Case Review

Case Report: Use of the Immediate Post Concussion Assessment and Cognitive Testing (ImPACT) to Assist with Return to Duty Determination of Special Operations Soldiers who Sustained Mild Traumatic Brain Injury

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Case Report

A team of Special Operations Soldiers in Iraq and their Host Nation (HN) counterparts were enroute to a target in a convoy of High Mobility Multi-Wheeled Vehicles (HMMWVs) when one of their vehicles swerved and violently flipped. The result was the death of one host nation occupant, and the ejection of two U.S. Soldiers. Both U.S. casualties were confused but responded appropriately to questions, with only minor complaints, and no life-threatening injuries. Due to the mechanism of injury, they were immediately evacuated to a Role 3 facility for further evaluation.

After arrival at the Role 3, both casualties were evaluated with a detailed neurological exam, a trauma panel of labs, x-rays, and a head CT. All exams and tests were unremarkable. Both casualties were discharged later that day back to their unit.

Within hours of returning to their unit, both Soldiers began experiencing symptoms of headache, fatigue, "feeling foggy", and balance problems. Both attempted to minimize their symptoms in order to continue with missions. The medic recognized the signs of mild traumatic brain injury (mTBI) which prompted him to conduct further evaluation in order to elicit the true severity of their condition.

The medic had access to a computer-based neuropsychological test called the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) exam which he administered to both Soldiers. Because their unit had the ImPACT program as a tool for this type of situation, both Soldiers already had pre-injury, or "baseline", exams available for comparison. Initial results highlighted a significant difference between the baseline and post-injury tests, which suggested ongoing cognitive sequelae that may have been underappreciated by both the medical providers who had initially cleared them, as well as the patients themselves. As a result, the medic recommended that both Soldiers be restricted from missions and strenuous activity in order to manage their injury properly.

The medic then emailed the results to and consulted with his medical officer and a task force psychologist by phone for further interpretation of the test results. Both agreed that the test revealed deficits in several areas, and agreed the medic's management plan was clinically appropriate. Over the next week, the Soldiers' conditions improved and their symptoms subsided. A subsequent ImPACT exam given 48 hours after the initial post-injury test confirmed their improvement. One Soldier had a complete resolution of symptoms and his ImPACT results returned to baseline within a couple of days, while the other took almost a week to see a return to baseline across all cognitive domains.

In both cases, if the ImPACT program and its objective data were not available to demonstrate the extent of their injuries, it is most likely that these Special Operations Soldiers would have immediately returned to duty. Their impaired mental status ("fogginess" or decreased executive functioning, fatigue, and difficulty concentrating on tasks) during subsequent combat missions could have caused unnecessary injury to themselves or other team members. In addition, by recognizing their condition early and initiating proper management, these Soldiers were returned to duty when it was appropriate and minimized their risk for potentially chronic symptoms of Post Concussive Syndrome and Post Traumatic Stress Disorder (PTSD), which could have not only interfered with the remainder of their deployment, but could have affected them and their families for the rest of their lives.

Introduction

Traumatic Brain Injury (TBI) has had an unprecedented impact on Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) veterans, and has become one of the "signature" injuries of the current conflicts. According to the Joint Trauma Theater Registry (JTTR), mTBI cases have substantially risen since 2002. This may be somewhat attributable to increased awareness and detection of these cases. In particular, the initiation of the DOD Policy on Theater Screening and Management of Mild Traumatic Brain Injury (Concussion) Clinical Practice Guideline (CPG), distributed in 2007, may have caused a spike in the numbers.[1] For example, less than 10% of the total number of casualties admitted to Role 3 medical facilities in OEF in 2002 were diagnosed with mTBI. For both OEF and OIF, the average went above 10% in 2005, climbed above 30% in 2007, and above 50% in 2009.[2] (Figure 1) Despite the improvement of systems to protect the Soldier, it is almost impossible to shield Soldiers from blast overpressure and other mechanisms that cause mTBI.

As this is likely to remain a significant battlefield management issue, awareness, early recognition, and proper management are vital.

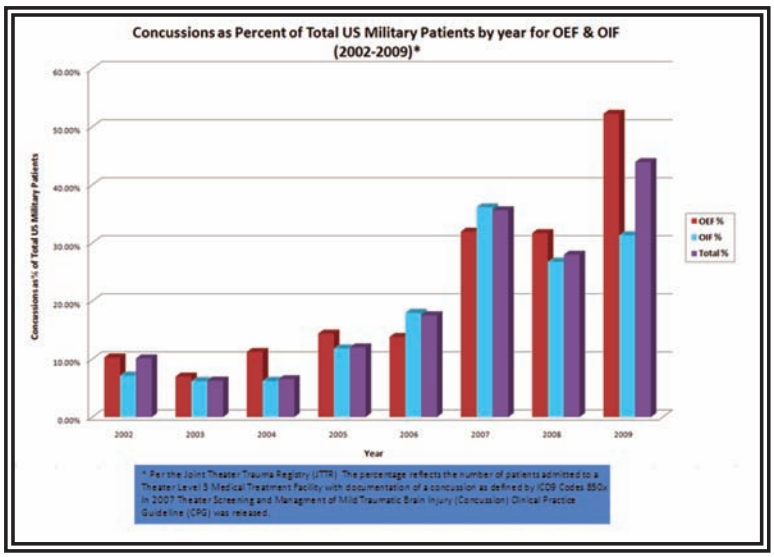

Figure 1: ***Joint Theater Trauma Registry (JTTR) Concussion Statistics from 2002 to 2009.*** *Mild Traumatic Brain Injury results in a variety of subtle signs and symptoms that can be difficult to identify. This condition often occurs with no detectable pathologic change; traditional neurodiagnostic tests such as CT, MRI, and EEG are usually unable to identify the subtle neurologic changes after injury.[3] Although management of mTBI is relatively basic, focusing on physical and cognitive rest plus protection from subsequent injury, the detection of mTBI can be complicated.*

The medical provider is often consulted to make return to duty decisions based on a Soldier's self report of symptoms, limited observation, and often with only a basic neurocognitive screening evaluation, such as the Military Acute Concussion Evaluation (MACE), as the sole objective data point. In contrast, the sports medicine community has included the use of more robust neuropsychological screening measures as an essential element in return-to-play decisions at the high school, collegiate, and professional roles. As the cognitive effects of concussion are often the last to resolve and in many cases be recognized), this added information helps to ensure the risk of persistent post concussion syndrome and/or PTSD is minimized. Detailed neuropsychological evaluation can be time consuming and costly. In addition, there are a limited number of trained neuropsychologists in the Army. Computer-based neuropsychological screening tests, such as the ImPACT, can serve as a way to identify more subtle cognitive deficits without initially requiring a neuropsychologist. A second benefit is that the ImPACT allows for the evaluation of large numbers of individuals with minimal manpower, which translates well to the military. In addition, tests can be easily disseminated to other medical specialists, often in other geographic locations, for their review and consultation. In this case, the authors asked Dr. Kratz, a clinical neuropsychologist and former Army psychologist, to review the ImPACT results for this case review.

As outlined in the Winter 2010 *Journal of Special Operations Medicine*, the United States Army Special Operations Command (USASOC) has provided specific guidelines for the diagnosis and management of mTBI, to include the use of the ImPACT program, as part of their new CPG. The purpose of this article is to use a case review as the background for how the ImPACT may be used in the field for early detection of mTBI in Special Operations Soldiers.

Mild Traumatic Brain Injury Overview

The terms Mild Traumatic Brain Injury (mTBI) and "concussion" are interchangeable terms with many definitions. Currently there are no universal standard criteria for those definitions and the diagnosis is primarily based on the characteristics of the immediate sequelae following the event. The Defense and Veterans Brain Injury Center (DVBIC) convened an expert panel regarding the management of mTBI in 2006. The result of deliberation included this operational definition of mTBI:

"Mild TBI in military operational settings is defined as an injury to the brain resulting from an external force and/or acceleration/deceleration mechanism from an event such as a blast, fall, direct impact, or motor vehicle accident which causes an alteration in mental status typically resulting in the temporally related onset of symptoms such as: headache, nausea, vomiting, dizziness/balance problems, fatigue, insomnia/sleep disturbances, drowsiness, sensitivity to light/noise, blurred vision, difficulty remembering, and/or difficulty concentrating."[4]

The diagnosis of mTBI is challenging and the use of all available tools for detection is necessary, to include a thor-

ough history, a focused physical exam, and a neurocognitive assessment.

An extensive history, to include a detailed mechanism of injury, is an important part of the evaluation of a patient with mTBI. Providers should maintain a high index of suspicion regardless of how minimal the insult seems, or the lack of subjective symptoms. The diagnosis of mTBI in the military has traditionally relied on a Soldier's self report. However, research has suggested that exclusive reliance on individual report of symptoms can result in an overlooked diagnosis and further injury.[5] Many times Soldiers minimize symptoms in order to stay with their team and continue with the mission. Symptoms of mTBI, in addition to those listed in the definition above, can include are feeling sluggish or slowed down, feeling "foggy", memory problems, and change in sleep patterns. Headache is the most commonly reported symptom, and may be observed in as many as 70% of individuals, but mTBI may occur without headache.[6]

The physical exam is also an important part of mTBI evaluation. Signs and symptoms that may be observed by medical providers include being dazed or stunned, confused, or disoriented to time and place, clumsy movement, cognitive slowing, loss of consciousness, personality change, memory loss of events prior to incident (retrograde amnesia), and memory loss of events after incident (anterograde amnesia).[7] Inclusive to the exam should be an assessment of postural stability and the vestibular system, which is often affected soon after sustaining an mTBI.[8] Fellow teammates may be the first to recognize these signs, which underscores the need for basic education and general awareness of this subtle injury at the lowest Role.

Although neuroimaging studies are often used to rule out severe injury, such as epidural hematoma, it is rarely useful in detecting mTBI, which is a metabolic rather than structural brain injury.[9] Functional MRI (fMRI) has been shown to be a viable tool for the assessment of neural processes after mTBI, but they are not readily portable or cost effective to use in the field. On the other hand, fMRI has correlational data that confirms that the uses of neuropsychological tests provide objective and accurate assessment regarding deficits in memory, reaction time, and processing speed.[7,10]

Although the discussion regarding the management of mTBI is beyond the scope of this article, the fact that there are no curative medical treatments for mTBI emphasizes the importance of early and proper identification of mTBI. In addition to a comprehensive history and detailed physical exam, neurocognitive testing is the third leg in the proper evaluation of mTBI.

Neurocognitive Testing

The use of neuropsychological testing as a diagnostic tool for mTBI began in the mid 1980s and became more popular in the 1990s after a number of high-profile athletes prompted their employment.[11] Now, neuropsychological testing is the "cornerstone" of mTBI evaluation endorsed by most major athletic associations.[12,13] Neuropsychological testing allows a baseline versus post-injury analysis of the subtle aspects of cognitive function likely affected by mTBI, thus providing objective data to make a more informed return to duty decision. Traditional neuropsychological testing is time consuming, costly, and complicated by the limited number of neuropsychologists available to oversee and interpret the process. Thus, computer-based neuropsychological programs developed over the past 20 years help alleviate some of those issues.[7]

The computer-based programs allow for the evaluation of large numbers of individuals with minimal manpower. The data can be easily stored in a specific computer or network and easily accessed later. The computer promotes a more accurate measurement of the cognitive process to within 1/100th of a second. This accuracy increases the validity of the test by detecting subtle changes. The computer also allows for randomization of test stimuli to improve reliability and minimize "practice effects". Finally, computer-based programs allow for rapid dissemination of clinical information into a coherent clinical report that can be interpreted by trained medical personnel.[7]

Due to the significant number of mTBI cases in OIF and OEF, the Defense and Veterans Brain Injury Center (DVBIC) assembled 32 key military and civilian experts in November 2006 to gather the best practice evidence regarding the assessment and management of mTBI in the military.[4] One of the areas reviewed was neurocognitive assessment. The group reached broad consensus that baseline testing should be performed on all servicemembers in an effort to enhance the clinical interpretation and overall utility of post-injury neuropsychological testing. Although they did not recommend a specific computer-based test, they did recommend specific criteria that the test should encompass. First, they recommended that the test should take 20 minutes or less to administer. Second, they recommended that five cognitive domains be assessed: Attention/Concentration, Memory, Processing Speed, Reaction Time, and Executive Function. In addition, they recommended several factors related to the applicability, utility, and practicality of the test which include:

- Reliability, Validity, Sensitivity, Specificity, and Clinical Utility
- Availability and applicability of a normative data base and reliable change index
- Internet access and portability
- Time to administer metrics
- Ease of administration and training required
- Ease of speed of interpretation
- Ease of speed of data comparison across test administration
- Alternate forms for multiple administrations
- Flexibility of adding test modules or questions
- Ease of data transfer
- Cost per test and for maintenance and training
- Direct clinical application of results to return to duty recommendations

There are four computer-based models detailed in the scientific literature: ImPACT,[12] CogState,[13] Headminders,[14] and the Automated Neuropsychological Assessment Metrics (ANAM).[15] Of these, only the ANAM and ImPACT have been used in military research. Despite the data collected using the ANAM, no scientific evidence associates poor ANAM performance with a history of mTBI.[16] In addition to this, the psychometric properties of ImPACT appear to be better for clinical samples than the ANAM. Moreover, some of the key components recommended by the DVBIC consortium[4] are not featured in the ANAM. The lack of features is mostly related to availability, applicability, and practicality.

The other computer-based test used in military research is the ImPACT program, which is the most scientifically validated neuropsychological testing program. It was developed by sports concussion researcher Mark Lovell, PhD, who is now the director of the University of Pittsburgh Medical Center (UPMC) Sports Medicine Concussion Program. It is the most widely used computerized evaluation system to objectively assess the severity and effects of concussion and injury recovery progression following mTBI.[17] The ImPACT is comprised of seven test modules that assess eight neurocognitive abilities within 20 minutes. Several modules are designed to simultaneously evaluate multiple cognitive domains. The ImPACT is scientifically proven to be extremely sensitive. The probability that a concussion is present when the test is positive (Positive Predictive Value) is 89.4%. The probability that a concussion is not present when the test is negative (Negative Predictive Value) is 81.9%.[18] The ImPACT meets all of the criteria recommended by the DVBIC expert panel. As a result, USASOC has adopted the ImPACT as the primary neurocognitive test for the evaluation of mTBI in its personnel.

Interpreting the Impact

The ImPACT does not yield one summary score that concludes a "yes" or "no" indication of mTBI, but rather a series of indicators that have been demonstrated to be sensitive to mTBI. The interpretation of the ImPACT should ideally follow a multi-Role path of analysis.[19] Remember that the ImPACT is not a stand-alone tool; it is meant to be used in conjunction with a detailed history and physical exam as outlined in the USASOC CPG.[20] The CPG recommends that the ImPACT be administered 24 hours post-injury, then 72 hours post-injury, and finally when complete symptom resolution occurs (just prior to return to duty), approximately 7-10 days post-injury in most cases of mTBI.

According to the ImPACT Clinical Interpretation Manual,[19] the first step in the clinical interpretation of the ImPACT is an evaluation of the *Composite Score Summary*. A quick glance can reveal subtle deficits in five areas: *Verbal and Visual Memory*, which test attention and memory; *Reaction Time* and *Visual Motor Processing*, which test cognitive speed; and *Impulse Control*. In addition, the program determines whether or not an individual's scores deviate beyond that which is expected given a typical test-retest situation. This is referred to as the Reliable Change Index (RCI) (Figures 2 & 6). This helps ensure that any changes in an individual's scores reflect clinically meaningful change and not just variability in scores due to the reliability of the test. If there is no individual baseline for comparison, normative comparisons are made based on the individual's age and gender, which determines where they would fall in comparison to a matched peer group. These percentile scores are also reported on the report for comparison. The results of the *Composite Score Summary* are also represented by graphs which illustrate the differences in each of the five composite scores using multicolored bars for comparison (Figures 4 & 8).

The *Composite Score Summary* and associated graphs can be quickly analyzed by medics and other providers who have only elementary training on the ImPACT. However, occasionally there is not clear evidence of mTBI from evaluation of those scores alone. Therefore, further test analysis by a neuropsychologist or a medical provider with advanced training and familiarization of the ImPACT is recommended.

The second step of test analysis involves a more specific evaluation of each individual score that comprises the five composite scores (Figures 5 & 9). This requires that each individual module be analyzed in order to identify a "pattern" of strengths and weaknesses in each area of performance. This is important because many of the ImPACT modules are multi-dimensional, measuring both speed and memory. In many cases, the Soldier with mTBI may sacrifice performance in one dimension for added performance in another. These subtleties are recognized by an astute clinician who has advanced training and experience with the ImPACT.[19]

Another feature of the ImPACT is the symptom scale. The *Symptom Score Summary* is viewed in the same section as the *Composite Score Summary*. The scale lists 22 symptoms and allows the injured Soldier to rate each symptom from 0 (none) to 6 (severe), producing a combined score. This procedure promotes the quantification of the severity of symptoms and also allows the injured Soldier, medical provider, and commander to accurately track the recovery process and alert them to any potential post-concussive symptoms. (Figures 3 & 7)

According to the USASOC CPG[20] regarding the diagnosis and management of mTBI, results from the ImPACT stratify the Soldier into one of four categories: 1) **No evidence of mTBI**: No ImPACT subcomponent scores outside of the RCI, minimal symptoms at most. 2) **Simple mTBI**: ImPACT symptom score range below 30 and/or only one ImPACT subcomponent score outside of the RCI or two subcomponent scores below the 25th percentile. 3) **Complex mTBI**: ImPACT symptom score above 30 and two or more ImPACT subcomponent scores outside of the RCI or below the 16th percentile. 4) **Severe or potentially severe head injury**: Evidence of more severe injury requiring imaging, potential need for neurosurgical intervention, or potential for further deterioration and need for supportive care such as airway management.

Along with Soldiers who try to minimize mTBI symptoms in order to be with their team and continue opera-

tions, there is a potential for some Soldiers to "sandbag" or perform poorly on the ImPACT to purposely establish a low baseline, thus making it easier to exceed this Role of performance after sustaining an mTBI. "Sandbagging" during baseline testing is usually evident by an extremely high Impulse Control Composite of greater than 30. In this case the Soldier should be asked to retake the baseline test.[19]

The most common causes of test invalidity during baseline testing are: 1) Failure to properly read directions, 2) Attention deficit hyperactivity disorder (ADHD), 3) Excessive fatigue, 4) Horseplay, 5) Left-right confusion, mostly seen during the X's and O's distracter task, and 6) "Sandbagging" as discussed above.[19] In order to ensure a Soldier performs their best on the ImPACT, it is important that they are tested in a secluded environment that is not distracting. It is essential that they know to read the directions carefully and comprehend them thoroughly before starting each test module; once the module starts there is no stopping, and speed and accuracy are vital in each phase. Finally, it is recommended that the test administrator review all scores in an attempt to identify Soldiers who did not extend good effort or who misunderstood directions. These Soldiers should be asked to complete an additional baseline evaluation.

Case Discussion

Casualty 1

The first factor to consider in reviewing the ImPACT scores following an injury is the validity of the test results. At times, residual confusion or a misunderstanding of test directions may make some scores invalid. In this case, the intra-test indicators demonstrated valid baseline and post-injury ImPACT assessments. Cognitive test results within 24 hours of the concussion suggest a significant decline in visual recognition memory (immediate and delayed), visuomotor speed, and reaction time. Reaction time was the primary deficit, which fell from the very superior range to the severely impaired range. Of note, this is readily identifiable by the highlighted scores on his ImPACT score report. Highlighted scores demonstrate a statistically significant change in performance in that domain, and that this change exceeds the normal variability in scores that take place when you give someone the test a second time; this is referred to as reliable change index (RCI). In addition to the cognitive data, his total Post-Concussion Symptoms (PCS) clearly exceeded that which he had reported at baseline, thereby providing additional support for both physical and cognitive postconcussive symptomatology at that time.

Two days later, Casualty 1's visual memory and visuomotor speed returned to baseline Roles, although his reaction time remained impaired. In comparison to his baseline, reaction time remained about 2.6 standard deviations below his baseline expectation. As his baseline reaction time fell in the very superior range, a full recovery in this cognitive domain would likely have resulted in scores closer to the average to high average range (50th to 75th percentiles). As such, this suggested ongoing cognitive sequelae two days after the injury despite other indicators of a possible return to baseline (i.e., self report).

According to the USASOC CPG, this Soldier was considered a "Complex mTBI". He had a symptom score of 30. Additionally, he had three composite scores outside of the RCI: Visual memory, Visual motor speed, and Reaction time.

Casualty 2

For casualty number 2, intra-test indicators demonstrated valid baseline and post-injury assessments. Cognitive test results on the day of the concussion suggest significant deficits in verbal and visual recognition memory (trended toward greater difficulty with delayed memory versus immediate memory, which was determined by subtest scores). Two

Composite Scores *								
Memory composite (verbal)	93	73%	99	96%	98	95%		
Memory composite (visual)	91	96%	**71**	62%	83	92%		
Visual motor speed composite	44.25	97%	**31.83**	31%	47.63	99%		
Reaction time composite	0.52	98%	**0.86**	<1%	**0.70**	26%		
Impulse control composite	2		1		1			
Total Symptom Score	16		**30**		7			
PTSD Score			0		0			
PITT Score	2							

* Scores in **bold** type indicate scores that exceed the Reliable Change Index score (RCI) when compared to the baseline score. However, scores that do not exceed the RCI index may still be clinically significant. Percentile scores, if available, are listed in small type. Please consult your ImPACT User Manual for more details.

Figure 2: *Casualty 1 Composite Score Summary; Baseline, 24 & 72 hours post-injury.*

Symptom Inventory (at time of exam)			
Headache	1	4	0
Nausea	0	3	0
Vomiting	0	0	0
Balance Problems	0	2	0
Dizziness	0	1	0
Fatigue	2	2	1
Trouble falling asleep	2	3	2
Sleeping more than usual	0	0	0
Sleeping less than usual	2	0	0
Drowsiness	3	3	1
Sensitivity to light	0	0	0
Sensitivity to noise	0	0	0
Irritability	0	0	0
Sadness	0	0	0
Nervousness	0	3	1
Feeling more emotional	0	0	0
Numbness or tingling	0	0	0
Feeling slowed down	3	3	1
Feeling mentally foggy	2	2	1
Difficulty concentrating	0	2	0
Difficulty remembering	1	1	0
Visual problems	0	1	0
Total Symptom Score	**16**	**30**	**7**

Figure 3: *Casualty 1 Symptom Inventory; Baseline, 24 & 72 hours post-injury.*

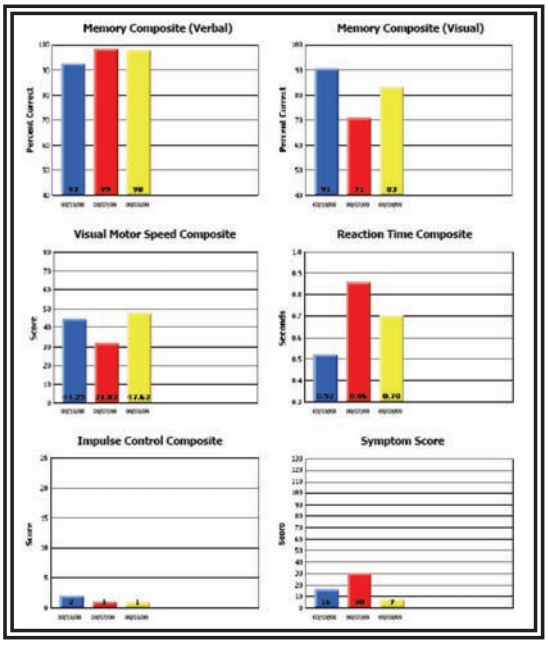

Figure 4: *Casualty 1 Composite Score Graphs*

days later, these abilities had returned to baseline, as did his total symptom scores.

According to the USASOC CPG, this Soldier was considered a "Complex mTBI". He had a symptom score greater than 30 (39). He had two composite scores outside of the RCI: Verbal memory and Visual memory.

Implementation of the ImPACT in USASOC

In November 2009, a representative from the USASOC Surgeon's Office briefed the ImPACT Neurocognitive Testing and Clinical Practical Guidelines to medical personnel from several USASOC units in order to begin its implementation. The goal was to have select United States Army Special Forces Command (USASFC) units begin ImPACT baseline testing by December 2009, prior to their upcoming deployments. The 4th Battalion, 5th Special Forces Group (Airborne) was the first unit to incorporate the ImPACT prior to its deployment to Iraq in early 2010. Initially, accessibility was a concern for such a large community in such a short period of time. In response, the University of Pittsburg developed a USASOC specific online test site.

Exam Type	Baseline	Post-injury	Post-injury
Date Tested	03/19/2008	09/07/2009	09/09/2009
Last Concussion		09/07/2009	09/07/2009
Word Memory	*WG = 1*	*WG = 2*	*WG = 3*
Hits (immediate)	12	12	9
Correct distractors (immed.)	12	12	12
Learning percent correct	100%	100%	88%
Hits (delay)	12	12	12
Correct distractors (delay)	12	10	12
Delayed memory pct. correct	100%	92%	100%
Total percent correct	100%	96%	94%
Design Memory			
Hits (immediate)	11	10	11
Correct distractors (immed.)	11	7	11
Learning percent correct	92%	71%	92%
Hits (delay)	11	9	11
Correct distractors (delay)	10	6	11
Delayed memory pct. correct	88%	63%	92%
Total percent correct	90%	67%	92%
X's and O's			
Total correct (memory)	11	9	9
Total correct (interference)	138	113	129
Avg. correct RT (interference)	0.36	0.55	0.42
Total incorrect (interference)	2	1	1
Avg. incorrect RT (interfer.)	0.23	0.36	0.50
Symbol Match			
Total correct (visible)	27	27	27
Avg. correct RT (visible)	1.40	1.84	2.01
Total correct (hidden)	7	9	9
Avg. correct RT (hidden)	1.97	2.33	2.12
Color Match			
Total correct	9	9	9
Avg. correct RT	0.75	1.41	1.01
Total commissions	0	0	0
Avg. commissions RT	0.00	0.00	0.00
Three Letters			
Total sequence correct	5	5	5
Total letters correct	15	15	15
Pct. of total letters correct	100%	100%	100%
Avg. time to first click	2.34	3.20	1.78
Avg. counted	18.0	14.0	21.6
Avg. counted correctly	18.0	11.8	21.0

Figure 5: *Casualty 1 Individual Module Scores; Baseline, 24 & 72 hours post-injury*

Composite Scores *								
Memory composite (verbal)	88	65%	**73**	16%	82	49%		
Memory composite (visual)	84	86%	**60**	25%	93	99%		
Visual motor speed composite	30.88	29%	33.15	42%	36.68	56%		
Reaction time composite	0.55	88%	0.59	69%	0.55	88%		
Impulse control composite	1		3		3			
Total Symptom Score	4		**39**		0			
PTSD Score			0		0			
PITT Score	12							

Scores in **bold** type indicate scores that exceed the Reliable Change Index score (RCI) when compared to the baseline score. However, scores that do not exceed the RCI index may still be clinically significant. Percentile scores, if available, are listed in small type. Please consult your ImPACT User Manual for more details.

Figure 6: *Casualty 2 Composite Score Summary; Baseline, 24 & 72 hours post-injury*

Symptom Inventory (at time of exam)			
Headache	0	4	0
Nausea	0	3	0
Vomiting	0	0	0
Balance Problems	0	3	0
Dizziness	0	3	0
Fatigue	0	3	0
Trouble falling asleep	0	0	0
Sleeping more than usual	0	0	0
Sleeping less than usual	0	0	0
Drowsiness	2	4	0
Sensitivity to light	0	0	0
Sensitivity to noise	0	0	0
Irritability	2	0	0
Sadness	0	0	0
Nervousness	0	3	0
Feeling more emotional	0	0	0
Numbness or tingling	0	0	0
Feeling slowed down	0	2	0
Feeling mentally foggy	0	4	0
Difficulty concentrating	0	3	0
Difficulty remembering	0	4	0
Visual problems	0	3	0
Total Symptom Score	**4**	**39**	**0**

Figure 7: *Casualty 2 Symptom Inventory; Baseline, 24 & 72 hours post-injury*

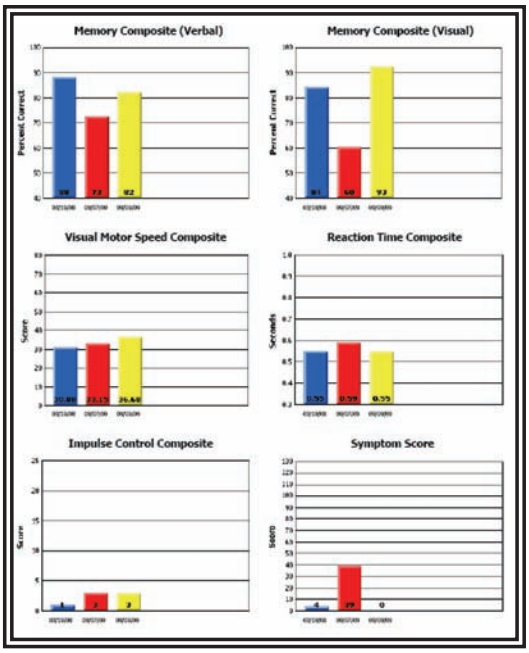

Figure 8: *Casualty 2 Composite Score Graphs*

Word Memory	WG = 1	WG = 2	WG = 3
Hits (immediate)	12	12	12
Correct distractors (immed.)	12	12	11
Learning percent correct	100%	100%	96%
Hits (delay)	12	12	11
Correct distractors (delay)	11	10	10
Delayed memory pct. correct	96%	92%	88%
Total percent correct	98%	96%	92%
Design Memory			
Hits (immediate)	9	9	9
Correct distractors (immed.)	10	8	11
Learning percent correct	79%	71%	83%
Hits (delay)	12	10	10
Correct distractors (delay)	10	7	11
Delayed memory pct. correct	92%	71%	88%
Total percent correct	85%	71%	85%
X's and O's			
Total correct (memory)	10	6	12
Total correct (interference)	127	126	135
Avg. correct RT (interference)	0.43	0.43	0.37
Total incorrect (interference)	1	3	3
Avg. incorrect RT (interfer.)	0.36	0.36	0.29
Symbol Match			
Total correct (visible)	27	27	27
Avg. correct RT (visible)	1.52	1.39	1.38
Total correct (hidden)	6	2	5
Avg. correct RT (hidden)	4.22	1.89	3.98
Color Match			
Total correct	9	9	9
Avg. correct RT	0.70	0.87	0.81
Total commissions	0	0	0
Avg. commissions RT	0.00	0.00	0.00
Three Letters			
Total sequence correct	5	5	5
Total letters correct	15	15	15
Pct. of total letters correct	100%	100%	100%
Avg. time to first click	2.83	3.21	1.99
Avg. counted	10.0	11.8	13.2
Avg. counted correctly	10.0	11.6	13.2

Figure 9: *Casualty 2 Individual Module Scores; Baseline, 24 & 72 hours post-injury*

The USASOC ImPACT site is accessible from any modern, non-secure computer that has a broadband internet connection and uses a mouse. The link allows more flexibility in administrating baseline and post injury screenings without having to rely on a designated computer loaded with ImPACT software. In addition, there are two separate links, one for testing (https://wwwimpacttestpro.org/military/), and the other for credentialed providers to review results (https://www.impacttestpro.org/resultsMilitary/). Ease of accessibility for multiple providers allows for quick review of test results and consultation throughout the echelons of care.

The 4/5th SFG (A) implemented a modified plan to conduct baseline screening for all assigned personnel. USASOC recommended administering baseline screening in a controlled environment, ideally using a computer bank to conduct supervised tests to multiple individuals. The computer facilities at Fort Campbell at that time did not support this requirement, and the unit had less than 30 days to complete the baseline exams. A train the trainer and decentralized testing approach was adopted. Each Special Operations Medical Sergeant (MOS 18D) was briefed on the USASOC testing guidelines and then given a baseline exam themselves. The goal was to emphasize the importance of conducting the screening in a quiet, controlled environment and to avoid some of the more common mistakes that resulted in invalid tests. Each 18D then administered baseline exams to their respective team or section. Headquarters and Support personnel were tested by the Battalion Medical section. The majority of exams were administered either in the team room during periods of limited activity or at home using personal computers that met the minimal support requirements. Despite the operational constraints of limited time and less than ideal testing circumstances, only 2% of the baseline tests were invalid with the first attempt. Invalid results were identified on the ImPACT website with an annotation of (++). These individuals were retested, resulting in valid baseline exams.

Using a decentralized screening method, 4/5th SFG (A) achieved 100% valid baseline screening prior to its OIF deployment within less than 30 days. While deployed, the ImPACT website was accessible through both military and civilian web servers. This type of access proved to be very beneficial to the 4/5th SFG(A) mission, which often required elements to be spread out over a large geographic area with varied base communication support.

During 4/5th SFG (A) deployment, only one hostile incident resulted in the need for post injury ImPACT evaluation. An Operational Detachment was conducting convoy operations when they were struck by an Improvised Explosive Device (IED). The IED struck a Partner Force vehicle resulting in non-life threatening injuries and minimal damage to other vehicles in the convoy. Due to the proximity of the explosion to detachment members, each received immediate MACE exams and then ImPACT screening within 24 hours. Fortunately, no detachment members had evidence of mTBI and returned to duty after a 24 hour United States Forces-Iraq (USF-I) mandatory post explosion exposure stand down. Utilizing the ImPACT website, the Special Operations Task Force (SOTF) Surgeon was able to review baseline and post injury results and make timely recommendations to the commander that resulted in proper patient management as well as minimal interruption to operations.

The approach that 4/5th SFG (A) took to administer the pre-deployment baseline ImPACT was not ideal, but it demonstrated the true reality that most deploying SOF units face. Despite the challenges, they completed their mission by

testing over 450 Soldiers in less than 30 days. In the future, baseline screening for 4/5th SFG (A) will be conducted during initial Battalion in-processing in a controlled environment. Another solution may be to implement baseline testing during the Special Forces Qualification Course.

Conclusion

Mild Traumatic Brain Injury is the "signature" injury of the current wars. The diagnosis of mTBI is challenging and the use of all available tools for detection is necessary, to include a thorough history, a focused physical exam, and a neurocognitive assessment. The ImPACT is the most widely used computerized evaluation system to objectively assess the severity and effects of concussion and injury recovery progression following mTBI. USASOC has implemented the use of the ImPACT in its Clinical Practice Guidelines for the diagnosis and management of mTBI. It is imperative that all USASOC medical personnel are familiar with the ImPACT in order to ensure their personnel have valid baseline tests prior to deployment. The proper implementation of the ImPACT, along with the other USASOC CPG recommendations, allows for early and accurate identification of mTBI and initiation of proper management to reduce morbidity and mortality of Special Operations Soldiers and protect against further insult.

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