

## Telerehabilitation for Veterans with Combat Related TBI/PTSD

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### **ABSTRACT**

Traumatic Brain Injury (TBI) and Post Traumatic Stress Disorders (PTSD) are “signature” wounds related to combat and accidents in combat theatres in Iraq and Afghanistan (OIF/OEF). They can result in life-long impairments in physical, cognitive, behavioural and social function.

**Objectives:** The ongoing telerehabilitation at the James Haley Veterans Administration (VA) Hospital at Tampa, Florida (Tampa VA) continues and expands the existing rehabilitation program in place for veterans discharged from the hospital with combat related trauma. The primary objectives of this 36 month quasi-experimental study is to 1) Provide medical care coordination to meet the needs of OIF/OEF veterans with combat injuries. 2) Determine the immediate and sustained effects of telerehabilitation on patient outcomes including function, cognition and community participation and 3) To examine the perceived benefits and limitations of the intervention from the veteran and caregiver perspectives.

**Study design:** This 36 month study started in June 2008 and evaluates telerehabilitation care provided to a sample of 65 OIF/OEF veterans discharged from the Tampa VA with a diagnosis of mild or moderate TBI and or PTSD incurred in combat zones. Telerehabilitation involves using computers and the internet to provide therapy and monitor health outcomes.

**Methods:** Data is collected in multiple ways including 1) administrative data bases and 2) validated instruments to monitor health outcomes. In addition, patient satisfaction surveys and interviews with patients and caregivers are conducted after a year of enrolment in the study.

**Findings:** Our findings indicate that 1) Functional capabilities measured by locomotion and mobility appear to have stabilized among our cohort of veterans while deficiencies in cognition (memory, problem solving), psychosocial adjustment (anger, emotional status) and problems in integrating into society pose challenges 2) Those with comorbid PTSD appear to exhibit greater variability in rehabilitation and ultimate integration into society as compared to those without the diagnosis 3) Individualized treatment pathways are needed for rehabilitation and ultimate integration into society and 4) Veterans have expressed appreciation for the program.

### **1.0 INTRODUCTION**

As of October 2009 over 5,000 U.S. military personnel have died in Iraq and Afghanistan and more than 30,000 have been wounded in combat in Operations Iraqi Freedom and Enduring Freedom<sup>1</sup>. Traumatic Brain Injury and Post Traumatic Stress Disorders related to combat and accidents in combat theatres can cause life-long impairments in physical, cognitive, behavioural and social function that are usually more disabling concerning activities of daily living than the residual physical and deficits. Injury from explosions (i.e., improvised explosive devices, landmines, rocket-propelled grenades, and other causes of blasts) is the most common cause of evacuation from the combat theater in Operations Iraqi Freedom and Enduring Freedom. TBI related to combat and accidents in combat theatres can cause life-

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14. ABSTRACT

**Traumatic Brain Injury (TBI) and Post Traumatic Stress Disorders (PTSD) are signature wounds related to combat and accidents in combat theatres in Iraq and Afghanistan (OIF/OEF). They can result in life-long impairments in physical, cognitive, behavioural and social function. Objectives: The ongoing telerehabilitation at the James Haley Veterans Administration (VA) Hospital at Tampa, Florida (Tampa VA) continues and expands the existing rehabilitation program in place for veterans discharged from the hospital with combat related trauma. The primary objectives of this 36 month quasi-experimental study is to 1) Provide medical care coordination to meet the needs of OIF/OEF veterans with combat injuries. 2) Determine the immediate and sustained effects of telerehabilitation on patient outcomes including function, cognition and community participation and 3) To examine the perceived benefits and limitations of the intervention from the veteran and caregiver perspectives. Study design: This 36 month study started in June 2008 and evaluates telerehabilitation care provided to a sample of 65 OIF/OEF veterans discharged from the Tampa VA with a diagnosis of mild or moderate TBI and or PTSD incurred in combat zones. Telerehabilitation involves using computers and the internet to provide therapy and monitor health outcomes. Methods: Data is collected in multiple ways including 1) administrative data bases and 2) validated instruments to monitor health outcomes. In addition, patient satisfaction surveys and interviews with patients and caregivers are conducted after a year of enrolment in the study. Findings: Our findings indicate that 1) Functional capabilities measured by locomotion and mobility appear to have stabilized among our cohort of veterans while deficiencies in cognition (memory, problem solving), psychosocial adjustment (anger, emotional status) and problems in integrating into society pose challenges 2) Those with comorbid PTSD appear to exhibit greater variability in rehabilitation and ultimate integration into society as compared to those without the diagnosis 3) Individualized treatment pathways are needed for rehabilitation and ultimate integration into society and 4) Veterans have expressed appreciation for the program.**

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long impairments in physical, cognitive, behavioural and social function that are usually more disabling than the residual physical deficits<sup>ii</sup>. Recovery can continue many years after initial trauma. Little is known about optimal methodologies to treat the vast and complicated secondary manifestations of combat related polytrauma. Wounded warriors who are discharged from the armed forces are eligible to seek medical treatment at Veterans Administration health care facilities in the United States. A shortage of rehabilitation resources to meet the demands of all veterans remains a critical challenge. Telerehabilitation using the internet may represent a viable means for the delivery of care coordination and therapeutic services to combat wounded veterans with TBI who require continued care.

*The Telerehabilitation intervention at the Veterans Hospital in Tampa, Florida:* In June 2008 the US Department of Defense Congressionally Directed Medical Research Program (CDMRP) awarded the James A Haley Veterans Research and Education Foundation in Tampa, Florida funding to provide care coordination and monitor veterans discharged from the Level 1 Polytrauma/Blast Related Center at the Tampa VA with a diagnosis of mild and moderate TBI incurred in combat theatres. Patients who met the inclusionary criterion were identified using the VA Computerized Patient Recording System.

*Inclusionary criterion:* Veterans who meet the inclusionary criterion of a clinical diagnosis of combat incurred mild or moderate TBI in Iraq and Afghanistan with or without comorbid Post Traumatic Stress Disorders and who utilize the James A Haley Veterans Hospital in Tampa, Fl as their primary source of care and who in the opinion of care providers in the Polytrauma Clinic at the Tampa VA will possibly benefit from the program are eligible to be consented for participation.

*Care coordination:* The enrollees are provided laptop computers to communicate at least once weekly on a secured VA server with the care coordinator who also meets them at their scheduled outpatient visits at the hospital. The Advanced Registered Nurse Practitioner (ARNP) helps in a variety of care coordination efforts including scheduling appointments with specialists, medication management and compliance, counseling, education and monitoring outcomes. The ARNP coordinates care for TBI with the Director of Physical Medicine and Rehabilitation at the Tampa VA and PTSD with a clinical psychologist at the hospital.

### **Examples of care coordination**

**Drug therapy:** Drugs are frequently used in the management common of complications of polytrauma such as TBI particularly for mood disorders such as depression and anxiety and pain management. Regaining insight into the changes caused by polytrauma is often accompanied by an increase in depressive symptoms. Increased suicidal ideation has also been reported to occur for many years after initial trauma. The ARNP evaluates, periodically, the adequacy of drug therapy to treat symptoms. In consultation with Dr. Scott the RN may change the dosage and frequency as well as change medications to overcome side effects and provide optimal pharmacological management including drug tapering interventions to prevent addiction.

**Behavior modification:** One of the manifestations of polytrauma is uncontrolled and damaging behavior. The veteran may be asked to start a digital diary to document the frequency and type of temper episodes and what triggers the episodes. Strategies to avoid triggers may be recommended, and complex tasks that act as triggers may be simplified to avoid frustration (e.g., with the use of aids and lists). Such strategies have been successfully tried at the Tampa VA with returning veterans for anger management. A consultation with a psychologist may be initiated.

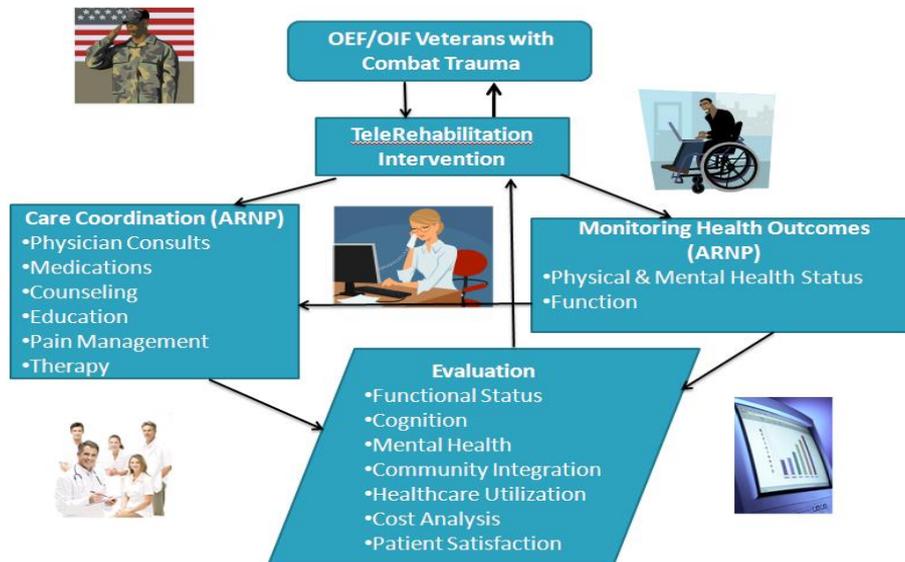
**Wound care management:** Telerehab allows for clinician to observe wound and provide guidance and therapy without requiring the veteran to travel thereby avoiding unnecessary sheering forces and edema. Some patients with TBI also have SCI that may result in pressure ulcers.

## **1.1 Conceptual Model**

The conceptual model used in the telerehabilitation is an adaptation of the analytic framework developed by the US Agency for Health Care Research and Quality (AHRQ)<sup>iii</sup> as shown in Figure 1. The AHRQ

model was originally constructed to evaluate the efficacy of telemedicine services for the elderly Medicare population. The analytic framework begins with the telerehab encounter extends to the monitoring of health outcomes and care coordination, evaluating the intervention on functional status, community integration and health utilization and using information gathered to further refine telerehab to meet the needs of individual veterans.

**Figure 1**



## 2.0 OBJECTIVES

The ongoing telerehabilitation at the James Haley Veterans Administration (VA) Medical Center at Tampa, Florida (Tampa VA) continues and expands the existing rehabilitation program in place for veterans discharged from the hospital with combat related trauma. The primary objectives of this 36 month quasi-experimental study is to 1) Provide medical care coordination to meet the needs of OIF/OEF veterans with combat injuries and 2) Determine the immediate and sustained effects of telerehabilitation on patient outcomes including function, cognition and community participation and 3) Examine the perceived benefits and limitations of the intervention from the veteran and caregiver perspectives and 4) Evaluate the impact of telerehabilitation on VA resource utilization (e.g., clinic visits, hospital bed days of care).

This is one project in a planned program of research to improve care for injured Operation Enduring Freedom/Operation Iraqi freedom veterans. We propose with this study to test a telerehabilitation program for veterans with combat related traumatic brain injury with or without comorbid post traumatic stress disorders by monitoring functional, cognitive and mental health outcomes together with their integration into society using a variety of instruments. Coordinating medical care at a distance and thereby reducing their utilization of the VA health system is another important goal of this telerehabilitation intervention. The *long term* goal of this program of research is to optimally define telerehabilitation services for all veterans with polytrauma, including accurate and efficient screening instruments, educational material for patients and families, family support, and family counselling to enhance care coordination and to maximize functional outcomes and quality of life.

### **3.0 STUDY DESIGN**

This 36 month study started in June 2008 utilizes a quasi-experimental design to evaluate telerehabilitation care provided to a convenient sample of 65 OIF/OEF veterans discharged from the Tampa VA with a diagnosis of mild (mTBI) or moderate TBI and or PTSD incurred in combat theatres in Iraq and Afghanistan.

#### **3.1 Data collection**

Health outcomes are monitored in multiple ways including 1) administrative data bases and (2) instruments such as the Functional Impairment Measure<sup>TM</sup> (FIM), the Craig Handicap Assessment and Reporting Technique (CHART), the PTSD Checklist Military Form, Modified PTSD Symptom Scale, Self-Report Alcohol Use Disorders Identification Test (AUDIT): Self Report Beck Depression Inventory and the Medical Outcomes Social Support Survey, patient satisfaction surveys and interviews with patients and caregivers at six month intervals. Veterans are required to access a secure website and input health data at the time of consenting to participating in the study (baseline) and every six months thereafter till the end of the study. Data has been collected at 0, 6, 12 and 18 months for the entire cohort of veteran enrolled in the study.

#### **3.2 Sample characteristics**

*Inclusionary criterion:* Veterans or active duty military personnel ages 17 and older who have sustained a TBI as evidenced by primary or secondary diagnosis on initial admission, enrolled and receiving medical services through the Tampa VA and medically stable as clinically determined by the patient's physician. Severity of injury may be denoted by a Glasgow Coma Scale score at time of injury or initial rehabilitation. Participants must reside within a two hour drive from the Tampa VA or the Miami VA, use the two facilities for their primary and specialist care and be willing to accept computer technology in their homes for monitoring purposes and sign a consent form or have it signed by a proxy. Veterans and/or care givers must also possess basic computer literacy such as being able to access a web page and making entries in survey instruments posted on a secured website. They must agree to participate in the care coordination and completing survey instruments in a timely manner. We exclude from our intervention those who have a diagnosis of psychosis and the severely injured who are institutionalized.

Table 1 outlines demographic characteristics of the sample. A total of 75 veterans were enrolled in the study. We are actively following 65 veterans due to veterans moving away from the area, opting out of the program and one death from a drug overdose. Veterans are stratified into two groups: those with a diagnosis of TBI alone and those with comorbid PTSD as well. The latter group is more likely to have incurred wounds in combat as evidenced by a higher rate of service connected disability. Many in this group without PTSD sustained non combat injuries such as those resulting from vehicle accidents. It partially explains the lower incidence of PTSD among those with non combat related Traumatic Brain Injury.<sup>iv</sup> Two of the veterans were female. Female veterans cannot be enlisted in combat units but do sustain injuries due to accidents and indirect fire. The majority of veterans enrolled classified themselves as white.

Table 1. Subject Characteristics (N=75)

	Group 1 TBI N=61	Group 2 TBI/PTSD N=14
	N (%)	N (%)
Male, %	58 (95.1)	14 (100.0)
Age, mean ± SD	32.6 (8.4)	39.3 (9.0)
Marital status		
Married	32 (52.5)	7 (50.0)
Divorced	5 (8.2)	1 (7.1)
Never Married	20 (32.8)	6 (42.9)
Single	4 (6.6)	0 (0.0)
Ethnicity, %		
Not Hispanic	44 (72.1)	9 (64.29)
Hispanic or Latino	15 (24.6)	4 (28.57)
Unanswered	2 (3.3)	1 (7.14)
Race, %		
White	50 (82.0)	10 (71.4)
Black	4 (6.6)	0 (0.0)
Native Hawaiian	2 (3.3)	1 (7.1)
Unanswered	5 (8.2)	3 (21.4)
Race/Ethnicity, %		
White	39 (63.9)	8 (57.1)
Black	4 (6.6)	0 (0.0)
Hispanic	15 (24.6)	4 (28.6)
Native Hawaiian	1 (1.6)	1 (7.1)
Unanswered	2 (3.3)	1 (7.1)
Service Connected, %		
0%	17 (27.9)	5 (35.7)
10-29%	10 (6.1)	0 (0.0)
30-59%	14 (22.9)	1 (7.1)
60-100%	20 (32.8)	8 (57.1)
Annual Income, %		
\$0-29,000	43 (70.5)	9 (64.3)
\$30,000-59,000	14 (22.9)	4 (28.6)
\$60,000-90,000	4 (6.6)	1 (7.1)

### 3.2 Health Status of enrolled veterans

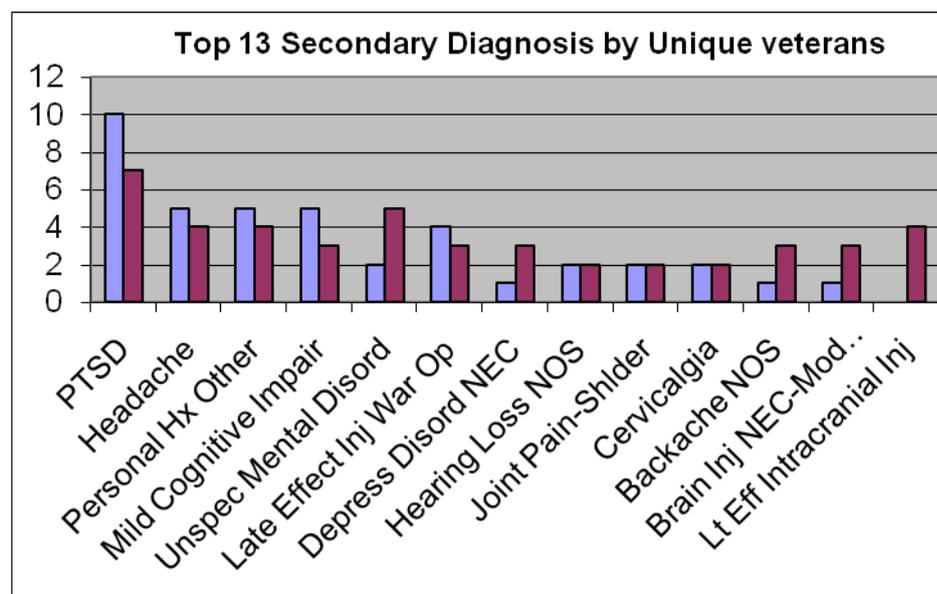
As per the inclusionary criterion for participation in telerehabilitation all veterans have a primary clinical diagnosis of Traumatic Brain Injury incurred in combat theatres in Iraq and Afghanistan. Though the mechanism of injury is not always identified in their medical charts in the VA, conversations with

wounded warriors have revealed that the majority suffer from the effects of blast related injuries due to direct or indirect fire. Many of the wounded suffer from other adverse side effects of TBI.

Data on veterans whom we are actively following was available when this report was first compiled and contained in Figure 1. Explosions are the most common cause of combat trauma and frequently result in polytrauma characterized by lung, bowel, and inner ear injuries; traumatic limb or partial limb amputation; soft tissue trauma from fragments and other missiles; and brain injuries.<sup>v,vi,vii,viii</sup> Of those with battle injuries severe enough to require evacuation from theatre to a military hospital in OEF/OIF, 71% had traumatic brain injuries, with approximately half being mild and the rest moderate to severe.<sup>ix</sup>

As can be observed, Post Traumatic Stress Disorders and the adverse effects of TBI manifested as headaches and cognitive impairment were common ailments of our study cohort. Post Traumatic Stress Disorder (PTSD) is a specific anxiety disorder resulting from exposure to a life-threatening traumatic event such as physical injury. It is characterized by symptoms of re-experiencing (e.g. nightmares, flashbacks), avoidance behaviour (e.g., emotional numbing), and increased arousal (e.g. difficulty sleeping). More relevant to our study are the high rates of PTSD associated with bombs or explosions. PTSD after terrorist attacks in the form of bomb explosions can range from 27% to 82%. The relationship between PTSD and explosions is also verified by a study showing that 68% of veterans diagnosed with PTSD currently enrolled in PTSD and/or substance abuse treatment identified as having a history of blast exposure.<sup>x</sup> Our findings compare favourably with other studies that have investigated organ damage due to combat exposure.<sup>xi</sup>

**Figure 1: Secondary diagnosis among veterans recorded during inpatient (IP) and outpatient (OP) visits.**



### 3.3 Findings

#### 3.3.1 Baseline Surveys

Baseline surveys were conducted to: 1) To characterize rehabilitation trajectories over time in the areas of function, cognition, psychosocial adjustment, integration into society and mental health disorders over time and 2) To individualize treatment patterns customized to each veterans needs so as to maximize the effect of telerehabilitation. Unlike traditional telemedicine that deals with disease specific monitoring

or intervention (diabetes, CHF, dementia etc), our cohort exhibits a very diverse population in terms of disease affliction, complexity and propensity to receive care. Listed below are findings from baseline health status measures from the FIM + FAM and the Patient Competency Rating scale. They concisely describe the cohort followed and are similar in findings to other instruments used to measure outcomes.

**Functional Independence Measure™ (FIM) and Functional Assessment Measure (FAM):** The (FIM™)<sup>xii</sup> is a widely accepted functional assessment measure in use in the rehabilitation community. The FIM measures independent performance in motor and cognitive skills in addition to the Activities of Daily Livings pertaining to the self care categories of feeding, grooming, bathing, dressing upper body, dressing lower body and toileting. Because disturbances in communication, cognition, and behavior are prominent characteristics after brain injury, additional items considering those issues were added to the FIM, resulting in a functional assessment measure, FIM+FAM.<sup>3</sup> The FIM+FAM has been increasingly adopted as an outcome measure in brain injury rehabilitation.<sup>4,5</sup>

*Findings:* Table 2 provides for the means, standard deviation and range of self scoring by veterans. This constitutes our baseline scores. The range of scoring for each item is 1-7 with a response of 1 denoting a near total assistance (able to complete less than 25% of task) and 7 implying complete independence. Communication skills as contained in reading and verbalizing were adequate. As clearly evident psychosocial adjustment and cognitive function are the main areas of concern in coordinating care. Depression, anger, substance abuse, inability to integrate into society and post traumatic stress disorders of varying magnitude and complexity afflict many returnees with wounds incurred in war. Emotional outbursts are fairly frequent among this population.

**Table 2: Functional Independence Measure™ and Functional Assessment Measure.**

<b>Variable (Domains)</b>	<b>Mean</b>	<b>Std Dev</b>
Self Care Items (Totals)	6.51	0.97
Sphincter Control	6.70	0.69
Mobility Items	6.60	0.93
Locomotion	6.52	0.70
Communication Items	5.91	0.99
Psychosocial Adjustment	4.81	1.75
Cognitive Function	4.55	1.46

**Patient Competency Rating (PRC):** The Patient Competency Rating provides for a rating of basic competencies in performing everyday chores with responses on a 1-5 scale with 1 denoting the most difficulty in addressing a problem and a score of 5 implying ability to handle the problem with total ease. The range of most responses is 1-5 though the means tend towards the higher numbers. This is due to the binary nature of our cohort where the majority of individuals display good health and a small minority are of poor health status. There are thirty items comprising various items in the PRC instrument and include categories such as everyday activities including financial planning. The mean competency rating for all items was 2.94.

*Findings:* In Table 3 are outlined areas of concern in where the mean ratings for individual areas of competency are less than the mean value of 2.94 for all items in the instrument. Findings are similar to those of FIM/FAM with psychosocial adjustment (problem controlling temper, keeping from being depressed, adjusting to changes) and cognition (remembering, scheduling and participating) posing challenges to the veterans and care providers.

**Table 3: Patient Competency Rating (areas of concern)**

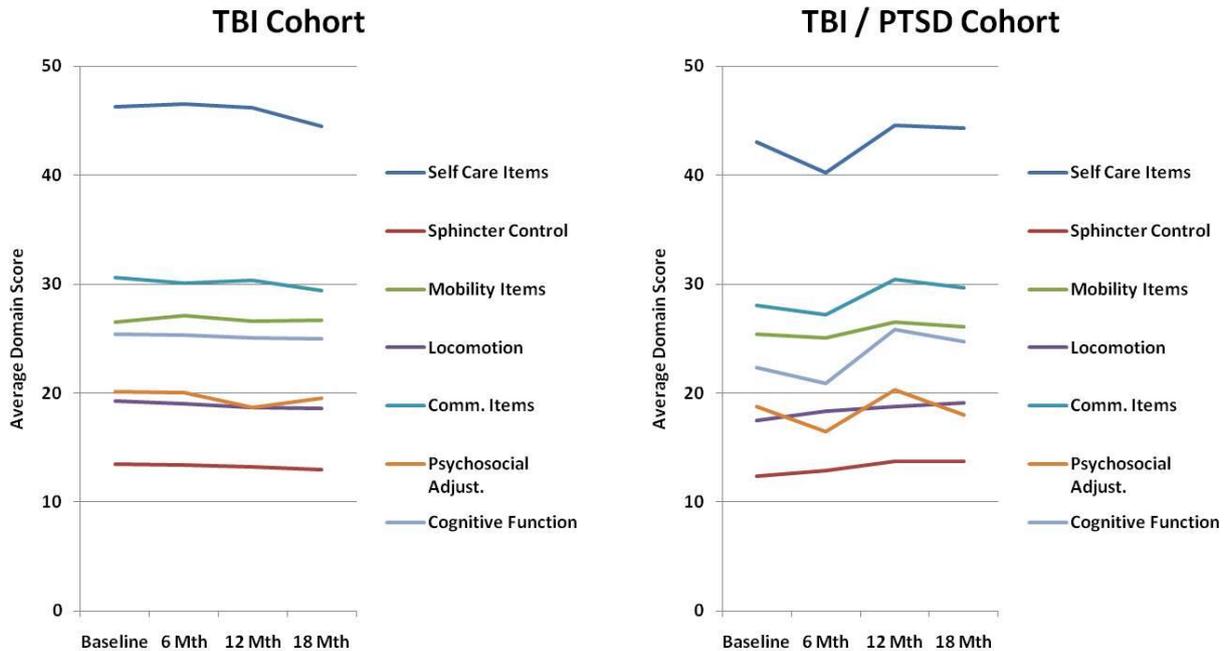
<b>Variable</b>	<b>Mean</b>	<b>Std Dev</b>
1. Keeping appointments	2.52	0.82
2. Starting conversations	2.68	1.03
3. Staying involved in work	2.52	0.65
4. Remembering names	2.48	0.82
5. Remembering important things	2.32	0.75
6. Adjusting to changes	2.6	0.82
7. Handling arguments	2.32	0.95
8. Showing affection	2.52	1.08
9. Controlling temper	2.28	0.84
10. Keeping from being depressed	2.32	0.8
11. Keeping emotions from affecting abilities	2.72	0.84
<b>Totals</b>	<b>2.94</b>	<b>0.45</b>

**3.3.2 Rehabilitation trajectories and health outcomes**

We illustrate changes in functional status and cognition over time using the FIM + FAM health outcomes instrument. Changes reflected in FIM + FAM are similar to the findings in administering the CHART and PRC. Hence, for the sake of brevity we have confined our presentation to those in Figure 2. Figure 2 denotes trajectories in the areas of physical functioning, cognition and other domains as measured by FIM + FAM for veterans enrolled in the telerehabilitation intervention. They represent composite scores for each of the domains of Self Care, Sphincter Control, Mobility items, Locomotion, Communication items, Psychological Adjustments and Cognitive Function. The two graphs represent stratification by comorbidities: a clinical diagnosis of TBI only (n=51 at baseline) and TBI with comorbid PTSD (n=14 at baseline). Data was collected at six month intervals. Not all veterans initially enrolled have completed surveys at 6, 12 and 18 months.

As compared to veterans with TBI only those with a dual diagnosis of TBI/PTSD indicate greater fluctuation in physical and mental health outcomes over time. Though the later group pertains only to small cohort of 15 patients the findings nevertheless emphasise the mood swings, depression, anger and problems with psychosocial adjustment that characterises this population. Problems with law and order issues and substance abuse are also more prevalent with this group with one veteran incarcerated and another dying of a drug overdose.

**Figure 2: Health outcomes as measured by the Functional Independence Measure and the Functional Assessment Measure.**



### 3.4 Conclusion

This study is one of the first to explore the long term health implications of wounded warriors treated at the Veterans Administration. We are still in the phase of data collection and at the completion of the study in June 2012 should have robust longitudinal data that can be used for rigorous statistical analysis to provide clues as to identifying the most vulnerable of veterans who need urgent and intensive care. Our intervention appears to have resulted in delaying or curtailing visits to the emergency department due to the timely intervention of the ARNP. We are in the process of exploring multi modal individualised treatment for veterans with PTSD because of the diverse behavioural consequences of the diagnosis.

### References

- <sup>i</sup> U.S. casualty status. Washington, D.C.: Department of Defence, 2006. (Accessed November 15, 2009, at <http://www.defenselink.mil/news/casualty.pdf>.)
- <sup>ii</sup> Khan F, Baguley I and Cameron I. Rehabilitation after traumatic brain injury. *Medical J Australia*; 2003, 178(6):290-5
- <sup>iii</sup> Hersh WR , Hickam DH, Severance SM, Dana TL , Pyle K, Helfand KM, AHRQ Publication Evidence Report/Technology Assessment Number 131Telemedicine for the Medicare Population: Update, Feb 2006
- <sup>iv</sup> Belanger HG, Kretzmer T, Vanderploeg RD, French LM: Symptom complaints following combat-related traumatic brain injury: relationship to traumatic brain injury severity and posttraumatic stress disorder. *J Int Neuropsychol Soc* 2010, 16:194-99.

<sup>v</sup> Belanger HG, Scott SG, Scholten J, Curtiss G and Vanderploeg RD. Utility of mechanism-of-injury-based assessment and treatment: Blast Injury Program case illustration. *J of Rehabilitation Research and Development*, 2005, 42, 403-412.

<sup>vi</sup> DePalma RG, Burris DG, Champion HR, Hodgson MJ. Blast Injuries. *New Eng J Med* 2005; 352(13):1335-1342.

<sup>vii</sup> Phillips YY, Richmond DR. Primary blast injury and basic research: a brief history. In: Bellamy RF, Zajtchuk R, eds. *Conventional Warfare: Ballistic, Blast, and Burn Injuries*. Washington, DC: Office of the Surgeon General of the US Army; 1991:221-240.

<sup>viii</sup> Stuhmiller JH, Phillips YY, Richmond DR. The physics and mechanisms of primary blast injury. In: Bellamy RF, Zajtchuk R, eds. *Conventional Warfare: Ballistic, Blast, and Burn Injuries*. Washington, DC: Office of the Surgeon General of the US Army; 1991:241-270.

<sup>ix</sup> Defense and Veterans Brain Injury Center data, Warden, personal communication, April, 2005

<sup>x</sup> Trudeau DL, Anderson J, Hansen LM, Shagalov DN, Schmoller J, Nugent S, Barton S (1998). Findings of mild traumatic brain injury in combat veterans with PTSD and a history of blast concussion. *Journal of Neuropsychiatry and Clinical Neurosciences*, 10, 308-313.

<sup>xi</sup> Owens BD, Kragh JF Jr, Wenke JC, Macaitis J, Wade CE, Holcomb JB. Combat wounds in operation Iraqi Freedom and operation Enduring Freedom. *Trauma*, 2008 Feb;64(2):295-9.

<sup>xii</sup> Wright, J. The FIM(TM). The Center for Outcome Measurement in Brain Injury.  
<http://www.tbims.org/combi/FIM>.