

Long term neurobehavioral characteristics after brain injury: implications for vocational rehabilitation

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Abstract

A sample of 97 unemployed persons with traumatic brain injury receiving rehabilitation services at an urban outpatient rehabilitation center were identified. Patients were divided into two groups based on time elapsed since injury, 5–9 years and 10–35 years post-injury. Family members reported a high incidence of cognitive, motor, and emotional problems lingering well beyond the first few years postinjury. Rates of moderate and heavy drinking, psychiatric treatment, and criminal behavior were identified. Transportation, cognitive, and physical problems were described as primary obstacles to employment. Analysis revealed few differences in the occurrence of cognitive, emotional and motor problems between follow-up samples, supporting contentions that disability is often permanent. Family members' perceptions of injury-related obstacles to work were also strikingly similar. Recommendations are made for individually tailored, holistic rehabilitation programs with long-term, proactive follow-up.

Keywords: Traumatic brain injury; Unemployment; Employment; Neurobehavioral vocational rehabilitation

1. Introduction

The goals of acute and post-acute rehabilitation programs are to maximize recovery from traumatic brain injury and enhance the individual's quality of life and productivity within the community. As the number of rehabilitation pro-

grams has increased, the need for assessment of patients' psychosocial outcome and level of integration into the community has also grown.

One widely used index of psychosocial recovery has been return to competitive employment [1]. The results of studies investigating employment outcome following brain injury have not been encouraging. Postinjury employment rates have ranged from 22–50% [2–5]. There has also been evidence that high unemployment rates persist at long post-injury intervals, ranging from 7–15 years [3,4,6].

Persons with traumatic brain injury often have impairments that place potentially serious obstacles to employment. Problem areas include atten-

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tion, initiation, learning and memory, self-monitoring, and motor speed and coordination [7]. In response to concerns regarding the influence of cognitive impairments on self report, early research has primarily gathered data about neurobehavioral sequelae from family members or caregivers. European researchers were among the first to systematically document family members' complaints of cognitive, emotional, and behavioral difficulties in patients beginning at 3 months post-injury and persisting at 6 and 12 month follow-ups [8,9]. Frequently reported difficulties included slowness, tiredness, poor memory, irritability, restlessness, and apathy or lack of interest.

Although some difficulties apparently resolve over time, there is evidence that many persist for a decade or more [10]. Brooks and colleagues [11] interviewed relatives regarding difficulties encountered by patients at 5 years post-injury. Besides memory difficulties, the top problems corresponded to emotional and behavioral impairments. The top five problems reported were: personality change; slowness; poor memory; irritability; and bad temper. Difficulties were strikingly similar to those reported by relatives at 1 year after injury. Thomsen [12] also reported on relatives' perceptions of patients' difficulties up to 5 years post-injury. Consistent with the findings of Brooks and colleagues [11] emotional and behavioral problems were frequently reported, including irritability, bad temper, restlessness, and decreased initiation. In the longest term follow-up to date, Thomsen [6] again interviewed 80% of the original sample at 10–15 years post-injury. A majority of symptoms reported at initial evaluation continued to be problematic. More than a decade after injury, a large proportion of relatives reported problems with slowness, poor memory, lack of social contact, and irritability. Significant increases were reported in tiredness, lack of interest, and sensitivity to distress. In contrast, significant decreases were noted in childish behavior and impaired concentration. Furthermore, persons who were injured before the age of 21 generally demonstrated significantly more difficulties than those injured afterward. Age related differ-

ences were noted for irritability, restlessness, and disturbed behavior.

Given the relative persistence of many neurobehavioral symptoms, investigators have attempted to identify the pattern of cognitive and neurobehavioral impairments related to difficulty gaining competitive employment. Cognitive difficulties associated with unemployment include impairments in learning, memory, attention, and perceptual-motor skills [3,13,14]. Only a few investigators have examined emotional and behavioral characteristics related to unemployment. Brooks and colleagues [3] attempted to discriminate employed from unemployed persons at 2–7 years post-injury, based on relatives' responses to a bipolar adjective checklist describing patients' personality characteristics. Ten characteristics were found to discriminate between the groups, including temper, immaturity, insensitivity, reasonableness, and self-reliance. Serio and Devens [15] investigated relatives' reports of problems hindering employment. Memory difficulties were most frequently reported. Also included among the top five obstacles were trouble using limbs, thinking problems, and lack of transportation. Motivation and temper difficulties were identified as employment obstacles by more than 10% of the sample. Alcohol use has also been identified as a hindrance to sustained employment [14,16].

In summary, European researchers have suggested that persistent cognitive, behavioral, and emotional difficulties contribute to unemployment following traumatic brain injury. However, the applicability of these findings to populations outside Europe has not yet been established. Furthermore, researchers have developed and relied on structured interviews and questionnaires. The reliability and validity of these individually developed assessment procedures has not been demonstrated.

The current study has two primary aims. The first is to characterize the neurobehavioral attributes of American, unemployed patients who are between 5 and 35 years postinjury. The second is to systematically examine the pattern of long-term problems and discuss implications for development of effective vocational rehabilitation

programs. The study is unique in describing patients who are more than 15 years postinjury and using an evaluation approach with demonstrated reliability and validity.

2. Method

2.1. Subjects

Patients were recruited from an outpatient rehabilitation medicine clinic sponsored by a major urban medical center. To focus on long-term outcome, all patients at least 5 years post-injury were first identified. Among this group of 130, 97 unemployed (75%) and 33 employed persons were identified.

For further study, the 97 unemployed persons ranging from 5–34 years post-injury was divided into two samples based on time elapsed since injury. Sixty persons injured between 5 and 9 years ago (1991–1987) were placed in follow-up Group I. Mean years post-injury was 6.1 ($SD = 1.1$). The majority were male (87%). Two thirds (68%) were Caucasian and 17% were African-Americans. A second follow-up group (Group II) was comprised of 37 persons injured more than 10 years ago. Mean time post-injury was 15.8 years ($SD = 5.8$). The majority of patients were male (76%). Most were Caucasian (78%) and 14% were African Americans. For both follow-up samples, 3% of participants described themselves as having other ethnic or cross-cultural backgrounds.

Information about days unconscious was used as a primary indicator of injury severity. The full spectrum of brain injury severity was represented in the study population. Both groups' means and standard deviations for days unconscious, age at time of injury and evaluation are given in Table 1. T tests and Chi Square analyses were used to

compare Groups I and II in regard to socio-demographic and injury characteristics. Analysis revealed no difference between groups with regard to education and coma length, gender, racial, or ethnic composition. As expected, the groups differed by age at time of injury, with Group II being younger when injured $t(94) = 5.34$, $P = 0.041$.

2.2. Instruments

Descriptive information pertaining to patient and respondent demographics, in particular, the patient's current vocational status, post-injury employment, academic status, alcohol use, criminal behavior, and psychiatric history was obtained from persons identified by the patient as a primary caretaker. Primary caregivers were designated based on having close knowledge of and frequent contact with the patient. Information was provided by family members, primarily wives and mothers. All data was collected via the General Health and History Questionnaire [17]. The General Health and History Questionnaire (GHHQ) was developed specifically to assess the psychosocial, vocational, and neurobehavioral status of patients with traumatic brain injury.

Contained within the GHHQ is a version of the Quantity-Frequency-Variability Index (QFVI) developed by Cahalan and Cisin [18,19]. Based upon the quantity and frequency of alcoholic beverages consumed, individuals are categorized as abstinent, infrequent, light, moderate, or heavy drinkers. The present version was adapted from the original self-report measure for completion by informants. In addition, the questionnaire was modified to separately examine pre- and post-injury drinking habits. The present study assessed

Table 1
Sample demographics

	Group I		Group II	
	Mean	SD	Mean	SD
Age at time of injury	27.4	10.0	17.4	17.0
Days in coma	40.1	51.1	58.1	59.5
Age at time of evaluation	33.4	9.9	33.2	5.7

drinking patterns during the 3–6-month period preceding the patient's evaluation. The QFVI is especially useful because representative data is available for a large sample of drinkers within the United States population. Moreover, several investigators have also used the questionnaire to assess drinking patterns among persons with brain injury [20] and other disabilities [16].

A section within the GHHQ provides information regarding the patient's post-injury vocational, academic, and psychosocial adjustment. For patients who are unemployed, respondents are queried as to which medical or psychological factors impede the patient's ability to work or attend school. For patients who were arrested, information was collected regarding conviction and the nature of charges.

A final section of the GHHQ contains a 105 item behavior and symptom checklist, the Neurobehavioral Functioning Inventory (NFI). For each item, respondents provide a frequency rating ranging from 1–4 (never, sometimes, often, or always). A recent investigation provided support for construct validity and internal reliability [21]. For the present investigation, items comprising the following NFI scales were examined: (a) motor; (b) somatic; (c) depression; (d) communication; (e) attention/memory; and (f) aggression. Also examined was the 20 item Supplementary Scale which contains items reflecting fatigue, slowed information processing, dangerous driving, and impatience.

2.3. Procedure

The General Health and History Questionnaire was mailed to participants prior to their scheduled physical and/or neuropsychological examination. Upon arrival for evaluation, responses to the questionnaire were reviewed for accuracy and completeness. When necessary, respondents were asked to clarify or provide additional information.

3. Results

3.1. Post-injury characteristics

For both groups, the majority of patients were not in school. Only four persons reported attend-

ing school at least part-time. For Group I, one third of patients had not graduated from high school, slightly more than a third (40%) were high school graduates, and the remainder (28%) had completed at least some college. Group II had relatively more persons post high school (43% had attended at least some college). Only 17% had not graduated from high school and the remaining third were high school graduates. Chi square analyses did not indicate differences between groups' level of formal education ($P > 0.05$).

Information on post-injury psychiatric care was available for 60% of Group I and 46% of Group II. Chi square analyses indicated differences between groups. ($1, N = 37, 17 = 4.63, P < 0.05$). One third of persons five to nine years post-injury reported receiving psychiatric, psychological or counseling interventions. In contrast, 65% of persons in Group II reported using psychiatric care. In regard to illicit drugs, less than 12% of either sample reported recent use. Less than 25% of persons in either group reported being arrested post-injury. No significant differences were found between groups' arrest history and use of illicit drugs (see Fig. 1).

Among persons in Group I, 44% were categorized as abstinent. Similarly, 50% of persons in the second follow-up group were described as abstinent. Moderate and heavy drinkers constituted 30% of the first and 25% of the second follow-up group. Table 2 depicts drinking patterns during the three to six month interval immediately preceding the evaluation. *t*-tests were used

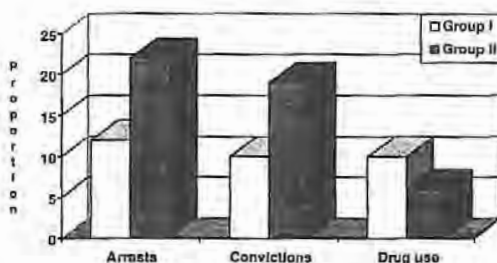


Fig. 1. Post-injury characteristics.

Table 2
Post-injury drinking patterns

Drinking category	Group I		Group II	
	Proportion	(n)	Proportion	(n)
Abstinent	44%	25	50%	18
Infrequent	13%	7	17%	6
Light	13%	7	8%	3
Moderate	14%	8	17%	6
Heavy	16%	9	8%	3

to investigate differences between groups' drinking quantity and frequency. No significant differences were found ($P > 0.05$).

3.2. Obstacles to work

More persons in the early follow-up group (48%) were medically restricted from driving in comparison to the later follow-up group (27%). However, the between groups difference was not statistically significant ($P = 0.10$). Among persons without medical restrictions, the proportion holding valid driver's licenses was examined. For the early follow-up group, three quarters (75%) of unrestricted drivers had a valid license. Two thirds (68%) of the unrestricted drivers in Group II held a valid license.

Table 3 depicts the top five perceived obstacles to employment. Although the ranking of problems was not identical, both groups identified the same five symptoms as problematic. The five most commonly reported problems were diverse, reflecting difficulties related to transportation,

thinking, coordination, and vision. Seizures were reported as a return to work obstacle for 13% of persons in Group I and 20% of persons in Group II. Motivation was listed as an obstacle for 15% of persons in Group I and 3% of persons in Group II. Finally, depression was listed as a vocational obstacle for 20% of persons in Group I and 13% of persons in Group II.

To further examine differences between the earlier and later follow-up samples, responses to individual NFI items were examined. A high degree of similarity was observed between the samples' rankings of individual items (see Table 4). For example, problems with boredom, frustration, slowness, losing train of thought, decision making, fatigue, and impatience were rated as being most frequent by members of both follow-up groups. Sample means for items were quite similar with differences ranging from 0.0–0.3.

To help identify between group differences, the means and standard deviations for NFI scale values were also examined (see Table 5). For the earlier follow-up group, the highest means were observed for the Depression and Motor scales.

Table 3
Commonly reported obstacles to employment

Group I		Group II	
Obstacle	Proportion	Obstacle	Proportion
Memory	49%	Memory	53%
Trouble using hands, arms, or legs	47%	Thinking problems	37%
Thinking problems	44%	Trouble using hands, arms, or legs	37%
Transportation	29%	Transportation	27%
Poor vision	26%	Poor vision	19%

Table 4
Most frequently endorsed neurobehavioral (NFI) problems

Group I		Group II	
Symptom	Mean	Symptom	Mean
Bored	2.57	Frustrated	2.44
Moves slowly	2.54	Forgets what he/she reads	2.38
Frustrated	2.40	Impatient	2.33
Difficulty lifting heavy objects	2.33	Misunderstood by others	2.33
Writes slowly	2.30	Bored	2.28
Reads slowly	2.34	Loses train of thought	2.27
Poor concentration	2.27	Reads slowly	2.27
Trouble making decisions	2.33	Writes slowly	2.24
Tired	2.30	Moves slowly	2.22
Thinks slowly	2.27	Tired	2.19
Loses train of thought	2.24	Thinks slowly	2.19
Easily distracted	2.21	Difficulty thinking of the right word	2.17
Impatient	2.20	Restless	2.17
Loses balance	2.16	Trouble making decisions	2.17
Misunderstood by others	2.14	Trouble following instructions	2.11
		Learns slowly	2.11

Problems indicated by the Somatic and Aggression scales were least frequently endorsed. Most frequently endorsed by the later follow-up group were problems related to the Attention and Memory, Communication, Depression, and Motor scales. Somatic items were least often reported. *t*-tests did not reveal between group differences ($P > 0.05$). Concordance was also indicated by the lack of differences between the groups' mean scale scores. Remarkably similar were means for Somatic (difference = 0.03), Communication (difference = 0.02), and Attention and Memory (difference = 0.07) scales.

Attention, memory, and somatic difficulties were rated as occurring most frequently by members of both groups.

4. Discussion

A clear understanding of brain injury sequelae is necessary for rational development of comprehensive vocational services. Despite differences in cultures and assessment methodologies, researchers in Denmark, England, and Scotland provided the first pictures of outcome within the first decade after severe traumatic brain injury [1-3,6,8]. Personality and emotional changes, including depression, childishness, irritability, and

sensitivity to stress were most often reported. Within the cognitive domain, impairments of memory, concentration, and slowed thinking were commonly described. Finally, within the psychomotor realm, slowness, lack of coordination, and fatigue were reported. The likely permanence of these sequelae was indicated by Thomsen's [6] unique longitudinal investigation which described outcomes at 10-15 years post-injury.

The present investigation provides a description of brain injury sequelae consistent with that reported by European researchers. Slowness was a frequently reported and pervasive problem, affecting reading, writing, thinking, and motor skills. Cognitive problems reported by our sample related to trouble making decisions, learning, and

Table 5
Descriptive statistics for NFI scales

Scale	Group I		Group II	
	Mean	SD	Mean	SD
Aggression	1.59	0.54	1.50	0.50
Attention/Memory	1.99	0.67	1.92	0.48
Communication	1.96	0.67	1.94	0.58
Depression	2.06	0.72	1.91	0.61
Somatic	1.46	0.53	1.43	0.52
Motor	2.02	0.63	1.90	0.73

concentrating. Caregivers also described memory, thinking, and lack of coordination as major obstacles to employment. Impatience, feeling misunderstood by others, boredom, and frustration, were among the most commonly reported emotional and personality changes.

The severity of post-injury psychosocial adjustment difficulties was also indicated by substance use, arrest and conviction data. Among persons in the earlier follow-up group, 12% reported at least one arrest and 10% reported at least one conviction post-injury. For the later follow-up group, 22% reported an arrest history and 19% were reportedly convicted. For the entire sample, about one in four persons were described as a moderate or heavy drinker, with a small proportion reporting illicit drug use. In addition, a history of post-injury psychiatric treatment was reported by ap-

proximately one third of the earlier follow-up group and two thirds of the later follow-up group. A substantial number of employers are reluctant to hire persons with a record of criminal, substance abuse, or emotionally disturbed behavior. Considered in the context of Thomsen's findings, [6] our data also suggest that some difficulties are persistent and may worsen for a sub-group of patients.

The low proportion of persons driving was likely attributable to a combination of cognitive, neurological, and psychomotor problems. Approximately one third of persons in the earlier follow-up sample held a valid driver's licenses and one half in the later follow-up sample held a license. Caregivers commonly ranked transportation difficulties as a major employment obstacle. Driving ability and access to a personal vehicle have been

Table 6
Recommended holistic vocational rehabilitation program components

Obstacle	Program component
Limited access to transportation	Transportation training including driver's training and use of public transportation
Substance abuse	Education; prevention; ongoing monitoring and assessment; group and individual treatment
Lack of coordination and slowness	Occupational and physical therapy; organized sports; recreation activities; fitness training; additional time to complete tasks
Fatigue	Structured breaks; adjust work hours; work hardening; stimulants and sleep medication; improve sleep hygiene
Poor vision	Neuro-ophthalmologic consultation; corrective lenses, vision therapy, use large print reading and writing materials
Limited attention, learning, and memory	Compensatory strategies and cueing; structured breaks; reduce distracters; multimodal information presentation
Trouble following directions	Improve instructional format; simplify or reduce variety of tasks; shaping for complex tasks; reduce distractions
Slowed reading and writing	Focus on quality versus quantity; allow extra time for task completion; dictation; reduce distractions; remedial training
Trouble making decisions	Teach structured problem solving methods; assertiveness training; maintain mentor relationships
Depression	Supportive psychotherapy; medication; enhance support systems; increase participation in activities
Misunderstood	Communication and social skills training; co-worker education
Irritability and impatience	Stress management and relaxation training; medication; anger management, assertiveness, and social skills training

identified as one of the most important return to work predictors in the spinal cord injury population [22].

The present study indicates that a subset of patients continue to experience a diversity of psychosocial, cognitive, and behavioral problems many years after injury. Comparisons between the earlier and later follow-up samples provided little indication of substantial differences. Nevertheless, the cross sectional nature of the design limits our ability to draw conclusions about changes over time. Longitudinal research is needed to clearly delineate changes associated with aging and rehabilitation practices.

A major limitation of the present investigation relates to patient selection and selection of data for analysis. Our sample only included persons seeking rehabilitation services and this group likely constitutes persons with more problematic outcomes. Unemployment rates were quite high. Similarly, data analysis focused only on unemployed persons, though employed persons were also referred for services. Referrals were received from a large catchment area of rural and urban Southeast communities in the United States. Research outside this region is needed to investigate the influence of regional and cultural factors on outcomes. Finally, information regarding patients was derived from caregivers, typically female family members. Data from other sources including patients and standardized tests should be considered.

The present findings have important implications for vocational rehabilitation program development. Persons with brain injury encounter a wide variety of problems and many are long-term. A listing of obstacles to employment and remedial methods is provided in Table 6. To effectively address employment needs, proactive and holistic programs involving interdisciplinary professionals are required [23-25]. Wehman and colleagues have strongly advocated for long-term, proactive follow-along [26,27]. The long term nature of the problems reported in our investigation further supports the need for long-term service availability. Furthermore, a proactive approach is likely to help prevent new problems and reduce the longevity of existing problems.

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