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Long-Term Outcome After Severe Traumatic Brain Injury: The McGill Interdisciplinary Prospective Study

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Objective: To obtain a comprehensive understanding of long-term outcome after severe traumatic brain injury (sTBI). **Participants**: Forty-six patients with sTBI. **Design**: Comparison of interdisciplinary evaluation results at discharge from acute care and at 2 to 5 year follow-up. **Main Measures**: Extended Glasgow Outcome Scale, the FIM™ instrument, and the Neurobehavioral Rating Scale–Revised. **Results:** Significant improvement was observed on the FIM™ instrument, the Extended Glasgow Outcome Scale, and on 3 factors of the Neurobehavioral Rating Scale–Revised. These measures at discharge were significant predictors of outcome. **Conclusion:** Patients with sTBI 2 to 5 years postinjury showed relatively good physical and functional outcome but poorer cognitive and emotional outcome. **Keywords:** *cognition*, *functional*, *multidisciplinary*, *outcome*, *physical*, *psychosocial*, *traumatic brain injury*

TRAUMATIC BRAIN INJURY (TBI) has a significant impact on survivors and their relatives.[1] Medical advances have improved the survival rate after severe TBI (sTBI) but the survivor may face a lifetime disability, which in turn affects family. The long-term outcome for this population is of interest not only to patients and their significant others but also to clinicians needing to provide prognostic information and to insurance companies as well as healthcare providers who bear the costs of care.

Many long-term outcome studies of subjects with sTBI in the literature have concluded that patients with moderate and sTBI show physical and functional improvement but remain with cognitive and psychosocial adjustment problems.[2–6] In these studies, the majority of subjects showed good physical recovery with independence in locomotion and basic life skills but demonstrated neuropsychological sequelae of cognitive and behavioral disorders creating difficulty in social reintegration. In very long-term studies (more than 14 years), patients with moderate to sTBI continued to demonstrate significant limitations for complex activity of daily living and instrumental activity of daily living tasks.[4] Hoofien and colleagues[3] reported serious problems in the areas of psychiatric symptomatology, social functioning, and family integration. On the other hand, Wood and colleagues[6] concluded that although long-term psychosocial functioning in patients 17 years post-sTBI may remain compromised, adjustment may be better than expected, based on psychosocial outcome measured at earlier stages of recovery.

Methodology has differed in a number of outcome studies with some researchers having used standardized outcome measures[2,6–9] and others using descriptive measures.[5] In some studies direct testing was carried out[2,3,6,10,12] while other experimenters have relied on self-report[4,13] or telephone interviews[14,15] to study the long-term effects on the patient and/or his family several months or years following the trauma. Although more research looking at long-term outcome and even very long-term outcome (more than 10 years) is now being published, there remains a paucity of studies using standardized evaluation tools and outcome

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measures encompassing a broad range of domains for survivors of sTBI at least 2 years posttrauma.

Most long-term outcome studies of sTBI have investigated subjects discharged from rehabilitation.[3,4,8,10,12,13,15] Not including all survivors of sTBI introduces a selection bias. Long-term outcome of those patients who benefited from rehabilitation following sTBI and those who did not may differ. Investigation of long-term outcome for all survivors of sTBI irrespective of their discharge destination from acute care would allow a more complete picture of outcome in this patient population. In addition, most outcome studies following sTBI have been conducted in the United States or in Europe. Only a few from Canadian centers have been published.[14,16]

Not only is it interesting to describe patient status several years post-sTBI to learn about patient evolution in different areas but also determination of factors which influence their progress is important. Several studies have focused solely on sTBI and looked at factors predicting global outcome,[9,17,18] neuropsychological performance,[10,17] functional status,[19] employment status,[19] cognitive skills,[19] and quality of life[17] at 6 or 12 months. More specifically, age,[17,18] Glasgow Outcome Scale (GOS) at 3 months,[18] Glasgow Coma Scale score (GCS), and results of computed tomography scan[18] were shown to predict GOS at 6 months. Glasgow Coma Scale score at 3 months was also shown to predict GOS at 12 months.[9] Moreover, GCS has been found to be the best predictor of neuropsychological functioning at 6 months, whereas pupillary reactivity was significantly related to self-reported quality of life.[17] Novack and colleagues[19] using a multivariate path analysis discovered that premorbid factors (age, education, employment status, history of alcohol and drug use, history of suicide attempt, legal history) influenced injury severity, functional skills, cognitive status, and global outcome, including employment status at 12 months. They concluded that premorbid status and cognitive status at 6 months were more important than injury severity to global outcome at 12 months. Finally, a long-term predictive study of patients with sTBI postrehabilitation, published in 2002 by Hoofien and colleagues[12] found that preinjury socioeconomic status as defined by education, number of siblings, and quality of military service predicted cognitive, psychiatric, vocational, and social/familial functioning an average of 14 years postinjury. In this same study, severity of injury as measured by duration of stay in rehabilitation and duration of coma was predictive of functioning in activities of daily living (ADL).

As this brief review of the literature shows, few predictive outcome studies have focused only on sTBI, have included all patients admitted to acute care and not only those who were discharged from a rehabilitation program, and have looked at outcome beyond 1 year posttrauma. Thus, further investigation in this area could help patients and their families as well as healthcare providers and the different interdisciplinary professionals of the treating teams understand what variables predict long-term outcome in patients with sTBI.

This study therefore aimed to better understand and predict the overall functional, cognitive, and psychosocial outcome after sTBI in patients discharged from a Canadian acute care tertiary trauma center. It was carried out with a comprehensive and interdisciplinary approach[20] to the evaluation of outcome with the participation of interdisciplinary team members, who determined the procedure and who were directly involved in the evaluation of the specific tasks carried out by the subjects in this project as well as in rating the outcome measures. The investigation involved comparing pretraumatic, psychosocial status to status at 2 to 5 years postinjury as well as a comparison between 3 validated outcomes measures, the Extended GOS (GOS-E), the FIM™ instrument, and the Neurobehavioral Rating Scale–Revised (NBRS-R), obtained at discharge from acute care (20 days postinjury) and at 2 to 5 years postinjury. The second aim of this investigation was to identify which variables best predict outcome 2 to 5 years post-sTBI. On the basis of the literature, regression analyses will be performed on age, GCS as well as on the outcome measures obtained at discharge from acute care (GOS-E, FIM™ instrument) to predict psychosocial status, global, and neuropsychological outcome as well as level of functioning and the amount of assistance required to perform various ADL 2 to 5 years postinjury (GOS-E, NBRS-R, and FIM™ instrument).

The hypothesis of this study is that patients with sTBI will show improvement in all outcome measures (GOS-E, FIM™ instrument, and NBRS-R) at follow-up 2 to 5 years postaccident. Moreover, we expect to see a higher level of functional improvement in the physical portion of the FIM™ rating compared with the cognitive portion of the FIM™ instrument. In addition, an increase in psychosocial and employment problems is expected.

METHOD

Participants

Study approval was granted by the research ethics board of the McGill University Health Centre (MUHC). All medical records were reviewed to ensure accuracy of the GCS score on arrival (the first documented by the emergency room, trauma, or neurosurgery physician). Retrospective data were collected from the trauma registry and the TBI program data bank, by experienced support staff members of the TBI program. All survivors of sTBI (ie, GCS score $\leq$ 8, postresuscitation) admitted to the MUHC acute care setting from April 1999 to

March 2002, who were discharged from this center and progressed through 2 to 5 years of recovery, were invited to attend a clinical follow-up for this study. Data on a total of 88 patients with sTBI were collected without regards to their limitations. The clinical coordinator of the TBI team contacted these patients or their caregivers to invite them to participate in this study. Of the 88 patients, 7 of this total had died postdischarge, from medical complications (eg, pneumonia, infections or cardiac complications) and 17 patients refused to participate because of a lack of motivation, refusal to undergo evaluation, or refusal on the part of the caregiver to accompany the patient. Moreover, 15 patients were unreachable and 3 were ineligible to participate (medical instability). Thus, among the 88 patients, a total of 46 patients remained from the initial cohort. Among this group of participants, 30 had received intensive rehabilitation, posttrauma; 3 were referred to an outpatient rehabilitation setting; and 13 were transferred to a long-term care facility. The mean age of the sample was 40 years (SD = 17, range = 16–80) and the mean GCS was 5 (SD = 2, range = 3–8).

A one-way analysis of variance (ANOVA) showed no significant age difference between the study participants and those who had not been included (either refused to participate, were unreachable, or ineligible). Moreover, the one-way ANOVA showed no difference in sex, in the initial GCS score, in the GOS-E, or the FIM™ instrument scores at discharge from the acute care trauma center. These results suggest that TBI severity and functional impairments of the 2 groups were similar at discharge.

Procedure

The 46 patients who accepted to participate in the study were discharged from the acute care setting after a mean duration of stay of 22 days (SD = 4.6). During their stay, the NBRS-R had been carried out and at discharge the interdisciplinary team rated each patient on the GOS-E and the FIM™ instrument. These patients were then seen for the follow-up study at the MUHC and carried out the tasks of the interdisciplinary assessment (described below). Among the 46 patients, 14 patients were 2 years posttrauma, 14 others were 3 years posttrauma, 11 patients were seen 4 years postaccident, and 7 patients were seen 5 years posttrauma (mean of 3.5 years, SD = 0.8).

Descriptive variables

The following descriptive variables were obtained from medical record review for each patient: age, gender, educational level, mechanism of injury, GCS score at admission, history of previous TBI, previous mobility and cognitive limitations, past medical history, and special circumstances affecting premorbid functioning. Other variables gathered on admission and again at follow-up, included marital status, living arrangements, employment and source of income, history of psychosocial problems such as substance abuse, legal and psychiatric history, and history of neurological/physical problems.

Measures administered at discharge from acute care and at follow-up (2–5 years)

The GOS-E[21] was used to assess global outcome. The GOS-E score, in this study, represented the interdisciplinary team's evaluation of patient outcome. On this scale, *scores* of *0* or *1* correspond to good recovery referring to normal participation in social, vocational, and physical life. *Scores* of *2* or *3* indicate moderate disability describing the patient who is independent but physically or cognitively disabled and requiring an altered physical, social, psychological, or vocational environment for participation. Patients with severe disabilities receive *scores* of *4* or *5* and are totally dependent in managing a normal or modified environment, whereas a *score* of *6* corresponds to a vegetative state reflecting total dependency with no awareness of the environment. Patients who die receive a score of 7.

The FIM™ instrument[22] was used to measure functional level of independence and more specifically the amount of assistance required to perform various ADL. It is an 18-item, 7-point scale, with increasing values indicating greater level of independence. The 18 items assess levels of self-care, continence, mobility, communication, and cognition. Three ratings were used in this study. The first was a global rating including the 18 items for a total ranging from a minimum of 18 to a maximum of 126. The second was a physical rating including those items related to ADL, continence, and mobility with a range of 13 to 91. The last rating included the cognitive domains consisting of social interaction, problem solving, memory, expression, and comprehension and ranged from 5 to 35.

The NBRS-R[23] is an observer rating scale of behavioral and cognitive dysfunction, which varies between 0 (absence of deficits) and 4 (severe deficit). For each item, a validated and reliable description of the different levels of severity of the deficit is provided. Measures were categorized according to 5 factors:

1. *Intentional behavior*: decreased initiative or motivation, blunted affect, difficulty in planning, conceptual disorganization, self-appraisal difficulties, disorientation, difficulty in mental flexibility, memory difficulties.
2. *Emotional state*: depressive mood, anxiety, emotional withdrawal.
3. *Survival-oriented behavior/emotional state*: irritability, hostility, disinhibition, hyperactivity and agitation,

unusual thought content, excitement, suspiciousness, lability of mood.
4. *Arousal state*: reduced alertness, mental fatigability, attention, motor slowing.
5. *Language*: difficulties in oral expression, in oral comprehension, and in articulation.

Interdisciplinary assessment at follow-up

Subjects underwent an evaluation consisting of randomly set, rotating sessions. Because of logistics, the tasks included in this evaluation were not performed in a fixed sequence. Therefore, the sequence was randomized to control for fatigue bias. Because there were generally 2 patients seen in the same period, a first and second hour grouping of tasks was determined. Patients were randomized to either group. The first hour group randomly performed the neurological assessment and the neuropsychological assessment. The second hour group randomly completed the functional cognitive task and the physical/ADL tasks. All these tasks were assisted, supervised, and evaluated by interdisciplinary members of the TBI program. A 15-minute break with refreshments separated the first and second hour of testing. Following this evaluation, the experimenters scored the FIM™ instrument and the GOS-E.

1. *Neurological interview and examination:* The neurological interview focused on persistent symptoms such as headache, posttraumatic amnesia, delayed onset of seizures, episodes of loss of consciousness, use of medication, and subsequent head injuries. The neurological examination consisted of the standard mental status, cranial nerve, motor and sensory examinations, reflexes, cerebellar findings, and gait.
2. *Neuropsychological assessment:* The NBRS-R was administered by an experienced neuropsychologist to assess the various neuropsychological parameters it encompasses. Results on each subscale of this test were noted.
3. *Physical and functional tasks:* These tasks were presented by experienced physiotherapists and occupational therapists. Specific activities were designed to enable scoring of the physical FIM™ scale. These activities began with mobilizing into the testing area, transferring/sitting into an armchair, and having a snack using a utensil. If ambulatory, the patient then stood and proceeded to an adapted bathroom 20 to 25 meters away. The next activities included performing a toilet transfer, brushing teeth, and combing hair, putting on a hospital gown/shorts and a pair of slippers, transferring into the tub and simulating washing (wiping self with towel), walking up and down one flight of stairs. The patient or companion/caregiver was asked about personal toileting.
4. *Cognitive Task*: In this structured functional task, the speech-language pathologist instructed the patient to call the municipal information center to enquire about a citizen's rebate card for recreational, cultural, and entertainment activities. Each patient received standardized instructions regarding the task. They were given a 1-page phone number list as well as a written list of the information they were to ask about. The patient had 10 minutes to complete the phone call and another 10 minutes to report the information to the evaluator.

Statistical analyses

De-identified data were entered into Microsoft Excel and exported into SPSS version 14.0 (SPSS Inc., Chicago, Ill) for analyses. Univariate, bivariate, and multivariate statistical analyses were performed on the data. Independent variables were initial GCS score, age, marital status, employment at the time of trauma, premorbid history of substance abuse, psychiatric history, initial physical, cognitive, and total FIM™ ratings as well as GOS-E at discharge from acute care. Dependent variables were GOS-E at follow-up, FIM™ rating at follow-up, total NBRS-R at follow-up, return to pretrauma level of employment, return to pretrauma intimate relationships, and return to pretrauma living arrangements. Both parametric and nonparametric tests were used because the datasets are small and many of the variables were categorical or ordinal. Parametric tests included the following: paired samples *t* tests, Pearson's correlations, and ANOVA. Nonparametric tests included the following: chi-square, Mann-Whitney U, Spearman's P, McNemar test, and tests of marginal homogeneity.

Bivariate linear regression analyses were conducted to verify the predictive values of age, GCS score on admission, GOS-E score at discharge, and the total FIM™ rating at discharge on the follow-up outcomes measures (GOS-E, FIM™ instrument, and NBRS-R scores). Bivariate logistic regression analyses were performed to determine the predictive values of the GCS score on admission, GOS-E score at discharge, and the total FIM™ score at discharge on the psychosocial status at follow-up (employment, intimate relationship, living arrangements).

RESULTS

Demographic, neurological interview, and psychosocial analysis

The demographic and pretrauma characteristics of the sample are described in Table 1. Table 2 shows results of the neurological interview and Table 3 reports the difference between pretrauma and follow-up demographics and psychosocial status.

TABLE 1 *Demographic and pretrauma clinical characteristics**

Variable	N	%
Gender		
Male	36	78
Female	10	22
Right-handed		
Yes	30	88
No	4	12
Education, y		
1–6	5	11
7–13	29	66
14+	10	23
Mechanism of injury		
motor vehicle crash	17	37
CSST	2	4
IVAC	4	9
Falls	13	28
Other accidents	7	15
Attempted suicide	3	7
Previous traumatic brain injury		
Yes	4	9
No	42	91
Previous mobility status		
Independent	45	98
Cane/walker	1	2
Previous cognitive limitations		
None	43	96
Minor	1	2
Severe	1	2

*CSST indicates Commission de santé et sécurité au travail—workmen's compensation; IVAC, Indemnisation aux victimes d'actes criminels—compensation for victims of criminal acts.

TABLE 2 *Neurological status of severe traumatic brain injury patients at 2 to 5 year follow-up*

Variable	N	%
Headache		
Yes	11	30
No	26	70
Posttraumatic amnesia		
Yes	33	87
No	5	13
Seizure activity		
Yes	5	14
No	32	87
Episodes of fainting		
Yes	8	22
No	29	78
Subsequent head injury		
Yes	6	16
No	32	84
Neurological deficit		
Yes	24	67
No	12	33

Extended Glasgow Outcome Scale scores analysis

Results showed that mean GOS-E scores improved by 25% with a score of 3.43 at discharge compared with 2.63 at follow-up. Nonparametric tests showed a significant correlation between the GOS-E at discharge and at follow-up ($r = 0.685$, $P < .01$), which indicates that patients who were more severely impaired at discharge continued to be more severely impaired at least 2 years post-TBI and that those who initially scored better also did so at follow-up. In addition, ANOVA analyses revealed a significant difference between the measures ($F_{1,45} = 40.806$, $P < .01$).

FIM™ instrument analysis

There was a significant correlation between the FIM™ ratings at discharge and at follow-up ($r = 0.687$, $P < .01$) as well as a significant difference between these 2 measures ($F_{1,45} = 39.277$, $P < .005$) (See Table 4).

The t tests demonstrated a significant difference between the physical FIM™ scores ($t_{45} = 7.585$, $P < .01$) as well as the cognitive FIM™ scores ($t_{45} = 6.297$, $P < .01$) at discharge and at follow-up. Percentage of improvement measures showed an overall improvement of 60% for the total FIM™ score but the physical portion of the FIM™ scale improved to a greater extent (74%) than the cognitive part (46%). This suggests that physical abilities had recovered better than cognitive functions 2 to 5 years post-TBI (Table 4). Nonparametric analysis showed significant correlation at the 0.01 level (2-tailed tests) between discharge and follow-up scores on each subscale of the FIM™ instrument.

Neurobehavioral rating scale-revised analysis

For data analysis of the 29 items of the NBRS-R, t tests were performed on the 5-factor model. Significant differences between scores at discharge from acute care and scores at follow-up were noted for components of the intentional behavior factor ($t_{31} = -5.186$, $P < .05$), arousal state ($t_{31} = -7.772$, $P < .05$), and language factor ($t_{31} = -3.552$, $P < .05$). However, there was no significant difference for components of the emotional state and survival-oriented behavioral/emotional state factors (Table 5).

Regression analyses

Tables 6 and 7 display the results of the regression analyses described below.

TABLE 3 *Pre- and posttrauma demographic and clinical characteristics**

Variable	Frequency, pretrauma	%	Frequency at study	%
Marital status				
Married/common-law	16	35	15	33
Single	27	59	29	63
Partner, lives alone	3	7	2	4
Living status				
Alone	11	25	7	15
Supervised setting	1	2	9	20
With someone	27	61	25	54
With someone/dependents	5	11	5	11
Employment status				
Not working	7	15	31	69†
Full time	23	50	6	13†
Part time	4	9	1	2
Retired	4	9	2	4
Student	8	17	5	11
Revenue				
None	30	65	17	40†
Social assistance	6	13	6	14
Government pension	5	11	3	7
Disability	2	4	2	5
Employment insurance	1	2	2	5
SAAQ/IVAC/CSST	0	0	9	21†
Family	2	4	1	2
Combined sources	0	0	2	5
Legal issues				
Yes	8	17	9	20
No	38	83	36	80
Psychiatric issues				
Yes	12	26	23	52†
No	34	74	21	48
Alcohol use				
Yes	15	33	10	23
No	31	67	33	77
Drug use				
Yes	6	13	5	12
No	40	87	38	88

*SAAQ indicates Société d'assurance automobile du Québec—compensation from auto insurance board; IVAC, Indemnisation aux victimes d'actes criminels—compensation for victims of criminal acts; CSST indicates Commission de santé et sécurité au travail—workmen's compensation.
†denotes significance at the $P \leq .01$ level.

Extended GOS

A linear regression was performed to assess if patient age predicted GOS-E at follow-up (2 to 5 years postinjury). This variable significantly predicted the GOS-E at follow-up ($R^2 = 0.28$ [SE = 1.03], $F_{45} = 18.44$, $P < .01$). The GOS-E at discharge was a significant predictor of the GOS-E at follow-up ($R^2 = 0.47$ [SE = 0.89], $F_{45} = 40.81$, $P < .01$). The FIM™ score at discharge was a significant predictor of GOS-E at follow-up ($R^2 = 0.33$ [SE = 0.998], $F_{45} = 22.93$, $P < .01$). However, the GCS

TABLE 4 *Means of the total, physical and cognitive FIM™ scores*

Variables	Raw scores at discharge	Raw scores at follow-up (2–5 y)	Improvement, %
Total FIM™ score	74.09 (SD = 32.11)	100.1 (SD = 32.58)	60
FIM™ score, physical	55.92 (SD = 27.29)	75.67 (SD = 26.51)	74
FIM™ score, cognitive	18.17 (SD = 7.17)	24.48 (SD = 7.03)	46

TABLE 5 *Neurobehavioral Rating Scale—Revised scores at discharge and at 2 to 5 year follow-up**

Variable	Raw scores at discharge	Raw scores at follow-up (2–5 y)	Improvement, %
NBRS-R intentional	2.42 (SD = 0.79)	1.78 (SD = 0.74)	45
NBRS-R emotional	1.61 (SD = 0.53)	1.64 (SD = 0.67)	14
NBRS-R survival	1.35 (SD = 0.38)	1.28 (SD = 0.28)	5.3
NBRS-R arousal	2.36 (SD = 0.54)	1.60 (SD = 0.54)	59.4
NBRS-R language	1.87 (SD = 0.67)	1.57 (SD = 0.83)	33

*NBRS-R indicates Neurobehavioral Rating Scale—Revised.

score was not a significant predictor of the GOS-E at follow-up.

FIM™ instrument

Linear regression analysis showed that age was a significant predictor of the FIM™ rating at follow-up ($R^2 = 0.34$ [SE = 26.5], $F_{45} = 23.76$, $P < .01$). The GOS-E at discharge was a significant predictor of the FIM™ rating at follow-up ($R^2 = 0.52$ [SE = 22.5], $F_{45} = 50.2$, $P < .01$). The FIM™ rating at discharge was a significant predictor of the FIM™ score at follow-up ($R^2 = 0.46$ [SE = 23.96], $F_{45} = 39.28$, $P < .01$). The GCS score was not a significant predictor of the FIM™ score at follow-up.

NBRS-R

Linear regression analyses demonstrated that the initial GCS score was a significant predictor of the NBRS-R at follow-up ($R^2 = 0.12$ [SE = 2.04], $F_{35} = 5.68$, $P < .05$). The GOS-E at discharge was a significant predictor of the total NBRS-R at follow-up ($R^2 = 0.42$ [SE = 1.65], $F_{35} = 26.79$, $P < .01$) as was the FIM™ rating at discharge ($R^2 = 0.14$ [SE = 2.02], $F_{35} = 6.49$, $P < .05$), whereas age was not.

Psychosocial status

Logistic regression analysis revealed that neither the GCS, the GOS-E at discharge, nor the total FIM™ score at discharge were significant predictors for return to pretrauma level of employment, marital status posttrauma or return to pretrauma living arrangements. Results are displayed in Table 7.

DISCUSSION

The results of the present study show that patients with sTBI 2 to 5 years postinjury can be expected to present with higher functional independence and better participation in social, vocational, and physical activities of their daily life compared with their functioning at discharge from acute care. However, those who were

TABLE 6 *Linear regression analyses**

Independent variable	Dependant variable	β	*t*	*P*	R^2
Age	*GOS-E F/U*	*.54*	*4.3*	*.00*	*0.28*
GCS	GOS-E F/U	−.11	−1	.32	0.00
GOS-E D/C	*GOS-E F/U*	*.69*	*6.4*	*.00*	*0.47*
FIM™ D/C	*GOS-E F/U*	*−.59*	*−4.79*	*.00*	*0.33*
Age	*FIM™ F/U*	*−.59*	*−4.9*	*.00*	*0.34*
GCS	FIM™ F/U	.13	0.83	.41	0.00
GOS-E D/C	*FIM™ F/U*	*−.73*	*−7.1*	*.00*	*0.52*
FIM™ D/C	*FIM™ F/U*	*.69*	*6.3*	*.00*	*0.46*
Age	NBRS-R F/U	.03	0.18	.85	0.00
GCS	*NBRS-R F/U*	*−.38*	*−2.38*	*.02*	*0.12*
GOS-E D/C	*NBRS-R F/U*	*.66*	*5.17*	*.00*	*0.42*
FIM™ D/C	*NBRS-R F/U*	*−.4*	*−2.55*	*.02*	*0.14*

*Italic font indicates significance at the $P < .05$ level.
D/C indicates discharge; GCS, Glasgow Coma Scale; GOS-E, Extended Glasgow Outcome Scale; FIM™, FIM™ instrument; F/U, follow-up; NBRS-R, Neurobehavioral Rating Scale—Revised.

TABLE 7 *Logistic regression analyses**

Independent variable	Dependant variable	B (SE)	Wald df	*P*	Cox & Snell R^2
GCS	return to employment	0.25 (0.16)	2.4 (1)	.12	0.05
GCS	intimate relationships	0.19 (0.28)	.49 (1)	.49	0.01
GCS	living arrangements	0.14 (0.17)	.67 (1)	.41	0.02
GOS-E D/C	return to employment	0.04 (0.33)	.02 (1)	.90	0.00
GOS-E D/C	intimate relationships	0.56 (0.53)	1.2 (1)	.28	0.03
GOS-E D/C	living arrangements	0.51 (0.37)	1.9 (1)	.17	0.04
FIM™ D/C	return to employment	0.00 (0.01)	.03 (1)	.86	0.00
FIM™ D/C	intimate relationships	0.02 (0.01)	1.0 (1)	.31	0.02
FIM™ D/C	living arrangements	0.01 (0.01)	.30 (1)	.58	0.01

*D/C indicates discharge; GCS, Glasgow Coma Scale; GOS-E, Extended Glasgow Outcome Scale; FIM™, FIM™ instrument.

more dependent at discharge (±20 days postaccident) had a greater chance of presenting with a higher level of dependence and more limitations 2 to 5 years postaccident. Moreover, participants were more independent in their physical and functional skills than in their cognitive skills. In addition, despite a significant improvement at follow-up, they were more likely to present social interaction, problem solving, memory as well as oral expression and comprehension deficits. Those with worse cognitive skills at discharge had a greater chance of greater cognitive dependence at follow-up. Although improvement was noted in cognition and language, no significant difference was observed in emotional state and behavior.

The predictive results in this study were similar to those found in other investigations[17,19] and confirm that long-term prediction of global, functional, and neurobehavioral status can be based on what is observed at discharge from the acute care setting (± 20 days). The discharge data did not however predict psychosocial status. This may have been because of an insufficient number of participants and/or variability in each group. On the other hand, other unidentified factors including life experiences more than the 2- to 5-year period may have had more influence on long-term psychosocial status than level of independence a few weeks after sTBI.

Surprisingly, and contrary to reports in the literature,[3,6] the results of this study showed no difference in marital status and living arrangement nor in alcohol/drug intake or legal issues, pre- and post-TBI. Other investigations have shown that after a sTBI, patients abuse alcohol and drugs[24,25] and are more likely to have an arrest history[26] because of impulsivity and an increase in violence and aggressive behavior.[27,28] The difference in this study may be because of several factors. Firstly, patients were required to come into a testing milieu, which may have been intimidating for some. In fact, Corrigan and colleagues[29] found that patients with a history of substance abuse were less likely to participate in follow-up studies. It is therefore possible that patients with legal and substance abuse problems could have been more representative of the nonparticipant group that were unreachable or refused to participate in the study. Secondly, several patients were placed in a supervised setting, which discouraged legal or substance abuse problems. We can, thus, only conclude that the participants in this study had not developed more of these problems after their injuries.

As reported in other studies, many of our patients lost their pretrauma level of employment or were not able to work full time.[2] At follow-up, they were more likely to be receiving compensation from governmental agencies (Societe de l'Assurance Automobile du Québec, [SAAQ]–automobile insurance; Commission de la santé et de la sécurité du travail du Québec [CSST]–workmen's compensation; Indemnisation aux victimes d'actes criminels [IVAQ]–insurance related to criminal acts) or to have no income. Taking this into account, these patients post-sTBI would therefore be at more risk of presenting socioeconomical problems influencing their reintegration into the community or causing them to develop other psychosocial problems. They would also be at risk for loss of identity and poor self-esteem because of the changes in their work status and their role in the community. This in turn could cause them to become psychologically vulnerable and more likely to develop psychiatric complications. In fact, 52% of the cohort studied suffered from depression and anxiety disorders 2 to 5 years postaccident. Although patients with sTBI may not require multidisciplinary intervention in a rehabilitation setting on a long-term basis, recommendations based on the above results would be to provide psychological support services to this population not only on a short term basis but also for up to at least 2 years, according to their needs. This intervention could possibly lead to a decrease in the psychological and psychiatric distress of patients and indirectly support families by preventing burden of care.

Beyond the objective measurements of outcome obtained, this study was unique in bringing persons having suffered sTBI into an interdisciplinary assessment many years after injury. This interdisciplinary approach focused on viewing the patient as a global entity and allowed for a comprehensive assessment of various domains of functioning in the daily lives of the patient post-sTBI. Patients and their families responded positively and appeared grateful that their evolution was of interest to the acute care team and pleased that they could contribute to scientific research. In addition, direct patient contact may have enhanced performance because rapport was easily established. This was also an educational and enriching experience for the interdisciplinary professionals to be directly involved in a research project as well as to see the improvement in these patients who presented with severe impairments and disabilities at discharge. It allowed the team to view firsthand which skill domains eventually reach normalcy and which do not in the population with sTBI. This experience will potentially help each interdisciplinary professional and the team as a whole to better understand recovery post-sTBI and could influence their decision making regarding discharge disposition and potential for rehabilitation as well as patient and family counseling during the acute care phase on the basis of objective data.

In conclusion, the results of the present study confirm previous evidence in the TBI field. These results were obtained in a Canadian population in a context of a universal healthcare system from emergency treatment to postrehabilitation. All of these patients received the same services based only on their needs and their recovery potential with no financial considerations. The goal of a comprehensive evaluation of outcome in different domains was achieved by the use of an interdisciplinary team of health professionals specialized in TBI. Finally, this was a representative sample of patients with sTBI because it included not only those who made sufficient progress to benefit from rehabilitation but also those who required long-term care placement.

Limitations of this study should be mentioned however. First, because of an insufficient number of patients who were 2 years post-TBI, it was necessary to recruit subjects from the TBI data bank, who were past 2 years posttrauma, to obtain an adequate number for appropriate statistical power in the data analysis. Despite the fact that no difference was noted between patients assessed at 2, 3, 4, or 5 years post-TBI on all of the outcome measures, it is difficult to make comparisons with other research in the field because of the time span. A multicenter analysis would be one way of solving this problem (more patients available in a shorter period of time) and would also allow for generalization of the results, which cannot be done with this single site study. Moreover, although the study was prospective, patients were recruited retrospectively and the choice of validated measures was thus, limited to those used at the time of acute care admission to compare measures at discharge and at follow-up. Because of this, several objective, physical and cognitive tests could not be used. Despite these limitations, the information from this study will help clinicians, health administrators, insurance companies as well as families who seek to organize efficient care and to plan long-term services for patients with sTBI. Families will benefit, in particular, by being aware of the possible long-term needs allowing them to prepare for any possible adjustments required by their loved ones.

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