Rehabilitation Care of Combat Related TBI: Veterans Health Administration Polytrauma System of Care

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Abstract The U.S. Veterans Health Administration established the Polytrauma System of Care (PSC) in response to the growing need for Traumatic Brain Injury (TBI) and polytrauma rehabilitation services for our returning war heroes. The unique and complex patterns of injuries sustained during the conflicts in Iraq and Afghanistan have resulted in significant physical, cognitive, and psychological impairments which require an extraordinary level of specialized training and skill provided by the PSC interdisciplinary team. The PSC offers a holistic, coordinated, and comprehensive continuum of polytrauma/brain injury rehabilitation. These services range from intensive inpatient rehabilitation to residential and outpatient

programs designed to address all facets of combat injury. These services are available to Veterans and service members across the nation and have been involved in the direct care of tens of thousands of combat injured personnel. This article provides an overview of services and new initiatives created by the PSC to provide the best care for our Veterans and service members.

Keywords Traumatic Brain Injury · Polytrauma · Veteran · Rehabilitation · Blast injury

Introduction

In 2001, the US military began combat operations in Afghanistan known as Operation Enduring Freedom (OEF). OEF was expanded in March 2003 to include military operations in Iraq, referred to as Operation Iraqi Freedom (OIF) and in 2010 transitioned to Operation New Dawn (OND) to reflect the change of mission by US forces.

These wars now account for some of the longest military campaigns in US history with over two million troop deployments [1]. As of 5 April 2013, these conflicts have resulted in over 50,000 US casualties [2]. According to Fischer's 2013 Congressional Research Service Report to Congress [3], there have been over 48,000 moderate, severe and penetrating TBIs, 1,715 limb amputations, and more than 6,500 fatalities. In addition, the Defense and Brain Injury Veterans Center reported more than 219,000 cases of mild TBI (mTBI) highlighting this as a significant injury sustained during these wars [4]. These injuries likely would have been fatal in prior combat operations, but advances in battlefield emergency response and protective armor has led to an increased survival rate of these war heroes with a unique profile of injuries [5, 6].

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As a result of these conflicts, Section 302 of Public Law 108-447, *The Veterans Health Programs Improvement Act of 2004*, was established. This act charged the Veterans Health Administration (VHA), the largest integrated healthcare system in the US, with developing a system of specialized expertise to provide the best available medical care and integrative rehabilitation services to Veterans with TBI [7, 8]. Consequently, the VHA created a continuum of rehabilitation care for this growing cohort of Veterans and active duty service members, collectively known as the Polytrauma System of Care (PSC) [9, 10]. The PSC continuum spans the continental US, Alaska, Hawaii, and Puerto Rico and includes five Polytrauma Rehabilitation Centers (PRCs), five Polytrauma Transitional Rehabilitation Programs (PTRPs), 23 Polytrauma Network Sites (PNSs), 87 Polytrauma Support Clinic Teams (PSCTs), and 39 Polytrauma Points of Contact (PPOC) [11]. The VHA defines Polytrauma as “two or more injuries, one of which may be life threatening, sustained in the same incident that affect multiple body parts or organ systems and result in physical, cognitive, psychological, or psychosocial impairments and functional disabilities [9].” Such injuries include amputations, complex orthopedic injuries, burns, spinal cord injuries (SCIs), and injuries to the sensory organs, as well as post-traumatic stress disorder (PTSD) and other mental health disorders [12, 13].

The PSC continuum was designed to deliver rehabilitation care for service members and Veterans at different points of access depending on the acuity of injury and care needed. The PRCs specialize in rehabilitation services that provide comprehensive inpatient acute rehabilitation care for complex and severe polytraumatic injuries and serve as regional referral centers for acute medical and rehabilitation care. The PRCs also function as hubs for research and education related to TBI. The PTRP centers are co-located at the PRCs and provide a residential brain injury program for Veterans and service members with physical, cognitive, or behavioral impairments that may hinder effective reintegration into the community [14]. The PNS and PSCT outpatient TBI clinics offer continued medical care and rehabilitation services for Veterans and service members who are transitioning closer to home following discharge from the PRC or as an access point for rehabilitation services for those who have experienced a mild–moderate TBI or polytraumatic injury [15].

The PSC treatment paradigm includes a comprehensive, interdisciplinary team (IDT) model designed to meet the complex medical, psychological, prosthetic and rehabilitative care requirements for each Veteran or service member [16]. The PSC has a multidimensional team approach which incorporates specialized programs within the VHA such as the Amputee System of Care Program, Assistive Technology (AT) Program, Telehealth Programs,

and Driver Trainer Program to provide a complete individualized holistic care plan for each Veteran or service member. New initiatives and programs are constantly being developed within the PSC to meet the needs of this “new generation” of war Veterans, including the Polytrauma Integrative Medicine Initiative (PIMI), Patient Centered Care Model, Complementary Alternative Medicine and Wellness programs, Assisted Living TBI Pilot Program and VA TBI mobile applications.

Polytrauma Rehabilitation Center (PRC)

The PRCs were established to provide the highest level of specialized acute inpatient rehabilitation for the most severely injured service members and Veterans, utilizing state-of-the-art practices to treat complex physical, cognitive, and mental health sequelae of battle trauma [17]. They also provide medical and surgical support for ongoing and/or new conditions and provide support to families [18, 19]. The PRCs were incorporated into an existing framework of brain injury expertise at the VA Traumatic Brain Injury (TBI) Lead Centers, which have provided brain injury rehabilitation services to Veterans and the military since 1991. These VA TBI Lead Centers include Richmond, Virginia; Tampa, Florida; Minneapolis, Minnesota; Palo Alto, California and most recently San Antonio, Texas. These five specialized Polytrauma Centers have between 12–18 designated Polytrauma/TBI beds and are accredited by the Commission on Accreditation of Rehabilitation Facilities (CARF). These centers function as the nucleus for regional referrals, acute rehabilitative care, research and education [20].

A new cohort of Veterans and service members have emerged over the past decade with Polytrauma and TBI after exposure to improvised explosive devices, mines, rocket-propelled grenades, mortars, hand grenades, assaults, sniper and artillery fire and motor vehicle collisions [21, 22]. These polytraumatic injuries involve complex and often unpredictable patterns, resulting in combinations of TBI, SCI, amputations (often multi-limb), multiple fractures, limb salvage and other musculoskeletal injuries, genitourinary injuries, ocular injuries, burns and psychological trauma. These often cause significant impairments in cognition, communication, mobility and self-care, as well as pain, reduced vision, sensory disorders, and emotional issues [19, 23, 24]. These complicated and unique patterns of injuries require an individualized plan of care, developed by an IDT.

The IDT functions as a unit, ensuring cooperation among disciplines to achieve optimal patient and family outcomes [25]. Members of this comprehensive IDT include, but are not limited to, physiatrists, rehabilitation nurses, physical therapists, occupational therapists,

speech–language pathologists, case managers, counseling psychologists, family therapists, neuropsychologists, recreational therapists, and blind rehabilitation outpatient specialists [11]. The patient and family are at the core of this team guiding the plan of care. Goals and progress are continually reviewed with the patient and family and modified as needed to remain centered on the patient's needs. The PRCs IDT advocates for family involvement throughout the rehabilitation process and provides appropriate supportive resources to carry out the overall care plan [26]. The treatment plan provided must take into account medical stability, impairment, level of consciousness, and functional status. Depending on acuity and severity of injury, treatment may focus on alertness and responsiveness, orientation, communication, mobility and progress towards basic activities of daily living (bathing and showering, bowel and bladder management, dressing, eating, feeding, functional mobility, personal device care, personal hygiene and grooming, sexual activity, sleep and rest, and toilet hygiene) as well as instrumental activities of daily living (e.g. meal preparation, financial management, community safety, and driving).

Referrals for inpatient treatment at a PRC originate from local community medical facilities, Department of Defense (DOD) Military Treatment Facilities, self-referrals or family referrals and other VA medical centers nationwide. From March 2003 to September 2012, PRCs have provided intense rehabilitative care for 1,061 Veterans and 1,423 active duty service members, 1,078 of whom were injured in combat. For those PRC patients injured in foreign theater, 48 % were under the age of 25. Table 1 shows the most prevalent foreign theater injuries that were cared for in the PRCs (Bidelsbach D 2013, personal communication, 8 April).

In 2006, the PSC developed a unique program called the Emerging Consciousness Program (ECP), dedicated to supporting the recovery of the most catastrophically injured Veterans and service members with disorders of consciousness after a severe TBI [27]. The Polytrauma ECP is a national 90-day program at the five PRCs dedicated to supporting return to consciousness [28]. The ECP involves a specialized comprehensive interdisciplinary treatment approach for an individualized therapy program that includes a multimodal sensory stimulation program, pharmacological neuromodulation, intensive case management, psychological support services and education for families and caregivers with the ultimate goal of return to consciousness and the opportunity to develop a long-term healthcare plan with facilitation of the next level of rehabilitative care.

The PRCs have excellent outcomes as evidenced by a discharge rate to the community of 81.8 % for those with foreign theater injuries (Bidelsbach D 2013, personal communication, 8 April). Table 2 shows all foreign theater discharge destinations. Length of stay (LOS) at the PRCs

Table 1 Combat injury types sustained by service members during foreign theater conflicts from March 2003 until September 2012

Injuries	Prevalence (%)
Brain injury	86.5
Vision loss	29.8
PTSD	29.8
Hearing loss	20.1
Ortho/fractures	18.8
Wounds/infections	10.1
Anxiety	9.7
Amputations	6.9
Burns	1.9

Table 2 Discharge destinations after inpatient PRC stay for injuries sustained during foreign theater deployment from March 2003 until September 2012

Discharged destination	OEF/OIF injured personnel
Home	62.8 %
Military treatment facility	23.5 %
Home VA (inpatient)	7.6 %
Private facility	3.8 %
Polytrauma Transitional Rehabilitation Program	2.3 %

differs significantly from community rehabilitation facilities because of the complexity of injuries with an average LOS of 46 days, with 84 days for the more severely injured. According to the Uniform Data System for Medical Rehabilitation [29] the average LOS for patients with TBI in the community from 2006 to 2010 was 17.5 days.

The PTRP is an innovative, CARF-accredited, inpatient residential community reintegration program developed for Veterans and active duty service members with a polytraumatic and/or brain injury who have sustained physical, cognitive, and/or behavioral impairments that delay or inhibit their effective reintegration into the community or return to duty following their acute phase of rehabilitation [30]. Each of the PRCs has a free standing PTRP facility with a capacity of 10 beds with a goal of progressive return to independent living and aims to maximize the optimum level of performance through a milieu-based, comprehensive holistic neurorehabilitation program [31]. The treatment model is based on therapeutic principles of milieu psychotherapies involving the use of therapeutic communities where the onus is placed on the Veteran or service member to take responsibility for themselves and the others

within the unit, similar to the camaraderie they are accustomed to in the military. These residential facilities provide a “non-hospital” environment to facilitate an optimal level of independence with limited restrictions to simulate the home environment. These programs place a strong emphasis on return to duty, work or school, community navigation and mobility, self-management of complex life skills, interactive social skills, teamwork and development of psychological adjustment and coping skills [32, 33]. Staffing includes a psychiatrist, neuropsychiatrist, social work case manager, speech–language pathologist, occupational therapist, physical therapist, kinesiotherapist, recreational therapist, vocational therapist, psychologist, neuropsychologist, clinical pharmacist, registered nurse (RN), nurse admissions coordinator, licensed vocational nurses (LVNs) and vision rehabilitation specialist. Outcome measures utilized are the Satisfaction With Life Scale [34], Mayo-Portland Adaptability Inventory (MPAI-4) [35], World Health Organization Quality of Life, and patient and family satisfaction surveys [36]. From 2008 through 2012, the PTRP has treated 415 Veterans and service members with an average LOS of 67 days and an average age of 32 years (Bidelsbach D 2013, personal communication, 8 April).

Polytrauma Network Site

The PNS programs were created to facilitate the delicate transition from the inpatient setting to the community and to coordinate lifelong rehabilitation services. Outpatient rehabilitation programs are necessary to maintain and continue the functional gains made during inpatient rehabilitation after a TBI. A robust and comprehensive outpatient TBI program is also essential to address the needs of a large outpatient population who have suffered a mild–moderate TBI. There is currently at least one PNS located in each of the 21 regional Veterans Integrated Service Networks (VISNs), which directs VHA services in their distinct geographic locations. The PNS serves as a referral source and care coordination center for other clinics located within the VISN to provide advanced specialty services and continued management of existing and emerging sequelae of the Veteran or service member’s injury. The PNS is also responsible for identifying resources for VA and non-VA care across the VISN, providing proactive clinical and psychosocial case management, continued support for families, regular follow-up care, and check-ups. The sites coordinate services between VHA, Veterans Benefits Administration (VBA), the DOD and the private sector, and provide resources for education and employment to facilitate community reintegration.

TBI screening, evaluation, treatment: in 2007, a system-wide screening instrument, the Veteran TBI-screening Tool

(VATBIST), was initiated to capture returning OEF/OIF Veterans who may have suffered a TBI but have not been diagnosed or offered treatment [37]. Any provider may complete this screen, but is most often performed at the initial social work or primary care visit. Upon enrollment in the VA system and during the first encounter with any healthcare provider, Veterans are asked “Has the Veteran already been diagnosed as having TBI during OIF/OEF deployment?” If a diagnosis of TBI has already been made, the Veteran is offered follow-up care with the PNS providers. If the Veteran has not been previously diagnosed with TBI, the screening tool is implemented and is comprised of the following four questions:

- (1) Did you have any injury (or injuries) during your deployment from any of the following? Check all that apply: blast or explosion, vehicular accident/crash, fragment wound or bullet wound above the shoulders, fall, blow to head, other injury to head.
- (2) Did any injury you received while deployed result in any of the following? Check all that apply: loss of consciousness/“knocked out”, being dazed, confused or “seeing stars”, not remembering the event, concussion, head injury.
- (3) Did any of these begin or get worse afterward? Check all that apply: memory problems or lapses, balance problems or dizziness, sensitivity to bright light, irritability, headaches, sleep problems.
- (4) In the past week, have you had any of the above symptoms? Check all that apply: memory problems or lapses, balance problems or dizziness, sensitivity to bright light, irritability, headaches, sleep problems.

These questions aim to provide information important for implementing specialized care by determining that traumatic injury occurred and resulted in a brain injury. The incorporation of terminology that captures an event that resulted in “alteration of consciousness” is designed to reflect the evolution of the definition of TBI and thus improve sensitivity measures beyond those found with a more stringent “loss of consciousness” definition [38•]. Questions regarding the acute symptomatology that may be related to TBI as well as the timing and chronicity of these symptoms are also part of this screening tool.

An answer of “yes” to all four questions constitutes a positive screen; however, this does not confirm a diagnosis of TBI. The VATBIST was evaluated among 500 Veterans of Iraq and Afghanistan with demonstration of good sensitivity (94 %) and test–retest reliability (80 %), but moderate specificity (59 %) and high rate of false positives (41 %) [39]. The impact of co-morbid PTSD and associated symptoms was thought to contribute to the modest specificity. Belanger et al. [40] used a centralized database and a cohort of 48,175 Veterans to compare results from

the VATBIST screening tool to a comprehensive diagnostic interview. Findings were comparable to the prior study with excellent sensitivity (87–90 %), but very low specificity when compared to the diagnostic interview (13–18 %). These studies demonstrate the utility of the VATBIST as a screening tool to identify any OEF/OIF Veteran who may have sustained a TBI, however these studies also demonstrate the need for a confirmatory test. Currently the “gold-standard” for diagnosing TBI relies on the in-person diagnostic interview. The Comprehensive TBI Evaluation (CTBIE) was initiated in October 2007 and is completed following a positive VATBIST. A retrospective evaluation of its performance over a 3-year period after its initiation also showed its ability to identify detailed information about post-concussive and neurobehavioral symptoms in those diagnosed with TBI [41••].

Since 2007, over 660,000 Veterans have been screened with the VATBIST, with over 20 % testing positive and offered further evaluation with the CTBIE [41••, 42]. The CTBIE is then scheduled within 30 days to be completed by the Polytrauma clinic’s physiatrist, neurologist or neuropsychiatrist with specialized training. During this evaluation, a complete history and physical are completed and detailed information is gathered regarding the injury event, possible blast exposures, current symptoms, and how these symptoms are limiting function. In addition, the 22-question Neurobehavioral Symptom Inventory (NSI), a tool to assess current severity in various physical and cognitive domains, is completed and the PNS team is notified [43]. From April 2007 through February 2013, 56.1 % ($n = 52,934$) of Veterans evaluated have been confirmed to have sustained a TBI using the CTBIE [44].

After a TBI diagnosis is confirmed, a comprehensive treatment plan is developed with the patient and the IDT based on the patient’s goals. A heavy emphasis is placed on TBI education and prevention, usually accomplished through discussion during the visit and supplemented with educational material developed to address common symptoms after a TBI. The patient-centered approach focuses on development and tracking of goals, such as return to work or school, and encourages continued follow-up with IDT members. The core staffing for the PNS clinics include a rehabilitation physician, rehabilitation nurse, social worker, clinical psychologist, physical therapist, occupational therapist, speech–language pathologist, blind rehabilitation outpatient specialist, and certified prosthetist [11]. Once a patient is enrolled in the Polytrauma clinic, Polytrauma case managers monitor them closely and their care plan is discussed with the IDT. Outcomes are measured by monitoring individual symptoms through changes in the NSI score or with symptom specific tools such as the Headache Impact Test—6 [45]. Also, the MPAI-4 is tracked from initial evaluation through discharge to assess

which obstacles may impede community reintegration based on current functional ability [35]. The PNS clinics work closely with the VBA Vocational Rehabilitation Programs to optimize function and attempt to identify early barriers to reintegration. Once a Veteran has completed the treatment plan, goals and function are reassessed by the IDT with the Veteran and family, at which time a new treatment plan is developed, if needed. For those with the most severe and functionally limiting injuries, intensive case management is continued through the PNS for as long as needed, which is potentially lifelong.

The PNS teams coordinate care with PSCTs, which are located throughout each VISN and are tasked with providing comprehensive interdisciplinary outpatient rehabilitation services within their catchment areas. The PSCT services extend the reach of PSC by providing for local Veterans and service members with “mild or stable functional deficits due to Polytrauma and TBI”, supported by the option to refer to PNS or PRC if a higher level of care is indicated [11]. This type of hierarchical care model is designed to bridge catchment areas that span large geographic regions and provide patients with access to TBI/Polytrauma services. VA PPOC are available at 39 VAMCs without specialized rehabilitation teams. The PPOCs help coordinate case management and referrals throughout the PSC, ensuring that every Veteran has access to the PSC.

Complete Care Provisions

In order to provide a holistic treatment program, the PSC leverages new and existing VHA programs to ensure the injured Veteran or service members receives a care plan tailored to their needs. Given the high incidence of traumatic amputees, the PSC has joined with the existing Amputee System of Care to provide care for new amputees using state-of-the-art technology in patient evaluation and prosthetic design. The “Polytrauma Amputee Network Sites” will provide lifelong care for the amputee to minimize disability and permit the highest level of social, vocational and recreational reintegration utilizing advanced prosthetic technology [19, 46]. In addition, the PSC is working in association with the VHAs Blind Rehabilitation Services to support Veterans and service members who are blind or have impaired vision. There is an association with blast injury/exposure and ocular injury with those who suffer polytrauma. Even those with mTBI are at higher risk for visual impairments and dysfunction, which has led to a new directive for screening and treatment for ocular health [47–49].

The PSC utilizes a patient-centered care treatment model, which places the Veteran as a central member in his/her care, to ensure the patient is active in guiding clinical

decisions. This dynamic model focuses on changing health behaviors and providing a treatment plan that is health oriented, proactive, and lifelong. This model improves access to care, coordinates services, develops individualized goals, improves communication and provides continuity of care [50]. The PSC utilizes a variety of telehealth services such as an online personal health record (My HealtheVet), secure messaging to providers and video telehealth services to achieve the common goals of wellness and maximizing function. In December 2006, the VHA developed a state-of-the-art telemedicine care program called the Polytrauma Telehealth Network (“Telehealth Network”), which facilitates the use of advanced medical technologies to improve clinical care, family support and education programs to Veterans and service members in remote locations [11]. The telemedicine network allows improved access to care for Veterans in rural areas [51]. The Telehealth Network enables care coordination and referrals from military treating facilities to the PSC continuum and also allows for improved communication among inter-agency providers [52]. Also, the PSC leverages advances in information technology including telehealth and mobile technology to broaden access to specialized rehabilitation services. A “Concussion Coach” mobile app with tools for education, symptom tracking and self-management is scheduled for launch in the summer of 2013.

In May 2009, the VA founded a nationwide AT program to complement the PSC. The AT program encompasses areas of intervention including wheeled mobility, adaptive driving, adaptive sports and recreation, augmentative and alternative communication, electronic cognitive devices, adaptive computer access, and electronic aids to daily living [53]. The AT programs were established at each of the PRCs with the mission to effectively support Veterans and service members with cognitive, sensory and physical disabilities and to enhance their independence, comfort and general quality of life through the use of AT. As one of the essential activities on the road to independence and community reintegration is the ability to drive, the PSC has embedded a driver trainer evaluation program at each of the PRCs to determine whether a return to driving is a realistic and attainable goal [54, 55].

PSC Initiatives

The most catastrophically injured Veterans or service members who sustain a severe TBI or polytraumatic injury may require a significant amount of care after acute inpatient rehabilitation. The VHA PSC is investigating the benefit of longer term residential neurorehabilitation programs, known as the Assisted Living TBI Pilot Program, to assess the effectiveness of providing long-term assisted

living services to Veterans with moderate to severe TBI, thereby allowing access to a wide range of post-acute services and support that will help improve and maintain their skills and allow them to reside in a non-institutional setting.

The VHA Department of Physical Medicine and Rehabilitation has partnered with the VHA National Center for Health Promotion and Disease Prevention to create new programs and provide education, resources, coordination, guidance, and oversight for the field to enhance health, well-being, and quality of life for all Veterans. The VHA is embracing the concept of Integrative Medicine through the development of various programs that focus on engaging the mind, body, spirit, and community [56]. Smeeding et al. [57] showed that mind–body skills and CAM therapies, including meditation, mindfulness, acupuncture, hypnosis, aquatic body-work and yoga in an integrative health clinic, is an effective program to improve chronic pain, anxiety (PTSD), depression, and health-related quality of life with both short- and long-term benefits. The PSC is currently collaborating with the Office of Patient Centered Care and Cultural Transformation in an initiative referred to as the PIMI, a feasibility study that incorporates Integrative Medicine concepts of holistic health, mind, body, spirit and conventional treatment modalities into polytrauma care. The goal of this collaboration is to investigate the impact of an IM model on resource utilization and the improvement of physical and psychological health.

Conclusion/Summary

The PSC is a tiered network that includes four components: the PRC, PNS, PSCT, and the PPOC. Each component plays a critical role in the diagnosis and treatment of Veterans and service members. This treatment system was designed to care for Veterans during the most recent conflicts where blast-related injuries have led to a significant increase in polytrauma and TBI. This congressionally mandated program of Veterans’ healthcare is responsible for providing an integrated continuum of polytrauma and TBI rehabilitation to tens of thousands of mild to severely injured combat troops using IDT, patient centered care treatment models and state-of-the-art technology. The PSC will be providing lifelong services for these Veterans and will be well established to provide care for those who may be injured while currently serving. Long-term tracking and evidence-based medicine will be essential for understanding the chronic sequelae of their injuries and how best to treat these individuals.

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