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Assessing Severity of Traumatic Brain Injury in Life Care Planning

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Introduction

A traumatic brain injury (TBI) occurs when a force vector applied to the head or skull results in displacement of the brain within the cranial vault and is associated with either loss of consciousness, post-traumatic amnesia, disorientation, confusion, or focal or diffuse neurological signs (American Psychiatric Association, 2013). The prevalence of TBIs in the United States has grown exponentially over the past decade. Traumatic brain injury incidence rates rose from 521 per 100,000 in 2001 to 823.7 per 100,000 in 2010 (Faul, Xu, Wald & Coronado 2010a). Accordingly, a 2010 estimate from the Centers for Disease Control concluded that TBIs resulted in nearly 2.5 million hospital visits in the United States (Centers for Disease Control and Prevention, n.d.). This estimate, however, does not account for those who did not receive medical care, had outpatient or office-based visits, or those who received care at a federal facility, such as a Veterans Affairs hospital (Faul, Xu, Wald & Coronado, 2010b).

While a return to competitive employment for those who sustain severe traumatic brain injury (STBI) is quite challenging, the majority of those sustaining TBI sustain mild TBI (MTBI). The majority of individuals with a MTBI return to independent living and gainful employment (Fabiano & Sharrard, 2017). However, the recovery process can be arduous and nearly one-third of individuals with a TBI will experience residual difficulties such as reduced work-place productivity, decreased job stability, and lessened job responsibilities (Fabiano & Sharrard, 2017; Gamboa, 1994; Keyser-Marcus, et al., 2002). Part of the challenge is to assess the projected loss earning capacity concerning employability. Life care planning, which involves this assessment, is an essential component of the recovery process.

This article presents a review of TBI severity and its relationship to employment. Special attention will be paid to how the robust, empirically-driven evaluation afforded by a comprehensive neuropsychological assessment can identify prognostic factors and barriers to vocational rehabilitation. Additionally, this article offers a proposed model and strategies to assist vocational rehabilitation counselors, case managers, nurses, and life care planners in determining employability. Finally, this article will provide an overview of the cognitive, behavioral, and vocational rehabilitation services necessary to promote the recovery of those with a TBI.

Traumatic Brain Injury and Employment

Traumatic brain injury has been associated with a significant post-injury unemployment (Fabiano & Crewe, 1995; Keyser-Marcus, et al., 2002; Shames, Treger, Ring, & Giaquinto, 2007; Van Velzen, Van Bennekom, Edelaar, Sluiter, & Frings-Dresen, 2009). A review of existing literature finds a significant degree of variability in vocational outcomes with employment rates as high as 90% to as low as 15-30% (Fabiano & Crewe, 1995; Fabiano & Daugherty, 1998; Fabiano & Sharrard, 2017; Fraser, Dikmen, McLean, Miller & Temkin, 1988). A review of these studies indicates differences in severity of injury, differences in the settings in which the subjects were sampled, differences in the criteria in determining employment, and differences in the time post-injury in which the subjects were studied (Fabiano & Crewe, 1995; Fabiano & Daugherty, 1998; Fraser, Dikmen, McLean, Miller & Temkin, 1988; Humphrey & Oddy, 1980). In the first author's research, those who sustained STBI (defined as a minimum length of coma of 24 hours) had a return-to-employment rate of 37% compared to those who had sustained a MTBI, with return-to-work rates of 73% (Fabiano & Daugherty, 1998; Fabiano & Sharrard, 2017). Consequently, severity of injury becomes a highly significant factor concerning employability following TBI.

Severity of Injury

The use of two parameters that determine severity of injury following TBI include the depth in alteration of mental status and the duration of such disruption (Fabiano & Sharrard, 2017; McCrea, 2008). The range of alteration in mental status can include mild disorientation in cases of MTBI to coma in STBI. The Glasgow Coma Scale (GCS) is the most widely used for measurement of depth of alteration in mental status (Balestreri et al., 2004; Centers for Disease Control and Prevention, n.d.; Pangilinan & Kishner, 2017; Teasdale & Jennett, 1974). In brief, the GCS measures three areas of functioning: spontaneous eye opening, best verbal response, and best motor response. The scores range from a low of one to a high of four in spontaneous eye opening, one to five for best verbal response and one to six for best motor response. The overall score ranges from a low of three for those who are entirely unresponsive to a high of fifteen for those fully oriented and able to follow simple commands (McCrea, 2008). Assigning severity labels, those with GCS of 13-15 have sustained a MTBI, those ranging from 9-12 a moderate TBI and those at or below eight a STBI (McCrea, 2008; Teasdale & Jennett, 1974; Teasdale et al., 2014).

The second parameter in assigning severity of TBI is duration of alteration in mental status. The two measures used are loss of consciousness (LOC) and posttraumatic amnesia (PTA). Posttraumatic amnesia includes the period in

which the production of memories is disrupted from the time of impact until memory storage and retention has been restored (Levin, O'Donnell, & Grossman, 1979; Tate, Godbee, & Sigmundsdottir, 2015). Stein and Spettell (1995) indicate that those who demonstrate a LOC of 20 minutes or less and a PTA of fewer than 24 hours meet the criteria for a mild TBI. Those who have LOC from 30 minutes to 24 hours and/or a PTA of one to seven days are classified as having a moderate TBI (McCrea, 2008). Those who have LOC exceeding 24 hours and/or PTA exceeding seven days are classified as having a severe TBI (McCrea, 2008).

The severity of TBI has a significant impact on employment outcomes (Fabiano & Crewe, 1995; Fabiano & Daugherty, 1998; Fabiano & Sharrard, 2017). Those who have sustained STBI show rates of unemployment as high as 60% -70% (Fabiano & Crewe, 1995; Van Velzen, Van Bennekom, Edelaar, Sluiter, & Frings-Dresen, 2009). In a study of 94 subjects, 98% of the subjects were either working or in school prior to the onset of TBI, and only 37% were fully employed post STBI (Fabiano & Crewe, 1995). This is in contrast to a study of those treated for MTBI in which 73% of the subjects were employed following rehabilitation (Fabiano & Daugherty, 1998). Consequently, as a first step in vocational assessment, classifying TBI severity is important for assessing return to employment.

The Role of Neuropsychology

Assessing injury severity is a relatively straightforward process consisting of a review of injury characteristics including period and depth of loss of consciousness, period and depth of posttraumatic amnesia, and presence of other injury characteristics (i.e. intracranial hemorrhage, subdural hematoma, posttraumatic seizures, etc.). This is accomplished through direct observation of the individual and/or a review of the medical documentation. However, within the severity category, there exists some degree of variance necessitating the next level of analysis, analyzing the effects of the TBI. This is accomplished through the neuropsychological evaluation, which provides an objective evaluation of cognitive abilities and psychological functioning. The neuropsychological evaluation provides an objective measurement of an individual's intellectual functioning, memory and new learning capacity, language and communication skills, conceptual reasoning skills for verbal and nonverbal details, and psychological adjustment (Malik & Kishner, 2017).

Intellectual assessment includes objective measures in areas of verbal comprehension, visuospatial organization, nonverbal reasoning, auditory attention, and visual motor processing. The Wechsler Adult Intelligence Scale-Fourth Edition is one of the most widely used intellectual assessment batteries and provides four index scores: verbal comprehension, perceptual reasoning, working memory, and processing speed (Flanagan & Harrison, 2012). This culminates in a Full Scale IQ (FSIQ) which has been shown by the primary author to correlate with employability following STBI (Fabiano & Crewe, 1995; Goran, Fabiano, & Crewe, 1998).

Evaluation of memory and new learning capacity allows for identification of memory performance, preferred learning style, and strategies for memory enhancement. The Wechsler Memory Scale-Fourth Edition has been demonstrated by Carlozzi, Grech, & Tulsky (2013) to demonstrate construct validity in a study of 65 persons who sustained STBI. Assessment of language skills can identify areas of strength and weakness in receptive and expressive language functioning. Language measures include comprehensive batteries of specific language functions, such as the Boston Naming Test to assess visual naming ability and the Controlled Oral Word Association Test to assess verbal fluency (Tsaousides & Gordon, 2009). Evaluation of higher order executive functioning can help to assess problem solving, conceptual reasoning, and decision-making capacity. There are several measures of executive function, including single-test measures (e.g. the Category Test, the Stroop Test, and the Wisconsin Card Sorting Test) (Tsaousides & Gordon, 2009).

The psychological assessment includes psychological factors such as depression, anxiety, and post-traumatic stress reactions, which may be part of the adjustment process (Fabiano, 1998a). Such measures include Beck Depression Inventory-II, Geriatric Depression Scale, and Minnesota Multiphasic Personality Inventory-II (Strauss, Sherman, & Spreen, 2006). In more severe injuries, neurobehavioral changes resulting in issues of emotional dysregulation, impaired self-awareness, lack of initiative or motivation, and problems in interpreting social or environmental cues can often occur as a direct result of the brain injury (Lezak, 1978; Prigatano et al., 1984). The severity of these neurobehavioral symptoms can have an adverse effect on employment (Ashman, Gordon, Cantor, & Hibbard, 2006). Many psychological assessments also include measures of symptom exaggeration or dissimulation to help identify those who may be exaggerating symptoms or attempting to feign psychiatric or neurologic disability (Greiffenstein, Baker, & Gola, 1994). For example, one such measure, the Test of Memory Malingering (TOMM) has been shown to identify those who feign or exaggerate memory and cognitive impairment (Weinborn, Orr, Woods, Conover, & Feix, 2003). Test scores are compared with normative data provided with those who have documented serious neurological disorders such as severe traumatic brain injuries and dementia (Tombaugh, 1997).

The psychological assessment should also attempt to place relative weights on cognitive, behavioral, and psychological factors to culminate in an accurate differential diagnosis. Premorbid psychiatric disorders such as depression, bipolar disorder, anxiety, and personality disturbance may present with symptoms, which on the surface may be misconstrued as concussion related (Fabiano

& Sharrard, 2017). Post-injury adjustment disorders including depression, anxiety, post-traumatic stress disorder, conversion disorder, and malingering may all present with behaviors, which may appear concussive in nature (Fabiano, 1998b). Consequently, the neuropsychological evaluation is perhaps the most sensitive procedure to derive an accurate diagnosis within the context of competing disorders. Ultimately, a neuropsychological evaluation should be able to contribute to issues of employability determination relative to various occupations (Phillips & Radford, 2014).

The Clinical Validity of Neuropsychology in Employment Determination

In a study of 94 subjects who sustained STBI defined as a minimum length of coma of 24 hours), through the use of a series of analysis of variance (ANOVA), tests revealed that those who were successfully employed full-time (or enrolled in college) at a minimum of 1 year post-injury, had significantly higher intellectual functioning than those participating in part-time employment or sheltered/supported employment ($p<.001$) (Fabiano & Crewe, 1995). In this analysis, FSIQ was significantly predictive of employment outcome, showing greater predictive value than length of coma (FSIQ= $p<.001$; LOC= $p<.05$), years of education (FSIQ= $p<.001$; Education=ns), or pre-injury occupation (FSIQ=$p<.001$; Premorbid Occupation ns) (Fabiano & Crewe, 1995). Those who were successfully employed full-time or enrolled in college showed intellectual performance solidly within the average range with a FSIQ 99 compared to those limited to part-time employment with (FSIQ=87), those unemployed (FSIQ=87), or those participating in sheltered or supported employment (FSIQ=79). A follow-up study revealed that through the use of the Individual Ability Profile (Dean, 1982; Dean, 1983), an interpretation profiling of the Wechsler Intelligence Scale, predictive hit rates of over 90% for the successful full-time employed subjects were yielded (Goran, Fabiano, & Crewe, 1998). Consequently, the use of intellectual assessment can increase the ability to identify those who may be capable of successful full-time employment following STBI with over 90% accuracy.

Regarding those who have sustained MTBI, the literature indicates that as high as 90% enjoy a successful return to competitive employment (Kreutzer et al., 2003; Yasuda, Wehman, Targett, Cifu, & West, 2001). The first author's data in treating those with mild TBI revealed that 73% were able to return to successful employment (Fabiano & Daugherty, 1998). However, a closer inspection of those who made a successful return to competitive employment reveals that one-third or more may experience reduced job performance, reduced job advancement, less job satisfaction, and more frequent job changes (Gamboa, 1994; McMahon & Flowers, 1987). Therefore, a more robust clinical interview and vocational assessment are necessary to evaluate further needs regarding employment status.

Evaluating Specific Vocational Demands

Jobs in the U.S. economy vary in the degree of complexity based upon level of training required (i.e. unskilled vs. skilled; clerical vs. professional and managerial). Jobs also vary in terms of the degree of cognitive complexity and demands. For example, the ability to read and comprehend large volumes of technical information within the practice of law likely places greater demand on the neurocognitive system than working on an assembly line. The ability to screen out, tolerate distractions, and engage in multitasking in an executive secretarial job can place much greater demand on the ability to process information, compared to stocking products. The degree of cognitive complexity can result in a greater degree of mental fatigue and reduce the ability to tolerate an eight-hour day. The demand to perform jobs with a zero tolerance threshold in errors of inattention such as air traffic control, nursing, or medical practice may create risk factors that are unacceptable even in cases of mild neurocognitive impairments. Consequently, the cooperative work between clinical neuropsychology and vocational rehabilitation is necessary to address the relative employability for an individual with consideration given to injury severity, neuropsychological consequences, and vocational complexity.

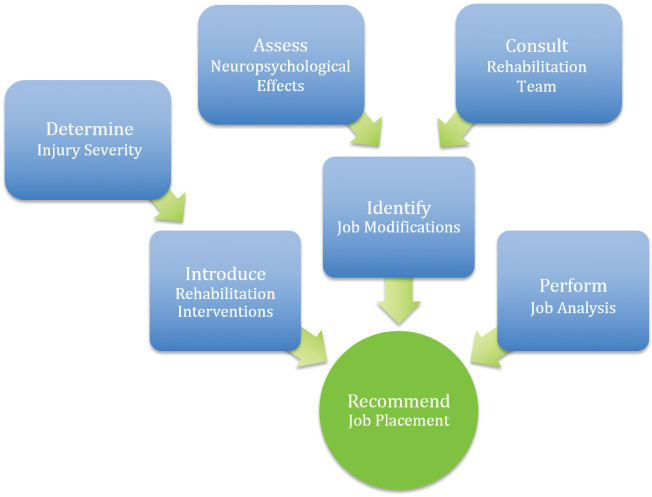
Vocational Planning

The vocational rehabilitation process is often multidisciplinary in nature, involving those who have been active in the treatment for a particular person (Fadyl & McPherson, 2009). Professionals involved may include physical therapy, occupational therapy, speech and language therapy, physical medicine and rehabilitation, neurology, social work, nursing, vocational rehabilitation, and neuropsychology. The size of the multidisciplinary team often grows as the severity of the injury increases. Vocationally relevant areas assessed include physical limitations (e.g. lifting restrictions, balance, and coordination, working at heights, bimanual dexterity, and other physical demands). This paper is concerned with the cognitive, neurobehavioral and psychological effects of a TBI and how these parameters impact vocational rehabilitation.

As seen in Figure 1, the goal of the vocational analysis process is to support placement back into the workforce. To recommend return-to-work among individuals who have sustained a TBI, the vocational analysis should address various components of TBI and ultimately lead to employment determination. First, a thorough understanding of the injury severity is necessary to identify and incorporate appropriate rehabilitation interventions into the care plan. Second, assessing neuropsychological effects and consulting the rehabilitation team will offer the opportunity to identify job modifications necessary for successful employment. Lastly, a comprehensive job analysis produced by the rehabilitation team facilitates recommendations for appropriate job placement. The job analysis also determines

whether and how quickly an individual may resume their vocational responsibilities. This process, which synthesizes information obtained by the rehabilitation team, will help to identify and circumvent barriers that may occur along the path toward vocational recovery.

Figure 1. Vocational Analysis Process



Therefore, we offer a five step analytic approach to employment determination based upon the factors discussed including severity of TBI, neuropsychological recovery and psychological adjustment.

The first step in the vocational planning process is to identify the severity of the TBI. This will help to prognosticate the vocational outcome. Consequently, with those who have sustained MTBI, the prognosis is optimistic, with return to work rates as high as 90% (Fabiano, 1998b). Conversely, among those who have sustained STBI, the outcomes are much more guarded and cautious (Fabiano, 1998b).

The second step in vocational planning is to review the neuropsychological findings within the context of the injury severity. As indicated, even within the category of STBI, those with favorable intellectual recoveries may be candidates for a return to competitive employment. Conversely, those who have sustained MTBI may show neuropsychological test patterns that identify areas of relative strength and impairments, which may prove relevant to the type and nature of targeted employment (McCue et al., 1994).

The third step is to identify those particular TBI characteristics identified by the multidisciplinary team (including neuropsychological findings). This will help identify the vocational strengths, weaknesses, and potential obstacles regarding a return to work (Powers, 2012).

The fourth step is to identify physical and cognitive occupational demands to determine the appropriate fit relative to the individual. For example, even within MTBI, there may be occupations that are too complex in terms of the demands of processing large volumes of information (e.g. law, medicine), tolerating distractions and multi-tasking (e.g. executive secretary), or the zero tolerance for error (e.g. air traffic controller, physician, or nurse). In contrast, even within the context of STBI, there may be jobs that have the repetition and lack of spontaneous new learning demands that increase the likelihood of a successful return to work (e.g. stock clerk, inspector).

The fifth step is to enlist the assistance of additional resources such as assistive technology, ergonomic modifications, and rehabilitative strategies, often provided by members of the multidisciplinary team to enhance successful placement. Given the familiarity of returning to the same job post-injury that one had worked, it came as little surprise that those who returned to work with the same employer were more likely to be employed post STBI as compared to those who entered new jobs (Fabiano, Crewe, & Goran, 1995). Additionally, early return to work efforts seem to be associated with higher rates of employment post-injury (Fabiano, Crewe, & Goran, 1995; Tyerman, 2012; Tyerman, n.d.). Consequently, there often is an advantage in attempting to return to the same job and/or employer post-injury.

Summary

Traumatic brain injury can cause significant challenges in the areas of cognitive, psychosocial, and vocational adjustment. While the severity of TBI, defined either by GCS score, PTA duration or LOC duration, casts tremendous influence on vocational outcome, the use of neuropsychological data in the vocational analysis and rehabilitation process can help to improve vocational outcomes and more accurately prognosticate employment status post-TBI. Neuropsychological assessment, by utilizing a battery of validated tools, helps to identify cognitive, psychosocial and behavioral factors which may impact employability. Additionally, reviewing an individual's vocational strengths and weaknesses and job demands helps to delineate goals of the rehabilitation process. Equipped with a neuropsychological assessment, a sound understanding of the job requirements and the individual's vocational strengths and weakness, the multidisciplinary rehabilitation team can better address employment barriers. The ability to target appropriate vocational placements relative to injury severity and neuropsychological status will enhance the ability to access rehabilitative interventions and improve vocational outcomes.

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