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Is Cognitive Performance Related to Level of Community Integration Many Years after Traumatic Brain Injury?

Angela Colantonio, Graham Ratcliff, Sue Chase, and Michael Escobar

University of Toronto; and Healthsouth Harmarville Rehabilitation Centre

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The aim of this study was to investigate the association between measures of cognition and level of community integration 7 to 24 years after moderate/severe traumatic brain injury (TBI). Subjects were recruited from in-patient health records of a large rehabilitation hospital in Pennsylvania. Eligible subjects were traced and then invited to participate in a face-to-face interview which included the Community Integration Scale (CIQ), and cognitive tests such as Trails A & B, the Rivermead Story Recall subtest, and the Neurobehavioral Cognitive Status Exam (NCSE). Linear regression analyses on 207 subjects showed that Trails A, Trails B, and story recall measure were significantly associated with CIQ scores ($p < .0005$) controlling for age and education. Results with other cognitive measures are discussed.

Rationale

There is a paucity of data showing the relationship between measures of cognition and measures of community integration among persons after traumatic brain injury (TBI). The aim of this study was to examine this relationship in a large sample of TBI survivors 7 to 24 years after moderate to severe brain injury.

Methodology

This study utilized a retrospective cohort design. Participants were identified from in-patient health records of a large rehabilitation hospital in Pennsylvania. These records were abstracted for sociodemographic and health data. Eligible subjects discharged from 1973 to 1989 were then traced and invited by letter to participate in a face-to-face interview. The interview included a cognitive screening battery including measures such as Trails A & B, the Story Recall Subtest of the Rivermead Behavioral Memory Test (RBMT), and the Neurobehavioral Cognitive Status Exam (NCSE). In addition, the Community Integration Questionnaire (CIQ), was administered.

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This is a measure developed by Willer and colleagues (1993) to assess the level of handicap for persons after TBI. Linear regression analyses were conducted to assess the independent influence of the cognitive measures on CIQ scores controlling for age and education.

Subjects. We report on the results of 207 participants in the study to date. All subjects had a moderate to severe TBI. The age of subjects ranged from 23 to 84 years of age with a mean age of 44.4 (*SD* 12.7). The mean follow-up period was 16.3 years (*SD* 4.0). The median years of education at follow-up was 12.

Results

Linear regression analyses showed that both Trails A and B were significantly associated with CIQ scores ($p < .001$) controlling for age and education. When both Trails A and Trails B were placed in the model, only Trails B retained significance ($p < .001$) indicating that of the two, it was the more powerful predictor. In addition, both immediate ($p < .005$) and delayed story recall ($p < .001$) of the RBMT were significantly associated with the CIQ. However, of the 8 NCSE subitems, only judgement scores were significantly associated with community integration ($p < .05$).

Conclusion

Previously it has been difficult to demonstrate strong relationships between performance on standard neuropsychological tests and everyday functional activities such as those required for community integration. These findings show that certain measures of cognition are strongly associated with the degree to which persons with head injury are integrated in the community. Trails A, Trails B, and the RBMT story recall subtest were the strongest predictors controlling for age and education. Overall, the subscales of the NCSE were not significantly associated with the CIQ with the exception of the subtest of ‘‘judgement.’’ This measure, therefore, may not be sensitive enough to discriminate level of community integration.

ACKNOWLEDGMENTS

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Cognitive, Emotional, and Behavioral Problems Associated with Traumatic Brain Injury: A Concept Map of Patient, Family, and Provider Perspectives

K. Z. Donnelly, J. P. Donnelly, and K. J. Grohman

Louisiana State University, Baton Rouge; V.A. Western New York Healthcare System, Buffalo, NY; Matrix Inc., Baton Rouge

The purpose of this study was to elicit an exhaustive list of problems associated with TBI, as characterized by the patient, significant others, and health care providers, to identify the underlying structure from the expert perspective, and to evaluate severity and frequency of the symptoms. Forty-seven participants generated a list of 174 discrete problems. These items were then sorted and rated for severity and frequency by a panel of six neuropsychologists. Concept mapping yielded a best-fit map of eight content clusters to characterize these symptoms. The clusters included independence, intimacy, treatment complications, executive functioning, nonexecutive cognitive functions, mood, and psychotic symptoms. Intimacy and treatment complications were rated as the most severe problems, with treatment complications and executive functioning rated as the most frequent.

While traumatic brain injury (TBI) is the most common cause of brain damage, relatively little attention is given to the ‘‘secondary’’ sequelae of this disorder. Primary medical and cognitive consequences have been well researched in survivors who recover to the point of functionality (Lezak, 1995), yet there are often more subtle behavioral disturbances following TBI that change the patients’ lives most dramatically.

A few researchers have evaluated these long-term sequelae from the patient’s and the family’s perspectives (e.g., van Zomeren and van den Burg, 1985; Hinkeldey & Corrigan, 1990) and have suggested two- and three-factor models of postinjury deficits, focused on general complaints, severity, and somatization. Bennett and Raymond (1997) identified three types of symptoms, as reported by mild TBI patients, to include physical, cognitive, and emotional problems.

Our study extended this concept to include primary providers’ (physicians, psychologists, occupational therapists) perspectives on their patients’ functioning and symptomatology, in addition to the input of the patients themselves and their significant others. Our purpose was (1) to elicit an exhaustive list of problems associated with TBI as characterized by the patient, significant others, and pertinent health care providers, (2) to identify the underlying nomological structure from the expert perspective, and (3) to evaluate severity and frequency of the symptoms.

Method

Subjects. Patients were identified from the Neuropsychology Clinic data base at a VA Medical Center. Forty-five individuals were sent recruitment materials, 20 completed the study. Nineteen were males; the subjects ranged in age from 20 to 76 ($M = 45.6$ years). All carried a primary diagnosis of TBI and had sustained the injury at least one year prior to the study.

Significant others were solicited through each patient completing the study. These subjects, aged 16 years and older, male and female, either lived with the patient or had contact with him or her several times per week. Usable data were obtained from eight family members, including three parents, four siblings, and one girlfriend.

Providers who regularly work with head injured patients were asked to participate in the study. All worked in university-affiliated medical settings. Of the 42 solicitations sent, 19 completed the study, including 16 psychologists (10 of whom were neuropsychologists), one neurologist, one psychiatrist, and one occupational therapist.

Procedure. 1) *Item Generation:* Upon giving written consent, patients and significant others were interviewed either in person or over the telephone. The interviews were conducted by a licensed neuropsychologist or a doctoral level psychology research assistant. Participants were asked to identify all of the problems they had encountered associated with the head injury. Questioning was as open-ended as possible, but prompts were given as needed (e.g., asked about changes in thinking, emotions, behavior) to elicit as many responses as possible. Interviews typically lasted 20 to 30 min, and patients and family members were paid $10.00 each for their participation.

Provider participants completed the study by mail, listing all of the problems they had observed in working with TBI patients on the form provided. Providers were not paid for their participation.

Of the 210 items originally identified by all 47 participants, 36 were deleted because of redundancy, leaving a pool of 174 items for sorting and rating.

2) *Item Sorting and Rating:* Six neuropsychologists (of the 10 who completed the item-generation phase) were selected for their significant experience and expertise in the treatment of patients with TBI. These clinicians completed a free-response sort with the following instruction: ‘‘Please sort the items into as many piles as you see fit and meaningful. Then label each pile with a post-it note and fasten the pile with a rubber band.’’ Each item was then rated on a one-to-five scale on the dimensions of severity and frequency of occurrence.

Analysis. Data were analyzed using The Concept System, Version 1.74. Concept mapping involves a sequence of multivariate analyses beginning with a two-dimensional multidimensional scaling analysis. In the present study, a final MDS stress value of .27845 was obtained, within the range

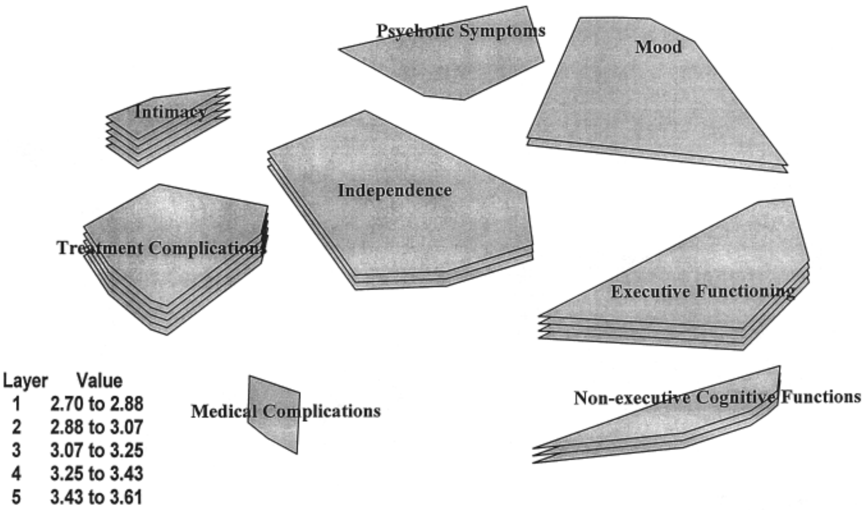

FIG. 4. Concept map of TBI problems with symptom severity ratings.

of acceptability described by Trochim (1989). Once the MDS solution was obtained, the *X–Y* data identifying each of the items in two-dimensional space were submitted to cluster analysis. The cluster analysis proceeded with iterative examination beginning with a 20-cluster solution and followed with successively fewer cluster solutions until an optimal map was obtained. Each candidate solution was examined on the basis of both statistical indices and interpretability. The final solution was the eight cluster map shown (with symptom severity ratings overlaid) in Fig. 4.

Results

The concept map in Fig. 4 was determined to be the optimal solution because the bridging values for the clusters were relatively low, indicating strong internal consistency of the items. In addition, the items comprising each cluster formed readily identifiable sets of TBI problems. The number of items per cluster ranged from 12 in the intimacy cluster to 40 in the mood cluster. Example items in the intimacy cluster included ‘‘unable to maintain a relationship with a significant other’’ and ‘‘divorce.’’ The treatment complications cluster included such items as ‘‘unrealistic about abilities’’ and ‘‘impaired awareness of cognitive deficits.’’ The medical complications cluster included ‘‘seizures,’’ ‘‘less physically fit,’’ and 20 other items. The cluster titled psychotic symptoms included ‘‘delusional’’ and ‘‘dangerous,’’ among 12 others. The large cluster called mood included ‘‘nervous,’’ ‘‘emotional lability,’’ and 38 others. Two neuropsychological clusters emerged discriminating between executive and other cognitive functions. The executive functions included ''inability to organize tasks'' and ''difficulty with sequencing,'' as well as 15 other problems. The nonexecutive functions included ''poor retrieval'' and ''attentional variability'' in addition to 32 others which spanned memory, concentration, language, and spatial deficits. The cluster at the center of the map was ''independence,'' which is significant not only for its central position, but also because the items represent maturity and core personal functioning. The independence cluster included such items as ''childlike responses'' and ''loss of long term goals.'' Altogether, there were 20 items in this cluster.

Figure 4 also displays the symptom severity ratings endorsed by the neuropsychologists who participated in the study. The number of layers on each cluster corresponds to increasing severity of symptoms. The clusters with the relatively greatest severity were intimacy and treatment complications, with mean ratings of 3.49 and 3.61, respectively. It is interesting to note that both of these clusters represent primarily interactive functioning. It is notable, if not unexpected, that the executive functioning cluster was rated as more severe in this population than the nonexecutive cognitive cluster. In a less intuitive fashion, the clusters representing medical complications and psychotic symptoms were rated as relatively less severe than the others.

The raters also judged each item as to frequency of occurrence in the population. These ratings, not shown in the figure, were highly correlated with the symptom severity ratings ($r = .94$).

Discussion

Previous understanding of the complexity of problems following TBI has most often been limited to two or three factors, typically solely from the perspective of the patient. Nonetheless, the nuances of social relationships, including those with family, significant others, and treatment providers, suggest the need to take those perspectives into account as well when producing a comprehensive description of the post-TBI experience. Our study produced an exhaustive list of problem areas from these three groups of stakeholders. Their problem identification resulted in 174 discrete items. From these items, we developed an eight cluster model via multivariate statistics. The clusters of independence, intimacy, treatment complications, medical complications, executive functioning, nonexecutive cognitive functioning, mood, and psychotic symptoms emerged as both statistically and conceptually sound in their representation of this syndrome. The neuropsychologists' severity and frequency ratings added texture and enhanced meaning to these clusters, resulting in valuable information for both theory generation and practical applications.

The primacy of executive functioning relative to other cognitive abilities, the distinctions between intimate and other types of social relationships, and the differential between mood and psychotic symptoms as outlined in the map enrich our previous understanding of these problems. Simpler two- or three-factor models described before lacked the depth of the current model. These eight clusters show potential to better individualize the profiles of TBI patients. Our next task will focus on constructing an instrument based on this model, with future plans for targeted interventions and their evaluation.

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Predicting Vocational and Independence Status from Early Assessment of Motor, Cognitive, and Social Abilities in Traumatic Brain Injury Patients

Brigitte Stemmer, Brigitta Gahl, Sieglinde Lacher, and Paul Walter Schoenle

Lurija Institute of Health and Rehabilitation Sciences, University of Konstanz, Kliniken Schmieder, Allensbach, Germany; and Centre de Recherche, Institut universitaire de geriatrie de Montreal, Montreal, Canada

Motor, cognitive, social, demographic, and lesion site data were obtained from traumatic brain injury (TBI) and stroke patients at the time of first admission (between 35 and 43 days post brain damage) to inpatient neurological rehabilitation. The relationship between these data and outcome measures (defined as ‘‘basic’’ independence, ‘‘complex’’ independence, employment status) was investigated. In TBI patients, employment was best predicted by drive, processing speed, and attention, ‘‘basic’’ independence by processing speed and drive, and ‘‘complex’’ independence by drive alone. Brain stem lesions also proved to be strongly related to independence measures and employment status. For stroke patients, no variable predicted employment. Motor function was weakly related to ‘‘basic’’ independence measures, and the ability to establish contact strongly predicted ‘‘complex’’ independence measure.

Introduction

Rehabilitation services are expected to provide plausible prognoses about outcome for groups of neurological patients that are characterized by their heterogeneity. Numerous studies have related demographic variables (age, sex, educational attainment) or injury related variables (quality and length of coma, length of posttraumatic amnesia) to outcome measures (for summary see Macniven, 1994), and few studies have focused on the relationship between cognitive abilities and outcome measures. The results reported are not always consistent across studies. Rarely has the cognitive assessment been comprehensive and no study has focused on the predictive value of early assessment of these functions. The purpose of our investigation was to examine the relationship of motor, cognitive, and social abilities to outcome measures in traumatic brain injury patients early in the rehabilitation process using a comprehensive assessment battery.

Methods

Subjects

The subjects included 35 traumatic brain injury patients admitted to neurological rehabilitation on average 35 days postinjury ($SD = 21.4$). Their age was between 17 and 55 years ($SD = 10.9$), 32 males and 3 females, premorbid educational attainment was on average 10.6 years ($SD = 5.9$). Individuals with the diagnosis vegetative state, with prior neurological or psychiatric disorders, or substance abuse were excluded from the study. At the time of the injury all subjects were employed. Control patients were 42 individuals, 31 males and 11 females, with a first time cerebro-vascular disease (stroke) who were admitted to neurological rehabilitation on average 42 days ($SD = 24$) poststroke. Their age ranged between 22 and 52 years ($SD = 6.9$). All stroke patients were employed at the time of stroke. Exclusion criteria were similar to those of the TBI patients.

Material

Predictor variables. The functional assessment included 13 items from the Functional Independence Measure (FIM) evaluating motor abilities, 2 items evaluating social abilities (social contact, taking the initiative), and 11 items evaluating cognitive abilities. The 11 cognitive items were extrapolated from a total of 50 standardized neuropsychological tests/subtests and comprised of 4 basic (drive, attention, orientation, memory) and 6 complex cognitive abilities (language, gnostic and visual functions, praxia, arithmetics, higher cognitive functions, problem solving, control mechanisms). In addition to the functional assessment variables, demographic variables (age, sex, premorbid educational level) and site of lesion (hemispheres, brainstem, cerebellum, hemispheres + brainstem, brainstem + hemispheres) were considered.

Outcome variables. The dependent variables were employment situation and independence measures. Independence measures subsumed four basic activities (motility, hygiene, eating, and drinking, speed with which these activities were accomplished) and four complex activities (housework, organization skills, finances, spare time). In addition, demographic variables and lesion site were included. Procedure Motor, cognitive and social abilities were assessed in all patients within five days of admission to neurological rehabilitation. On average one and a half years postinjury each patient was interviewed either personally or by telephone and a questionnaire was filled out from which the outcome variables were extrapolated. Analysis Multiple linear regression analyses were conducted to test for predictability of outcome. A regression coefficient was considered significant at the 95% confidence level.

Results

Functional Assessment Variables

In a first step, the TBI and stroke group was not separated and demographic variables, number of lesion sites, motor ability, social ability, and cognitive ability (grouped as basic and complex cognitive abilities) were entered as independent variables. Employment status was predicted best by age, basic cognitive abilities, and the ability to establish contact. Age was also a significant predictor for basic independence measures. In a second step, TBI and stroke patients were investigated separately. A multiple linear regression analysis was first performed with cognitive functions grouped in two categories and then repeated with cognitive functions specified as 11 subcategories. Including these predictors improved accuracy of prediction in the TBI group as well as in the stroke group (TBI group: increase of variance by 17% for basic independence measures, by 11% for complex independence measures, and by 32% for employment status; stroke group: increase of variance by 19% for basic independence measures, by 15% for complex independence measures, and by 14% for employment status). Concerning individual predictor variables, drive and attention were significant predictors of employment status with TBI patients. Drive also predicted basic and complex independence. With stroke patients, however, outcome was not predicted by any cognitive ability. Motor function was a weak predictor for basic independence measures, and the ability to establish contact was a strong predictor for complex independence measures. (See Table 1). As attention proved to be a strong predictor for employment status in TBI patients, a regression analysis was performed introducing components of attention (processing speed, sustained attention, and combined selected and divided attention). Accuracy of prediction was improved by an increase of variance

TABLE 1
Summary of Significant Results: Relationship of Predictor Variables and Outcome Measures

Predictor variables	Outcome variables	Correlation	Significance	*R* square
All patients				
Age	Employment	−0.0413	0.0115	0.3948
Basic cognitive abilities	Employment	0.4971	0.0321	0.3948
Ability to establish contact	Employment	0.9080	0.0111	0.3948
Age	Basic independence	−0.0439	0.0030	0.3730
TBI patients				
Drive	Employment	1.9675	0.0111	0.7030
Processing speed	Employment	1.4611	0.0138	0.7822
Attention	Employment	2.4575	0.0126	0.7130
Processing speed	Basic independence	1.3860	0.0058	0.7130
Drive	Basic independence	1.5262	0.0412	0.4264
Drive	Complex independence	3.2698	0.0252	0.5990
Brain stem	Basic independence	−1.4943	0.0414	0.4523
Brain stem	Complex independence	−4.2382	0.0112	0.4801
Brain stem	Employment	−1.8560	0.0414	0.5576
Stroke patients				
Motor function	Basic independence	0.0460	0.0325	0.2623
Ability to establish contact	Complex independence	2.4409	0.0327	0.4426

of 28%; no increase of variance occurred in the stroke group. Processing speed proved to be a significant predictor for basic independent measures and employment.

Demographic Variables

Of the demographic variables included in the analysis, only age was significantly related to outcome in all patients investigated.

Lesion Site Variables

In the TBI group brain stem lesions were significantly related to independence and employment outcome. No relationship was found between other lesion sites and outcome. Lesion site did not predict outcome for the stroke patients.

Summary and Discussion

Functional assessment and demographic and lesion site data were collected from a group of brain-damaged patients at the time of first admission to and discharge from a neurological inpatient rehabilitation hospital. The relationship between these data and outcome measures (basic independence, complex independence, employment status) was investigated. For all patients investigated, employment status one and a half years post brain damage was best predicted by age, basic cognitive abilities (drive, attention, memory, orientation), and the ability to establish contact. Different predictor variables were identified for stroke patients and for TBI patients. In TBI patients, employment was best predicted by drive, processing speed, and attention, basic independence by drive and processing speed, and complex independence by drive alone. Brain stem lesions also proved to be strongly related to independence measures and employment status. This was true only for TBI patients suggesting that the brain stem lesion was responsible for reduced drive. For stroke patients, no variable predicted employment. Motor function was weakly related to basic independence measures, and the ability to establish contact strongly predicted complex independence measures.

Our findings do not support Finch et al.'s (1997) conclusion that higher level cognitive abilities, specifically representational thinking, can be used as a prognostic tool at time of admission to rehabilitation. The main reason for this discrepancy is Finch et al.'s neglect to include measures for drive, processing speed, or attention components. Our study does, however, corroborate a study by Girard et al. (1996) who reported that the patients' speed of information processing, memory skills, and simultaneous processing abilities were positively related to outcome in terms of level of independence. In addition, our study showed that although patients were assessed very early in the rehabilitation process, a relationship between elements of the functional assessment battery and outcome could already be established. TBI patients and stroke patients develop differently during neurological rehabilitation, and this was reflected also in the different predictor variables that were related to different outcome measures in both patient groups. The only demographic variable that has been shown in various studies to be related to outcome was age. However, age was only a predictor for all patients but not for each patient group investigated.

Finally, a word of caution is warranted. We have only investigated a relatively small patient sample and the time window for which outcome has been predicted was approximately one and a half years postinjury. This is probably too short for most patients to reach vocational and social stability. Concerning the predictive power of our analyses, it must be realized that the model accounts for only 15 to 27% of variance when all patients were considered, and for 26 to 49% when patients were separated into a TBI and a stroke group. In cases of low variance the question is what accounts for the remainder of the variance? In cases of higher variance it seemed that it was the collective number of variables rather than few individual variables that influenced outcome, and a final question that remains unsolved is whether our findings also pertain to predictions in individual patients.

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Early Prediction of Neuropsychological Deficits and Global Outcome during the Acute Phase of Treatment Following Traumatic Brain Injury

S. Caillé, É. Deguise, M. Feyz, P. Hardy, and S. L. Richard

Psychology Department, Montreal General Hospital

The goals of this study are to explore the existing relation between results of cerebral imagery, initial GCS, the severity of neuropsychological deficits measured within the first week following TBI, and the global functional outcome upon discharge from the primary care hospital. Results showed a significant interaction between results of cerebral imagery and GCS on the severity of neuropsychological deficits. For the moderate to severe TBI patients only, the presence of a visible traumatic abnormality on the scan is associated with more important neuropsychological difficulties. Furthermore, the correlation between neuropsychological deficits and short-term global outcome is highly significant. These results provide clinicians with information that will help them intervene more rapidly and appropriately with TBI patients and plan rehabilitation in a more efficient way.

Introduction

Early prediction of disabilities and outcome is a crucial matter for clinicians treating patients who have sustained traumatic brain injury (TBI). In the literature, many studies have dealt with the prediction of functional, behavioral, and cognitive outcome following a period of time ranging from six months to many years after the TBI. In these studies, it has been shown that age, initial Glasgow Coma Scale (GCS), duration of coma, and duration of post traumatic amnesia are related to functional outcome of TBI patients (Asikainen, Kaste, & Sarna, 1998; Ellenberg, Levin, & Saydjari, 1996).

Recently, early rehabilitation programs for TBI patients have been implemented in trauma centers. Little data is available about the factors associated with disabilities and outcome during the first days or weeks following the accident. However, there is no doubt that this type of analysis should provide clinicians and interdisciplinary teams involved in the early evaluation and treatment of brain-injured patients with very useful guidelines.

The first goal of this study was precisely to explore the existing relationship between early factors (results of cerebral imagery, initial GCS) and the severity of neuropsychological deficits presented by the patients within the first week following the accident. Furthermore, we wanted to evaluate the relationship between these neuropsychological deficits and the functional global outcome upon discharge from the primary care hospital.

Subjects and Methods

Subjects. Fifty-two adult patients were included in this study (aged 17 to 76 years). They were all admitted in our establishment (a level one trauma center) following an accident and had received a diagnosis of TBI. At least one of the following criteria had to be documented after the accident for this diagnosis to be made: a loss or alteration of consciousness (disorientation, confusion, etc.), an amnesia of events preceding or following the impact, any neurological sign (transient or permanent). Exclusion criteria were premorbid history of psychiatric or neurological disorder, history of drug or alcohol abuse, and alcohol or drug intoxication upon admission.

Data collection. The lowest Glasgow Coma Scale score (GCS) recorded and the results of the cerebral imagery were gathered by reviewing the patients chart. For the GCS, patients were divided into two groups (mild TBI: GCS of 13 or higher and moderate to severe TBI: GCS of 12 or lower). For the results of cerebral imagery, patients were also divided into two groups (absence or presence of any traumatic abnormality visible on the cerebral CT-scan).

Neuropsychological deficits were measured within the first week following the accident via a semistructured interview with the patient, using the Neurobehavioral Rating Scale (NRS) (Levin, High, Goethe, et al., 1987). In addition, when possible, a brief cognitive battery was administered, covering pertinent areas of cognition (abstract thinking, long-term memory and learning abilities, attention and concentration, lexical access, constructional and planning abilities, word fluency, mental flexibility, visuo-graphic integration).

This evaluation enabled the clinician to rate each patient on the neurobehavioral and cognitive variables of the NRS (vigilance, hyperactivity/agitation, disorientation, attention, verbal expression and comprehension, memory, slowness, judgment, lability, irritability, disinhibition, concept organization, mental flexibility, planning, and mental fatiguability). For each variable, the deficit was quoted as absent (0), mild (1), moderate (2), or severe (3). A global NRS score was calculated by summing the 16 individual

TABLE 2
Number of Patients (*N*), Mean and Standard Deviation (in Parentheses) for the Cognitive FIM, the NRS, and the GOS Scores, According to GCS and Results of Cerebral Imagery

GCS	Results of cerebral imagery	*N*	NRS	Cognitive FIM	GOS
13 and higher (mild TBI)	Negative[a]	16	3.88 (3.74)	33.56 (1.90)	1.98 (0.77)
	Positive[b]	17	4.94 (4.75)	32.24 (4.12)	1.94 (0.83)
12 and lower (moderate	Negative	10	3.30 (2.31)	32.90 (2.23)	2.50 (0.85)
to severe TBI)	Positive	9	10.33 (6.00)	25.89 (6.43)	3.33 (0.71)

Note. A higher NRS score indicates more severe neuropsychological deficits, while a lower cognitive FIM score indicates more severe neuropsychological deficits.
[a] Absence of traumatic abnormality on the cerebral CT-scan.
[b] Presence of cerebral abnormality on the cerebral CT-scan.

scores. This score potentially varied from 0 to 48, a higher score indicating more severe deficits.

Furthermore, each patient was rated on the five cognition/communication variables of the Functional Independence Measure (FIM) (Research Foundation—State University of New York, 1990) (expression, comprehension, memory, social interaction, and problem solving). For these variables, a score ranging from 1 to 7 is given (1 = complete dependence, 7 = complete independence). A global cognitive FIM score was calculated by summing the five individual scores. This score potentially varied from 7 to 35, a lower score indicating more severe deficits.

Finally, the short term global functional outcome was measured using the Glasgow Outcome Scale score (GOS) (Jennet & Teasdale, 1981) It represented an interdisciplinary team decision made upon discharge of the patient from the primary care hospital. This score varies from 0 to 6, a higher score indicating poorer global functional outcome.

Results

Data analysis. Separated two-way analysis of variance (2 × 2 ANOVAs) were performed on the NRS and cognitive FIM scores, with GCS and results of cerebral imagery as main factors. In addition, corellational analysis (Pearson's r) were performed between the NRS, cognitive FIM, and GOS scores.

Results. Table 2 presents the number of patients in each group (*N*), the mean and standard deviation (in parentheses) for the cognitive FIM, the NRS and the GOS scores, according to the initial GCS and the results of cerebral imagery.

For the ANOVA performed on the NRS score, the interaction between the results of cerebral imagery and the initial GCS is highly significant ($F = 6.670$, $p = .021$). Analysis of simple effects reveals that the results of cerebral imagery are related to the NRS score for the moderate to severe TBI group ($F = 11.24$, $p = .02$), while it is not the case for the mild TBI group. For the moderate to severe TBI group, the presence of a visible traumatic abnormality on the cerebral scan is therefore associated with a higher NRS score, indicating more important neuropsychological deficits than a negative scan. For the mild TBI group, the difference between positive and negative scans is not significant.

The results obtained with the cognitive FIM score are in clear agreement with these results. The ANOVA reveals a significant interaction between the results of cerebral imagery and the GCS ($F = 6.656$, $p = .013$). Analysis of simple effects reveals that the results of the cerebral imagery are related to the cognitive FIM score for the moderate to severe TBI group ($F = 12.58$, $p = .01$), while they are not for the mild TBI group. For the moderate to severe TBI group, the presence of a visible traumatic abnormality on the initial cerebral scan is associated with a lower cognitive FIM score, indicating more important neuropsychological deficits than a negative scan. For the mild TBI group, the difference between positive and negative scans is not significant.

Finally, the correlational analysis performed on the NRS, cognitive FIM, and GOS scores yielded significant correlations between these three variables. The correlation between the cognitive FIM and the NRS is highly significant ($r = -0.866$, $p = .000$). Furthermore, the correlations between these two variables and the GOS are significant and equivalent ($r = -0.574$ for the cognitive FIM and $r = 0.510$ for the NRS, $p = .000$ in both cases).

Discussion

In summary, our study shows that there is a significant difference between mild TBI and moderate to severe TBI (as measured by initial GCS) regarding the relation between results of cerebral imagery and neuropsychological deficits exhibited by the patients during the first week posttrauma.

Primarily, patients exhibiting a mild alteration of consciousness upon admission are less likely to demonstrate significant neuropsychological deficits after one week, none withstanding the results of cerebral imagery. In contrast, for patients exhibiting a more important initial alteration of consciousness, neuropsychological deficits one week posttrauma are more severe for those with positive cerebral imagery than for those without visible cerebral traumatic abnormality. In fact, it appears to be the association of both significant initial alteration of consciousness and positive cerebral imagery that predicts more severe neuropsychological deficits one week posttrauma.

Second, our study demonstrates that the severity of neuropsychological deficits one week posttrauma, measured either by the NRS or the cognitive FIM scores, is a good predictor of the global functional outcome of the patients upon discharge from the primary care hospital.

At the clinical level, these results are of significant importance as they provide clinicians with information that will help them intervene more rapidly and appropriately with TBI patients within the first weeks posttrauma and plan rehabilitation in a more efficient way.

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