal. So, as Stephanie [Dr. Panker] already said, we started the conflict and the only thing that informed RTD was if you were absent of symptoms, we would run you for two minutes and see if any of the symptoms came back. This took the person telling us whether or not they had symptoms and possibly being truthful or not. Or, if they are falling down because they have so much photophobia, then it’s obvious. That was Phase 1, exertional testing only when the person says they are asymptomatic.

Now we have another capability that we don’t use very often, about 4% of the time, and that is to take the neurocognitive test that we would test in theatre before the soldier would deploy. And we would see how close to that you were when you were “normal.” That’s not diagnostic of a TBI, but what it does is give the clinician another piece of information that helps inform the entire judgment to RTD. This is an objective measure that could add to the other pieces of the puzzle. Then, as a clinician you’re asking, “What is it that you do? What will you be expected to do the next three days? What are your sleep patterns?” Et cetera.

In any clinical paradigm, it’s not a one-stop checkmark and you’re good, but incorporating and synthesizing in analytics and using state-of-the-art procedures. There’s a drive to add to that arsenal and I think that’s what some of the things we’ve brought up today can do. Will pupillometry be used as a diagnostic tool? “Your latency was wrong. You’ve had a concussion.” No, we are not there yet. Could we get there some day? Perhaps, that with a vestibular plate or something that tells us about sway [would work].

First we validate the original inclusion criteria and make sure we are really studying mTBI, which has been a huge problem for us. You go to IPRs [In-Process Review] and hear results, and you say, “Who was this cohort? Is this really mTBI? Did they really see this GCS [Glasgow Coma Scale]-15 in the ED [Emergency Department] note and put them in the study?” A lot of this is suspect.

I break it into three phases: Phase 1 – exertional testing where you make some decisions about RTD. Phase 2 – exertional testing in the absence of symptoms, plus a neurocognitive assessment tool for comparison. Phase 3 – adding vestibular components, latency components, attention/concentration components with eye tracking, etc. All these are clinical assessments.

Then there’s a point where you stop and traverse over to a functional assessment. These are all part of your arsenal, picking and choosing. There’s nothing mandatory that you do all of
them [the patients]. What do you feel most comfortable [doing] as a clinician, sending that person back, incorporating unique data for each individual’s service?

LTC CASTO: [The same way you have] an audiologist, a physical therapist, and an optometrist to determine when a pilot’s vestibular system has recovered enough for them to fly again. It has nothing to do with TBI, but that type of a test may be useful to monitor their progress. Auditory injury is, most of the time, not related to TBI but we need to evaluate if they have the auditory skills to do their job.

DR. PANKER: That gets back to Mike’s [MAJ Dretsch] point. Maybe an MFAP is part of the equation across the board, but not for TBI or anything TBI related.

LTC CASTO: Exactly, that’s what Doug [Dr. Brungart] was presenting yesterday. We need a way as audiologists, a clinical tool that will predict performance in the field. I can’t take everyone out to the field and patrol with them to see if they can perform.

MAJ DRETSCH: We also have individual variability when we come in. So I may have worse balance than Matt [MAJ Scherer], which isn’t the case [laughter]. You’re really talking about very small changes which can be picked up clinically in some of these instruments, but I don’t know if you are really ever going to solve this problem, per se. There are a lot of variables that can happen, but can we at least get it to a place that’s beneficial?

LTC CASTO: But to have tools available that can be paired with clinical judgments would be useful.

MAJ DRETSCH: I do think these are good to validate a clinician’s judgment, for realistic scenarios.

DR. THORNSON: They [MFAP scores] do correlate with the clinical assessment tools, which are already validated.

DR. ESTRADA: We have taken and validated, for the MFAP, those tools using archival data and validated them against the clinical assessments. If they did well on the clinical assessments, they predictably did well on the MFAP.

DR. WEIGHTMAN: One of the other issues we spend a lot of time thinking about is that the clinical tools are not difficult enough for a healthy, elite soldier who has memorized the answers to certain things – and who can run better than I can even if they’re drunk – and also had a concussion. So we need measures which are more difficult, which is what led us to using more brain resources (motor and cognitive). One of the questions is to just go back and test these Soldiers, whether it’s a Concussion Care Center or the go/no-go military tasks. The problem is that with some of them, it depends on what your grading scale is and if you can reliably measure it. You have got to figure out some kind of measure like that. It’s also a question if you’re looking for something for the person in theater. We’re answering different questions and need to figure out what do they want.
MAJ DRETSCH: As we get to a smaller military and we’re deploying differently than we have in the past, how is this really going to contribute? We need to be more dynamic, more agile, and jump into any environment.

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Breakout Sessions by Functional Area

Based upon the foregoing discussions among the Working Group members, and the various specialties of the attendees that had emerged over the course of the discussions, LTC Myatt adjusted the original plan in the Agenda from the three breakout groups into two teams, Team Red and Team Blue.

LTC Myatt indicated that Team Red would be comprised of those members specializing in vestibular and balance-related issues, including occupational and physical therapists, as well as those working with clinicians and engaged in human performance research. Team Blue would be made up of researchers in the human dimension/cognitive domain. LTC Myatt began by conveying to the Working Group the following:

LTC MYATT: I would like us to address some questions which are on this butcher block paper at the front and back of the room.

Question 1: Can or should we attempt to achieve a common approach in the Army or DoD for mTBI RTD applied research?

Think in a context of what’s going on in the environment through 2020 and 2025. Then turn to the next question.

Question 2: What in this line of research is mission critical, mission essential, and mission enhancing in mTBI RTD?

Mission critical is an effort that is required to fill a capability gap.

Mission essential is an effort that is needed in one or more multidisciplinary communities providing mTBI diagnosis and treatment. If it is not done, it would degrade the capacity to fulfill our research goals with RTD but it wouldn’t stop it.

Mission enhancing is a group of efforts that are nice to implement as we meet our research goals, but aren’t necessary clinically or operationally.

Question 3: Do we want to formulate MOS-specific clinical algorithms?

Some of the research presented showed specific tasks and there are questions as to whether or not you could use those across the board for every MOS.

We have until noon to answer these [questions], and when we come back from lunch we will discuss as a group.

Art [Dr. Estrada], would you mind leading Team Red and I will lead Team Blue?

DR. ESTRADA: No, I don’t mind. I do need to ask if we will consider these questions in the context of our financial resource environment now because MOS specificity takes more resources, more funding, and more time. It is very, very difficult to do.

DR. CROWLEY: Let’s not do that. That’s Richard’s [Dr. Shoge] problem. [Laughter]
DR. ESTRADA: Okay, unlimited resources.

DR. CROWLEY: Yes, let’s look at the need. What is needed and what is the gap? We are not shifting.

LTC MYATT: This is directed toward Task Area P1 research efforts. If you will allow yourselves to look at the environment – what it was when this requirement was first defined and what it is now. This is a well-resourced research effort. So where do we go within the context of our current environment? These questions will help us address that in part.

The two groups, the facilitators, the participating team members, and the research areas/specialties of each group are listed below.

**TEAM RED: Vestibular/Balance/Occupational/Performance Domain**

*Facilitator:* Arthur Estrada, Ph.D.

*Participating team members:*

- LTC Susan Fondy (M.D.)
- LTC Kristen Casto (Ph.D.)
- MAJ Matt Scherer (Ph.D., P.T., NCS)
- Angus Rupert, M.D., Ph.D.
- Margaret (“Maggie”) Weightman, Ph.D., P.T.
- Carol Thornson, Ph.D.
- Katherine Helmick, M.S., CRNP, ANP-BC

**TEAM BLUE: Human Dimension/Cognitive Domain**

*Facilitator:* LTC Craig Myatt (Ph.D.)

*Participating team members:*

- LTC Dave Walsh (O.D., Ph.D.)
- MAJ Michael S. Kim (OTR/L, CHT)
- MAJ Michael Dretsch (Ph.D.)
- John Crowley, M.D.
- Donald Marion, M.D.
- Mary Radomski, Ph.D., OTR/L
- Stephanie Panker, Ph.D., DPT
- Joshua E. Wilk, Ph.D.
- Emma Gregory, Ph.D.
- Mark Showers, M.S., OTR/L
Functional Area Breakout Session Evaluations

The Functional Area Breakout Session Evaluations began following lunch, with LTC Myatt asking Dr. Estrada to start the discussion with Team Red’s findings.

DR. ESTRADA: Would you like to speak, Kristy [LTC Casto]?

LTC CASTO: Sure, I think we were getting hung up on when we’re making these [RTD] decisions and I don’t think that’s our question to answer. I think the question is what tools are available to clinicians to have more data points with which they can make a decision about RTD and not so much telling them when they need to make a decision, because that just depends on some different factors, and I don’t think that’s our question to answer. Providing the tools that are available for clinicians to have more information is what I was getting at.

DR. ESTRADA: Dr. Rupert was making the point that we should be looking not only at return-to-duty, but at return-to-play. He feels that the big dollars are with the professional teams and that whatever we do, they’re going to beat us to the punch because they’re putting a lot of money for a return-to-play device, or series of tools that would make that determination whether to return somebody to play. Dr. Rupert was saying that it could be applicable to both communities.

Dr. Rupert also made the point that they’re not going to wait around for us to come up with the tools. They’re going to come up with their own tools and we should either be a partner with them or keep an eye on what they’re doing. There are lots of companies really interested in getting to those millions of dollars being made available by professional teams and we should partner with them. So, this is something else to consider in terms of funding opportunities. That’s the way Dr. Rupert does business. By looking for companies that are working on things that he is interested in producing, he will nominate an SBIR topic. He is very successful with those and gets companies to build things. So, we need to look at the return-to-play community.

MAJ SCHERER: I think the other thing I would add – you and Dr. Crowley both raised great points about the existing protocols that are ongoing. Part of our efforts to validate some of the tools we may already have in your pipeline may be merged with efforts from the research side and we can meet part of our scientific agenda, which is to do further validation.

DR. ESTRADA: Another example of that is what we’re engaged in right now at Fort Benning – looking at potential TBI injuries within the first couple of hours – because we’re there watching them in their Combatives class. We’re watching them jump out of airplanes. As soon as they land, we have access to them and we’re doing a series of tests, including possibly biomarker data. We’re also collecting data from the accelerometers they’re wearing to look for correlations between those who experience TBI or a concussion. And those who do, I should say, are immediately sent to their Concussion Management Center. We follow them and are involved there, so may be able to propose collecting data there, not anything rigorous or physically demanding, but something that is fairly benign. We could propose
with the clinicians that are doing the assessments—propose to collect data from which we can validate, correlate findings, so thank you for bringing that up.

DR. RADOMSKI: But I find myself wondering why do we go narrow? I see that over the last eight years there’s been a connection, and I think as we talked about a whole breadth of ways to evaluate RTD, are we at a point where we say there are no sacred cows or are we all loving our sacred cows still? I’m just asking as a rhetorical. Do we stay broad and find these new possible things or do we start to narrow and have a menu of things available?

MS. HELMICK: It seems to me that there is never going to be one thing. My gut-level feeling is that everything should be on the table as available to use—things that have shown to be somewhat useful, that bring some idea of progress or rehabilitation—or whatever with caveats—with what types of environment they will be useful for, and what you might get out of them. That’s what I’m thinking.

DR. ESTRADA: To your point, I think that it might be a good time to narrow down to those tests that show more promise than others.

DR. PANKER: I think what we’ve done successfully in this meeting is we have talked about ways to code for the chronicity of the 12-week rehab performance collectively by looking at the clinical instruments and performance. We have started to demarcate different rules of engagement and different thresholds, depending on if you’re primary care—you’re quick and done, or you are in the rehab bucket.

One thing I see clearly is the stuff we have talked about this afternoon has mainly been aimed at that right-hand side of chronicity [of mTBI]. When we start to look at the left-hand side of the picture, primary care/acute, it’s pretty uncomplicated. But we have high-risk groups in there that we probably want to think about how those performance measures can really be tested in a high-risk group that has acute concussion, but are going back to do pretty high-risk things. If they are not ready then, “shame on us!” They can get in a lot of trouble. The other piece in that primary care group that this meeting has elucidated is the need for some good clinical assessments, particularly in the area of vestibular, as we look at physical, cognitive, and vestibular.

I think about the actions we have in our current standards that we talked about yesterday—walking on uneven terrain, a function, but how something as a tactic will evolve in the later stages. Stages 1 and 2 are pretty low maintenance. As we look at stages 3, 4, and 5, how can we self-direct for that primary care population, and start tying more assessments to performance? Two main things I see are that, number one, we have two cohorts of patients identified and some programs that seem to be beneficial for those that are going to require more intensive rehabilitation with the end state of getting them back to the force. If the end goal is to get them out of the force, that’s not our priority right now. It’s to get them back to the force.

So what are those minimal stages to get them back to the force? I don’t think that people will be happy with a “high enough” or “low enough” metric [for this group]. [For] the primary care group, how do we take crisp, validated clinical assessments—and not be scared
by the word “validated” assessments – that help us make those best decisions linked to some type of not-as-in-depth performance measures? Do we have a good probability of sending [some] back with a focus on high-risk groups like EOD [explosive ordinance disposal technician], or Special Ops [operations]? [Should] we look at some heightened MOSs in that biggest bucket we have?

Way back, six or seven years ago, we had a slide that talked about the symptoms after TBI, followed by the manifestation of those symptoms, [such as] poor marksmanship, difficulty with recon [reconnaissance], tactical true life sequelae from symptoms, cognitive attention, whatever. I talked about our commander’s slide we presented at Elmendorf [Air Force Base], and with any chance we had to talk to nonmedical people – that was the slide that resonated with them. They said, “We can’t have that.” We got their attention. We had to present our argument why this should be important to them. By 2009, it was the line that came to medical, “Something’s not right with our Soldiers and you guys have to do something about it.” And that’s where the first in theater programs came about.

Since 2010, when those programs rolled out, we’ve gone backwards with our relationship with Command, in my view, where it’s not seen as the “something’s not right.” We’ve probably fixed that part. We did that through early detection programs. We worked on the left hand side of the continuum of care. You know why? Because these guys had concussions and they weren’t being detected. And they were suffering, and you were seeing the adverse sequelae.

Now, back up and we have early detection because there’s mandatory screening programs based on the incident base, so the problem starting with “something’s not right” – and the solution – was mandatory screening programs. There really isn’t a problem. We’re not getting copious amount of data to say that we’re erroneously returning people to active duty. So we don’t have find solutions if we don’t have a clear problem.

One of the reasons we haven’t been presented with a problem from commanders is because it’s off their radar we did a good job of diagnosing, so we’re not hearing a lot from them about, “You sent them back, dude, and they’re messing up left and right,” or, “You sent them back and they caused havoc with the whole group or the whole unit.” So, we’re not hearing that from the line which makes our problem statement a little more difficult to codify and connect to a solution. [That] doesn’t mean we’re not supposed to do it [solve the problem].

This actually might be a good way to bring Command and Medical back together on this issue – because we kind of separated and we have some very conservative guidelines. You have a second concussions, per the DODI [Department of Defense Instructions] Joint [Joint Staff], seven days of rest [is prescribed] after your symptoms resolve. We want it to be like that.

DR. ESTRADA: I think with all that’s going on with the sports teams that gives them some [credibility]. Not only the military medical community is imposing this, but the commanders in the field see that it’s an issue in professional football. All of this that adds more credibility to the argument that they need to take care of their Soldiers.
MAJ DRETSCH: We try the approach of “What’s the level of operational readiness and individual readiness in units on the front line?” Immediately after an event, the individual’s progress get worse – chronic, complex – you are seeing this in some of these [patients]. How well we can assess whether or not they can get back [to duty]? So, we identify that we don’t really know the impact of having concussions on the overall operational performance on the line. We don’t really truly know if the team is being brought down.

We do talk about what instruments could go in the toolbox, rather than a TBI toolbox. We know there are guidelines and what should take place during the first levels of a concussion, whether or not these instruments have evidence to use them as part of this process, subacutely or for chronicity. We have identified the use of instruments, which are currently being used with athletic teams like NCAA [National Collegiate Athletic Association] and things like that. Balance testing is prevalent. But, again, someone has to look forward to what can be put on a platform with technology. If everything is going to be a handheld device, how can that be utilized? How can we leverage that technology? You are on top of the mountain – how do you know if you can get down? How to asses – self-evaluate or have the medic evaluate with this device, whoever is available? Having some recommendations could take us far forward.

DR. ESTRADA: I do want to highlight [that] evaluating neurosensory RTD assessment for neurosensory injuries isn’t only TBI; [it] could be hearing [or] vision.

MAJ DRETSCH: TBI is easy to talk about and to measure success – pitching it in TRADOC or FORCECOM to enhance unit readiness.

DR. ESTRADA: This article you wrote is a great model for us. It is important for us to look at these proceedings and it’s a good way to document this meeting. It’s a great example of a product of this meeting.

MS. HELMICK: One of the limits that I remember was from the MHSRS [Military Health System Research Symposium] in St. Pete’s [St. Petersburg, Florida], with a lot of world experts in TBI. Dr. Marion was leading a workshop on objective markers to capture mild TBI in the patient population. Patient 1 comes in with a bump on his head, some kind of alteration of consciousness and a headache, but no memory or vestibular complaints, just a headache and that’s it. Patient 2 comes in with the same scenario – vestibular [issues], fatigue, and a little nauseous, but no headache, no cognitive or behavioral issues. Patient 3 has the same thing – bump on the head and complains of being highly irritable, headache, no, dizzy, no, cognitive issues, no. So, [there are] three different patients and three buckets of symptoms, if you will.

How do you get a tool that will capture whatever physiological events are going on? If you do a vestibular plate and the person doesn’t have vestibular issues, then would you rule them out for a TBI? I remember that being one of the dilemmas and really going toward that multiple arsenal and no silver bullet philosophy. It is an interesting thing to think about, how to characterize these folks when the symptom array, temporally speaking, attached to the injury event, can be so different. If you miss something, if they don’t have vestibular plates and they have no sway or normal sway, whatever’s supposed to happen – does that mean
they don’t have a concussion? If you look at a pupillometer and they don’t have latency, does that mean they didn’t have a concussion? And the way that it manifests itself so differently that it makes it difficult to make sure that you have a good screening – you have a low false-positive rate.

DR. MARION: The conclusion that is true today, what we have learned back then doesn’t jive with what we know about the physiology of what’s happening after a brain injury. We could say a lot more today than we could five years ago because of the microimaging data.

DR. WEIGHTMAN: One of our problems for the therapist is none of the clinical metrics we use has a huge ceiling effect.

DR. MARION: I said specific biomarkers.

DR. WEIGHTMAN: No, your comment before was, “Let’s focus on the first few weeks.”

MAJ DRETSCH: There are specific biomarkers but often they are transient and lack specificity. Are we assessing their ability to perform their job or do they need to sit out? Is it going to be a measure of cognitive processing or balance?

DR. WEIGHTMAN: Closest to the time of injury you mean?

MAJ DRETSCH: Yes, and then because we know that most people recover. We are not going into who has long-term problems more than the next person because there are a lot of other factors, such as genetics and we can’t determine those. What we are concerned about is can they fulfill this mission at that time point, deployed? Or if you are in training, should you sit out for a week or get right back in? So we need to use the metrics that are highly prevalent.

DR. RADOMSKI: I recall from this task area in 2009, when we started … my impression, my recollection, is that it is about later on in the continuum and not so much about the time of injury. It was about, “How do we know after they have gone through all of their stuff and rehabilitation and all that – how do we know when they are ready to go back to their job?”

DR. ESTRADA: The way I remember it, when the clinician was done, all the recommendations were done – treatment and rehab.

DR. RADOMSKI: Yes, how do you know they are ready?

DR. ESTRADA: How are you going to make the decision to send them back to their commander – what evidence do you have? It has evolved a little since then.

LTC MYATT: Since 2009, we’ve had DoD publications put out that demonstrate that acute care is critical. So long as we identify a continuum, then we don’t lose that population that was originally intended to be evaluated.

DR. ESTRADA: It’s changing.
Consensus and the Way Forward

Discussion flowed naturally from the previous section into this one. The original stated goal for the Working Group had been the following:

Reach consensus on how best to integrate the different performance domains (e.g., cognitive, vestibular, ocular) and assessment tools to provide a comprehensive RTD Toolkit – one that provides military decision makers with a high degree of confidence in answering the question: Can this Soldier (Airman, Sailor, Marine) perform his/her job effectively despite having experienced a neurosensory injury?

However, given all that was discussed and revealed during the two-day symposium, it seems that this goal was too simplistic. The complexity of what the RTD decision-making process entails, in terms of its antecedents and the amount of weight placed on each of those antecedents (e.g., clinical judgment, validated vs. nonvalidated assessments, research, expert opinion), whether the tools making up the toolkit should be more diagnostic in nature or more operational, and if both, what percentage of each? These were only a few of the questions that remained unanswered. Selected and relevant quotes as the experts struggled to reach consensus on several of these issues, in order to derive specific goals going forward, are presented below:

MAJ SCHERER: Are we diagnosing or are we making a determination to RTD?

DR. WILK: We’re really looking to enhance the decision-making process that’s already; small enhancements. That’s our goal. And maybe that’s learning from people who are further along.

DR. WEIGHTMAN: [In doing our research, we looked at] what did the MEB [Medical Evaluation Board], PEB [Physical Evaluation Board] say they did; what did the Line Commanders say they wanted; what did the high-end people in the Army say – who are making these policy decisions; what did PTs and OTs give to their medical doctors making a decision?

MAJ SCHERER: Also, we conducted a review of the state of the science, or the state of the practice in both the sports communities and military communities on RTD decision making.

MS. HELMICK: PRA [progressive return to activity] is different. Based on practitioners’ experiences in theater from 2003 to 2005, and the trauma-related literature, this culminated in the first 2006 Clinical Management Algorithm.

More work needs to be done to make sure the PRA is implemented and evaluated [which is] why three of the CRs [clinical recommendations] are looking at develop, disseminate, implement, evaluate. We’ve done 90% of the development work.

DR. PANKER: Education is important because I have heard the naysayers claim there isn’t enough evidence or that clinical recommendations are not evidence-based. There is something to be said for “experts coming around the table,” although it is not the highest
level of validity. [There was also an urgent need] to put tools into the hands of the providers who are just overwhelmed.

We know more research [is needed, and we also need] greater collaboration from the researchers in this room to combine forces. Maybe our next step is to get an August group like this around the table again to come together?

DR. ESTRADA: Step one is that I propose we meet next September [2016]. I will work over the next few months to coordinate that so that everyone is satisfied with that.

DR. WEIGHTMAN: The other “in the trenches” comment is to Red Team to gain access to subjects – to move from September 2015 to September 2016 – to facilitate our [studies]. And the MFAP needs to be further tested and gain access to subjects [more] quickly. It is the appropriate testing in a rehabilitation [setting].

DR. RADOMSKI: Instead of having six different projects, we need to [consolidate] them so it’s one [project, and] ask to get data on a category of things, for efficiency.

SGT McCULLEY: You identified that the MFAP and AMMP were pretty, I guess, promising, so I was thinking to take your comment earlier and take everyone’s “sacred cows,” instead of having them up here, you incorporate them into the more promising ones?

DR. WEIGHTMAN: We think the population would fit. That’s the question I have for the group. We know more research needs to be done. We have greater collaborations from the researchers in this room to combine forces. Maybe we should do some statistical clustering to see if there are five tests from all.

The goals and recommendations suggested by the foregoing discussion and others will be further elucidated in the Discussion section at the end of this report.
Closing Remarks – Dr. Crowley & Dr. Shoge

Prior to the closing remarks, a brief ceremony was held during which LTC Myatt and Dr. Thornson, on behalf of USAARL, formally acknowledged several attendees with a Certificate of Appreciation (COA) signed by the Commander of USAARL, COL Richard Malish. LTC Myatt read the verbiage of the COA aloud to the assembled group:

For your individual presentation and participation in the Return-to-Duty (RTD) Toolkit Working Group Symposium held September 1-2, 2015 at Fort Detrick, Maryland. Your efforts contributed to the overall success of the symposium and provided a clear way forward in the Military Operational Medicine Research Program mission to deliver cutting edge solutions in RTD applied medical research.

Each recipient named below (with the exceptions of Drs. Brungart and Lawson who were unable to attend Day 2) was presented with the COA, publically and personally recognized and thanked for their contributions:

- Ms. Katherine Helmick
- Dr. Angus Rupert
- Dr. Richard Shoge
- LTC Kristen Casto
- Dr. Douglas Brungart
- Dr. Maggie Weightman
- Dr. Mary Radomski
- Mr. Mark E. Showers
- Dr. Ben Lawson
- MAJ Dave Walsh
- SGT Nicholas L. McCulley

Consensus had been reached by all attendees over the course of the symposium and culminated at the closing, namely, that a useful and validated RTD Toolkit would be ready in FY16. It was agreed by all, and confirmed by Dr. Shoge, that the 2nd RTD Working Group Symposium would take place in FY16, once again to be held at Fort Detrick. The specific action items are to be completed by USAARL during FY16, listed in chronological order:

**Action Items**


2. Send invitations/save-the-dates to 30+ TBI experts in military performance standards, operational RTD decision-making, neurosensory trauma and military medicine for the 2nd Annual RTD Toolkit Working Group Symposium to take place at Fort Detrick, MD in September of 2016.
3. Assemble all task area research reports detailing the evaluation and initial validation of selected, established, and Task Area-developed Warfighter neurosensory performance assessment batteries for inclusion in the RTD Assessment Toolkit.

4. Conduct the 2nd Annual RTD Working Group Symposium at Fort Detrick and present updated Phase 1 validation results (along with other RTD toolkit assessments being considered).

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Analyses & Results

The working group attendees provided both quantitative data, in the form of Likert-scale ratings, and qualitative data, in the form of open-ended comments, on the Grading Sheets. These were filled out — and thus also displayed in this report — following each of the assessment tool presentations, in Tables 2 through 8. The Grading Sheet items base the ratings eight different criteria for Items 1 through 5, as Item 4 has parts (a) through (d). It is important to note that each of the item’s criteria upon which the raters based their judgments regarding inclusion into the RTD Toolkit is qualitatively different from the other items, to varying degrees. However, ease of comparability and categorization purposes, Table 9 displays the assessment tools in order, from left to right, with the highest to lowest overall means across the eight items (displayed in the bottom row).

For each of the eight items, the top three highest means are underlined. It is interesting to note, for example, that for Items 1 and 2, which inquire as to “the usefulness of the assessment tool for assessing RTD by medical vs. non-medical operational/unit personnel,” respectively, the AFDS, AMMP, and MFAP were rated highest in usefulness by medical personnel. One might speculate that this may be partly due to their heavy reliance on clinical staff. The PLR, SFT, and DSST were rated more highly useful by nonmedical personnel, which may be due to their greater portability and ease of use. The qualitative comments for each of the tools corroborate the overall ratings.

Item 5, although not more heavily weighted statistically here for the purposes of this analysis, embodies the original intent and purpose of the RTD Toolkit, that of “operational decision-making,” and not diagnosis. Item 5 asks: “How well does this tool appear to address concerns about Soldier readiness?” On this item, the AFDS, AMMP, and MFAP received the highest mean scores.

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### Table 9. Item Mean Scores of RTD Assessment Tools

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<th>Likert-Scale Items (rated 1-7)</th>
<th>AFDS Item Means</th>
<th>PLR Item Means</th>
<th>SFT Item Means</th>
<th>AMMP Item Means</th>
<th>AVO Item Means</th>
<th>DSST Item Means</th>
<th>MFAP Item Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How <strong>useful</strong> is this tool for assessing RTD by <strong>medical personnel</strong>?</td>
<td>5.14</td>
<td>4.44</td>
<td>4.38</td>
<td>5.10</td>
<td>4.18</td>
<td>3.47</td>
<td>4.67</td>
</tr>
<tr>
<td>2. How <strong>useful</strong> is this tool for assessing RTD by <strong>non-medical</strong> (operational/unit) personnel?</td>
<td>3.64</td>
<td>3.81</td>
<td>4.00</td>
<td>3.40</td>
<td>2.53</td>
<td>3.93</td>
<td>3.08</td>
</tr>
<tr>
<td>3. How do you rate the <strong>scientific value</strong> of this tool?</td>
<td>5.82</td>
<td>5.25</td>
<td>5.00</td>
<td>4.40</td>
<td>4.47</td>
<td>3.87</td>
<td>3.33</td>
</tr>
<tr>
<td>4a) How <strong>applicable</strong> would this tool be in a <strong>Combat Support Hospital</strong>?</td>
<td>3.93</td>
<td>4.88</td>
<td>4.81</td>
<td>2.90</td>
<td>3.13</td>
<td>2.87</td>
<td>2.00</td>
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<tr>
<td>4b) How <strong>applicable</strong> would this tool be in a <strong>Medical Treatment Facility</strong>?</td>
<td>5.25</td>
<td>5.50</td>
<td>5.31</td>
<td>4.60</td>
<td>4.35</td>
<td>3.33</td>
<td>3.09</td>
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<tr>
<td>4c) How <strong>applicable</strong> would this tool be in a <strong>Warrior Transition Unit</strong>?</td>
<td>3.93</td>
<td>4.19</td>
<td>4.25</td>
<td>3.90</td>
<td>2.80</td>
<td>3.53</td>
<td>3.92</td>
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<tr>
<td>4d) How <strong>applicable</strong> would this tool be in a <strong>Veterans Affairs Hospital</strong>?</td>
<td>4.77</td>
<td>4.73</td>
<td>4.93</td>
<td>4.00</td>
<td>4.00</td>
<td>2.71</td>
<td>2.70</td>
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<tr>
<td><strong>OPERATIONAL RTD</strong></td>
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<tr>
<td>5. How well does this tool appear to address concerns about <strong>Soldier readiness</strong>?</td>
<td>5.21</td>
<td>4.37</td>
<td>4.44</td>
<td><strong>4.80</strong></td>
<td>4.19</td>
<td>3.79</td>
<td><strong>4.67</strong></td>
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<tr>
<td><strong>Overall mean (across 8 items)</strong></td>
<td>4.71</td>
<td>4.65</td>
<td>4.64</td>
<td>4.14</td>
<td>3.71</td>
<td>3.44</td>
<td>3.43</td>
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</table>

*Underlined*= Top 3 highest means for that item

This space is intentionally blank.
Because Soldier readiness, as addressed in Item 5, is so important to RTD, further insights may be gained by examining the scores assigned by each rater, taking into account his or her background. Having the right blend of backgrounds for the group of experts, in addition to the group dynamics, were important consideration during the planning of this symposium. This information may be valuable to others who are planning similar workshops or symposia in the future. Below are the Soldier Readiness Scores by Rater/Specialty. The first column lists the raters and affiliations/specialties and the second lists the rating (1 to 7), arranged from highest to lowest.

Soldier Readiness Score by Rater/Specialty

1. Assessments of the Pupillary Light Reflex (PLR): How well does this tool appear to address concerns about Soldier readiness?

<table>
<thead>
<tr>
<th>RATER</th>
<th>Readiness Score</th>
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<tbody>
<tr>
<td>MAJ Michael Dretsch (Ph.D.), Chief, Cognitive Dominance Team at TRADOC</td>
<td>7</td>
</tr>
<tr>
<td>Mark Showers, M.S., OTR/L, Blanchfield Army Community Hospital, NICoE</td>
<td>7</td>
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<tr>
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</table>
2. *A Simple Field Test for Balance Impairment (SFT): How well does this tool appear to address concerns about Soldier readiness?*

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3. **Performance of Dynamic Simulated Shooting Tasks (DSST): How well does this tool appear to address concerns about Soldier readiness?**

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</table>
4. **Auditory Fitness for Duty Standards (AFDS): How well does this tool appear to address concerns about Soldier readiness?**

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</table>
5. **Auditory, Vestibular, and Oculomotor (AVO) Sequelae: How well does this tool appear to address concerns about Soldier readiness?**

<table>
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</table>
6. *Assessment of Military Multitasking Performance (AMMP): How well does this tool appear to address concerns about Soldier readiness?*

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<td>Donald Marion, M.D., Sr. Clinical Consultant, USAMRMC DCOE</td>
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</table>
7. **Evaluation of the Military Functional Assessment Program (MFAP): How well does this tool appear to address concerns about Soldier readiness?**

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Discussion

Throughout the symposium, there was a great deal of intelligent and thoughtful debate amongst neurosensory researchers, clinicians, and stakeholders regarding the objectives and overall purpose of the toolkit. There was considerable debate and various opinions expressed with respect to further clarifying these key elements. To move the program forward, our next steps include clarifying the toolkit’s purpose as well as the specific constructs to be measured, and to encourage collaboration amongst researchers.

Issue 1: Clarify Purpose of RTD Toolkit

*Diagnosing mTBI is qualitatively distinct from determining readiness to RTD*

Of all the issues discussed, the purpose of the toolkit (and of the tools comprising the toolkit) was the topic most frequently raised and most fervently debated. The assessment tools offered for consideration by the experts ranged from those favoring the more clinical/diagnostic side of the spectrum to those seeking to address the RTD issue itself. Kathy Helmick of DVBIC noted this discrepancy early on:

> Our priority is to focus our efforts on validating tools and information that will lead to the best decision making, to safely put that Soldier, Sailor, Airman, or Marine back out into the fight in a safe manner that will allow them to accomplish their duty and not get themselves hurt – or anyone else in their unit. So, with that being said, the two assessment tools presented this morning should be framed as more diagnostic in nature when looking at the continuum of care. They are not so much about RTD.

Compromises were attempted with some inquiring whether or not we might use diagnostic tools to make RTD decisions; that is, a negative diagnosis of mTBI would indicate the Soldier was ready to RTD? Or, perhaps these more diagnostic tools could be used as part of a comprehensive battery of tools in an RTD Toolkit?

Dr. Estrada and others raised the point that the RTD Toolkit might be assembled along the lines of the NIH Toolbox, with a tool to assess vestibular decrements in performance, neurological decrements, and so on. It is precisely because of debates such as these that test designers advocate the first step in assessment development must be to choose the purpose of the measurement tool (Cronbach & Meehl, 1955), and that the purpose must be based upon the types of decisions to be made and how the test will be used.

As one of the attendees phrased it, the essence of RTD decisions boils down to this: “How do we know after they have gone through rehabilitation and all that – how do we know when they are ready to go back to their job?”
Issue 2: Clarify Construct Confusion

*Identify constructs of interest, leading toward theory-driven programmatic research*

Constructs refer to theoretical, unobservable attributes that carry with them certain expectations, i.e., “persons who possess this attribute will, in situation X, act in manner Y” (with a stated probability). From these, we can derive (statistically) testable hypotheses. Such theory-driven approaches are unnecessary for simple diagnostic tests (i.e., a throat culture to assess growth of streptococcal bacteria), because bacterial growth can be observed.

Because constructs are unobservable (e.g., intelligence), they must be operationalized into measurement tools (e.g., tests, assessments) in order to be scored, analyzed, and interpreted (i.e., an intelligence test). Construct validity simply indicates how well our concrete operationalization matches our theoretical construct – are we measuring what we purport to be measuring? No measurement tool is perfect; some variability in what we observe is also attributable to aspects of the measurement process itself (i.e., unexplained or “error” variance) instead of to the construct we are attempting to assess (e.g., construct validity). To reduce the amount of error (increase reliability/validity), we must begin with a clear understanding of the construct to be measured and where it fits among other constructs (i.e., theory). This is what is described by Cronbach and Meehl (1955) in their paper on the nomological net, which represents the most well accepted view of construct validity. A few of the many comments made during the symposium highlight the need for theory-driven construct validation:

“We need to validate new tools against existing clinical tools.”

“I think the importance then is to cross-validate.”

“If you want to hang your hat on a clinical impairment-level metric as an RTD decision-making tool, let’s validate it with something that has face validity from the warfighter standpoint that is functional.”

“The MFAP scores correlate with the clinical assessment tools which are already validated.”

“If they do well on the clinical assessments, they predictably did well on the MFAP.”

In any programmatic research endeavor, especially one so large as TBI/RTD, once researchers begin to define their constructs carefully and constitutively, specifying the nature of the constructs through references to other constructs, this can quickly facilitate theory testing in such a way as to address these goals:

“We have to be able to predict how these people are going to do when they are in that situation and whether they are more likely to catastrophically fail.”

“The gold standard, as Dr. Crowley put it, is to actually execute some of these studies in the deployed setting.”
“What’s the level of operational readiness and individual readiness in units on the front line? (We don’t really truly know if the team is being brought down.)”

A final word of caution regarding the issue of construction validation has to do with confusing the effects of two different constructs. Despite following all the steps outlined in the preceding paragraphs, in order to find meaningful relationships among the variables, they must not be confounded. *Construct confounding* occurs when the effects of two different constructs cannot be distinguished (Shadish, Cook, & Campbell, 2002). Thus, we would be unable to answer the important research questions posed by the attendees.

During the early days of drug trials, researchers first learned to deal with construct confounding by employing the well-known gold standard of experimental design. In all experimental research, investigators strive to create manipulations that reflect only the independent variable of interest and nothing else (i.e., internal validity). Before fully understanding the implications of construct confounding, early drug trial researchers simply gave the experimental drug to one group of patients and nothing to the other group. When comparing the outcomes of both groups, although there were significant differences found between the two groups, especially if a drug was particularly efficacious, researchers soon realized that the comparison of the drug to the no-drug conditions involved two distinct, confounded, conceptual dimensions. That is, the therapeutic effects of the drug and the patient’s expectations that the drug would or would not be effective were confounded. As a result, researchers came up with new designs in which the patients receiving the drug were compared with patients receiving a similar appearing, but pharmaceutically inactive, substance (i.e., a placebo). Because patients were not informed whether they had received the drug or the placebo, the expectations of the drug’s effectiveness would not differ; therefore, researchers had more confidence in the outcomes to the unique pharmaceutical effects of the drug. This meant that truly ineffective drugs were less likely to be wrongly identified as effective because of positive expectation effects, and truly effective drugs were less likely to be wrongly identified as ineffective (or harmful) because of negative expectation effects.

Is not enough merely for patients to be blind to conditions (drug vs. no-drug), but expectations regarding the drug’s effectiveness by medical personnel can influence the outcome of the experiments. By knowing to which group the patients were assigned, the experimenter’s expectations were inadvertently influencing the outcome of the experiment. Whenever possible when conducting any research study, study personnel should be left uninformed of each participant’s treatment condition during random assignment, providing even more certainty that the study outcomes can be attributed to the active pharmaceutical agent of the drug (or experimental manipulation in non-drug trials). This is the well-known gold standard in experimental design – the “double-blind placebo-controlled experiment” – both the participants and researchers are blind to conditions, lessening the likelihood of confounding constructs (i.e., treatment and expectations).

Several discussions during the symposium revealed the potential for construct confounding, beginning with clear operational definitions of the key constructs of interest. This
is in no way due to a dearth of quality research. On the contrary, there is an abundance of research available (e.g., research studies, guidelines, policy and clinical recommendations). However, there seems to be a lack, at this point, of one overarching theory connecting the disparate avenues of research study. Collaboration is one important remedy; quantitative meta-analytic review across all relevant literature is another. The below excerpts highlight this issue:

“Maybe it isn’t a black/white, yes/no, go/no-go solution that we can provide, because at the end of the day, it still will come down to a judgment call by the provider.”

“Because it could be both a cognitive impairment and an intentional decrement, or it could be that my attention isn’t focused because of my vestibular, balance issue. It doesn’t matter – my performance is degraded.”

“Specificity doesn’t matter as much when it comes to RTD – maybe in certain areas, potentially, when you really identify there’s a specific deficit.”

“So, developing RTD metrics, like if I have the indoor firing range, it doesn’t matter if I have a cognitive impairment or it’s a vestibular issue that’s causing my performance decrement.”

“These assessments need to say there’s a correlation, but they could be impaired for many different reasons.”

“We’re not talking about specificity; we’re talking about sensitivity and functionality.”

“Because, again, we keep throwing out that no two single TBIs are the same; whether it’s blast, blunt, genetic factors, medication, PTSD, polytrauma, sleep deprivation, skull thickness – how do we narrow it down?”

“We’re going to spend our whole life chasing that rabbit vs. saying, ‘This is a functional task that is correlated with some functional ability to do your job.’”

**Issue 3: Greater Collaboration**

*How can we increase collaboration among researchers across organizations?*

The issue of collaboration became more salient on the second day of the symposium, subsequent to the presentations of the operational/functional assessment tools, the AMMP, followed by the MFAP. The two studies drew from very different populations; the former used a more experimental design, whereas the latter was a field study with greater access to active-duty military personnel at Fort Campbell.

The feedback following the MFAP presentation (transcribed in its entirety in that section) contains several references to collaboration. Some of the more relevant comments are presented below.
“There are ways to link those kinds of clinic-based assessments that predict that real world outcomes with all of these focused impairment-based measures.”

“Think about what percentage of self-reported function should go into the RTD Toolkit and the gradual return to activity model. Maybe there is more of a functional slice. We need to synthesize these studies.”

“Longitudinal studies [like the MFAP] are the holy grail in terms of what matters. We need to find a way to do predictive studies or find the right subjects so that we can get the follow-up results we need.”

“The MFAP and AMMP were pretty promising … [why not] incorporate [the others] into the more promising ones?”

“We have greater collaborations from the researchers in this room to combine forces.”

“Maybe we should do some statistical clustering to see if there are five tests from all.”

“Obviously, it’s a holy grail to say that we have this small confined battery of tests that will reliably, validly, predict readiness for RTD.”

“By collaborating across studies [we will have] better access to study participants.”

“The MFAP needs to be further tested and gain access to subjects [more] quickly.”

“Instead of having six different projects, we need to [consolidate] them so it’s one [project, and] ask to get data on a category of things, for efficiency.”

Dr. Rupert advocated strongly for collaborating with the return-to-play community. Possibly partnering with companies involved with professional sports teams who are funding a return-to-play device, or series of tools that would make that determination whether to return someone to play, would be wise to consider in terms of future funding opportunities.

**Conclusions**

The two-day symposium brought together professionals with various specialties and expertise. The presentations of assessment tools for possible inclusion in the RTD toolkit end-product were rated and reviewed by the attendees. This feedback will help guide future research efforts as well as assist in preparing a product that will be considered beneficial by the end-user community.
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