Cognitive and Behavioral Impairment in Traumatic Brain Injury Related to Outcome and Return to Work

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Objective: To evaluate the cognitive and behavioral disturbances related to return to work (RTW) in patients with traumatic brain injury (TBI) with the application of a differentiated outcome scale.

Design: Longitudinal cohort study.

Setting: Level I trauma center.

Participants: Adults (N=434) with TBI of various severity.

Interventions: Not applicable.

Main Outcome Measures: Extended Glasgow Outcome Scale (GOS-E), Differentiated Outcome Scale (DOS), and RTW.

Results: Patients encountered problems in the physical (40%), cognitive (62%), and social domains (49%) of the DOS, with higher frequency related to severity of injury. Even those with mild TBI experienced cognitive (43%) and behavioral problems (33%). Patients with good recovery (58%) according to the GOS-E experienced problems in 1 or more domains of the DOS. Half the patients were able to resume previous vocational activities completely, although 1 in 3 experienced cognitive or behavioral problems. Using multivariate logistic regression analysis, the cognitive (odds ratio [OR], 10.548; confidence interval [CI], 5.99-18.67), behavioral (OR, 2.648; CI, 1.63-4.29), and physical domains (OR, 2.763; CI, 1.60-4.78) were significant (P<.01) predictors of RTW. For subcategories of TBI, the cognitive domain was predictive for RTW in those with moderate and severe TBI, whereas both the cognitive and behavioral domains were predictive for RTW in those with mild TBI.

Conclusions: With application of a more detailed outcome scale, cognitive and behavioral impairments interfering with RTW were present in a substantial part of patients with TBI in the chronic phase after injury. More research is needed exploring the cognitive and behavioral outcome in different categories of injury severity separately.

Key Words: Behavior; Cognition; Outcome measures; Rehabilitation; Traumatic brain injury; Work.

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bances. A more detailed outcome scale, the DOS, has been described with validity similar to the GOS-E, allowing distinction of cognitive and behavioral impairments. Because the reliability and validation of this scale is evaluated only in patients who sustained a mild to moderate injury, applicability of the scale for patients with more severe injuries is not known to date.

The purpose of the present study was to evaluate cognitive and behavioral disturbances in all categories of head injury with application of the DOS. Furthermore, the relation of DOS scores to outcome determined by using the GOS-E and RTW is explored.

METHODS

Participants

All patients with TBI admitted to the University Medical Centre Groningen from 2000 to 2008 were eligible for inclusion in the study. The University Medical Centre Groningen is a level 1 trauma center with most patients admitted directly to the hospital within 1 hour after injury. Exclusion criteria were age younger than 15 years and concomitant psychiatric disease. Patients who died during hospital admission were not included in this study. Severity of injury was registered by using the GCS on admission. Patients were divided into 3 groups of severity: mild head injury (GCS score, 13–15), moderate head injury (GCS score, 9–12), and severe head injury (GCS score, 3–8). After discharge from the hospital, follow-up was performed at regular intervals (1, 3, 6, and 12 months postinjury) with administration of a symptom checklist and neurologic examination.

Outcome Measures

Outcome was determined by an experienced neurologist (J. N.) at 6 months for patients with mild and moderate TBI and at 12 months for those with severe TBI with application of the DOS, GOS-E, and RTW.

Extended GOS. Determination of the GOS-E is based on a structured interview concerning changes from preinjury status. The scale is an overall measure of outcome based on the degree of dependence on others and ability to participate in normal life. The GOS-E consists of the following categories: (8) good recovery; (7) good recovery with minor physical or mental deficits; (6) moderate disability, return to previous work with some adjustments; (5) moderate disability, work at a lower level or not at all. For analysis, a dichotomy was used for the separate domains, defined as no problems (subscale score=5) and presence of problems (subscale score≤4).

Return to Work. Resumption of previous activities was classified in 4 categories: (0) previous work or study resumed; (1) previous work or study resumed, but with lower demands or part-time; (2) previous work or study not resumed, different work on a significantly lower level; and (3) not working. For logistic regression analysis, RTW was divided into 2 groups: category 1 (RTW=0); resumption of previous work or study completely; and category 2 (RTW>0): resumption of previous work at a lower level or not at all.

Data Analysis

For analyzing data, regression analysis and multivariate techniques in the Statistical Package for the Social Sciences (SPSS®) were used. Spearman correlation coefficients were calculated to determine the relation between variables. Agreement of interobserver scoring was assessed by using $\chi^2$ analysis. Chi-square tests were used for frequency analyses. Regression analysis was performed when appropriate using the forward method for multivariate logistic regression.

RESULTS

In total, 434 patients were included in this study (mean ± SD age, 34.8±15.7y; range, 15–83y). Patient characteristics are listed in table 1.

Outcome scores with the GOS-E and DOS. According to the GOS-E, 53% of all patients obtained a good recovery. Most patients scored in the upper range of the scale; 87% of all patients had a favorable outcome (GOS-E score ≥5). Frequencies of GOS-E scores for the different categories of severity are shown in fig 1. Correlation between the GOS-E and DOS was very high (.921; $P<.01$). The cognitive and behavioral domain of the DOS showed a correlation of 0.7 for the total group of patients, with correlations for the TBI subgroups of .84, .47, and .76 (all $P<.01$) for mild, moderate, and severe TBI, respectively.

Subscales of the DOS compared with the GOS-E. Of the total group, 40% encountered problems in the physical domain; 62%, in the cognitive domain; 55%, in the behavioral domain;
and 49%, in the social domain. With increasing severity of injury, the frequency of problems increased in each domain (fig 2). Noticeably, even with mild TBI, 43% of patients experienced problems in the cognitive domain, and 1 in 3 in the behavioral domain. Percentages of patients with cognitive ($\chi^2=75.3; P<.01$) and behavioral problems ($\chi^2=85.4; P<.01$) differed significantly for the 3 categories of severity and also were significantly different from patients with physical limitations. Correlations between the separate domains of the DOS and GOS-E were significant ($P<.01$), with $r=.89$ (social domain), $r=.86$ (cognitive domain), $r=.76$ (behavioral domain), and $r=.74$ (physical domain).

Outcome scores of patients on both scales were compared (fig 3), and 58% of patients with good recovery according to the GOS-E still experienced problems in 1 or more domains according to their DOS score (DOS score $\geq$19). In patients with a GOS-E score of 8 (optimal score), only a few physical and behavioral problems were reported. However, in patients with a GOS-E score of 7, cognitive problems were present in 77 patients (54%) and behavioral problems were seen in 61 patients (43%).

Univariate regression analyses showed that all DOS domains were significant predictors of the GOS-E score. The social domain explained 80%; the cognitive domain, 74%; the behavioral domain, 58%; and the physical domain, 55% of the variance in GOS-E scores.

**RTW related to outcome scales.** Of all patients, 50% were able to resume previous vocational activities completely and 1 in 4 patients resumed work partially or on a lower level. Percentages of patients who resumed vocational activities completely increased with severity of injury (table 2). Both outcome scales correlated with RTW ($r=-.86$ for GOS-E, and $r=-.84$ for DOS). Scores for the different domains of the DOS correlated significantly with RTW: social ($r=.82$), cognitive ($r=.74$), behavioral ($r=.59$), and physical domains ($r=.59$; all $P<.01$). One in 3 patients who resumed their previous activities on the same level (category 1) experienced cognitive or behavioral problems on the DOS compared with 92% cognitive and 80% behavioral problems in category 2 (patients who were not able to resume previous activities). Percentages of patients with cognitive and behavioral problems were significantly different for the 2 RTW categories ($\chi^2=161.5; P<.01$, and $\chi^2=108.78; P<.01$ respectively).

Univariate logistic regression analyses showed that each DOS domain separately was a significant predictor for the ability to RTW. In a multivariate logistic regression analysis of data for all patients, each domain was a significant predictor of RTW: physical domain (OR = 1.388; CI, 1.66–2.91; $P = .049$), cognitive domain (OR = 3.807; CI, 1.78–8.13; $P = .01$), behav-

**Table 2: RTW for the Total Population and Different Categories of Severity of TBI**

<table>
<thead>
<tr>
<th>RTW Category</th>
<th>All Patients (n=434)</th>
<th>Mild TBI (n=208)</th>
<th>Moderate TBI (n=70)</th>
<th>Severe TBI (n=156)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete resumption of work</td>
<td>50</td>
<td>72</td>
<td>43</td>
<td>23</td>
</tr>
<tr>
<td>Part-time</td>
<td>24</td>
<td>22</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>Lower level</td>
<td>13</td>
<td>4</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>Not working</td>
<td>14</td>
<td>2</td>
<td>10</td>
<td>32</td>
</tr>
</tbody>
</table>

**NOTE.** Values are in percentages.
Table 3: Logistic Regression for All Domains of the DOS for RTW

<table>
<thead>
<tr>
<th>TBI Category</th>
<th>Physical</th>
<th>Cognitive</th>
<th>Behavioral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR</td>
<td>CI</td>
<td>P</td>
</tr>
<tr>
<td>All</td>
<td>2.763</td>
<td>1.60–7.48</td>
<td>.000</td>
</tr>
<tr>
<td>Mild</td>
<td>6.517</td>
<td>2.43–17.49</td>
<td>.000</td>
</tr>
<tr>
<td>Moderate</td>
<td>5.500</td>
<td>1.38–21.85</td>
<td>.015</td>
</tr>
<tr>
<td>Severe</td>
<td>1.172</td>
<td>0.52–2.66</td>
<td>.705</td>
</tr>
</tbody>
</table>

Because most problems were encountered in the cognitive and behavioral domains, we were interested in how these impairments might be related to outcome, measured by using the GOS-E. When favorable outcome according to the GOS-E was analyzed in relation to domains of the DOS, results showed that even in half the patients with a GOS-E score of “good recovery,” cognitive and behavioral problems were present. Comparing the several domains of the DOS, in all 3 categories of severity of injury, problems in the cognitive and behavioral domains prevailed over the physical domain. The high frequency of cognitive and behavioral impairments compared with physical limitations has to be emphasized because these impairments can cause different problems in daily life. In the acute stage, functional limitations were most obvious, whereas in the chronic phase, cognitive and behavioral sequelae become apparent in more demanding situations. Therefore, these problems, or the awareness of their existence, often had delayed onset, experienced when physical recovery had almost been achieved. The high correlation between the social domain of the DOS and the GOS-E indicates that these measures are similar to some extent because both measurements mostly assess work-related problems. This finding emphasizes the assumption that the GOS-E reflects work-related problems to a larger extent than cognitive outcome. However, the surplus value of the DOS is emphasized because this scale, a differentiated outcome score is given, reflecting all aspects of outcome by administering only 1 measure.

RTW can be regarded as an external measurement of outcome because it provides information about the actual ability to participate in previous activities. Because both the GOS-E and DOS are based on subjective information to a certain extent, comparison of both outcome scales can be made only in relation to an external criterion, represented in this study by RTW. In the present study containing patients with varying severity of injury, 50% of all patients were able to RTW completely 1 year after injury, with 1 in 4 patients only partially or on a lower level. For the different categories of severity, percentages of patients who resumed work completely ranged from 23% in patients with severe TBI to 72% in those with mild injury. This agrees with findings from other studies. However, resuming work does not imply that these patients are without impairments. Even some patients sustaining a minor injury, who resumed work quickly, were not free of symptoms. In the present study, 1 in 3 patients encountered cognitive or behavioral problems on the DOS despite having resumed vocational activities on a previous level. In patients who had not been able to resume previous vocational activities, 92% had cognitive and 89% had behavioral problems.

Logistic regression analyses showed that the cognitive domain was the best predictor of RTW. This agrees with former research, which indicated that work status was determined mainly by cognitive parameters, such as executive functioning, flexibility, attention, and speed of information processing. Noticeably, in patients with mild TBI, behavioral problems...
also were important in predicting RTW. It is important to realize that especially behavioral problems, mostly studied in patients with severe TBI, can be very subtle in patients with mild TBI and may be unnoticed because behavioral problems in general are not routinely tested in neuropsychological tests. Furthermore, cognitive and behavioral problems can be complex and may need a different approach regarding rehabilitation and integration of work. An interesting area to explore would be the contribution of behavioral problems, especially in patients with mild TBI, to problematic resumption of work.

Study Limitations

Some limitations of the present study have to be mentioned. It should be acknowledged that not all confounding factors for outcome were evaluated; for example, injury characteristics (such as GCS or age) or the rehabilitation provided. The study’s primary objective was to focus on the assessment and predictive value of the different domains of outcome. That all scales (GOS-E and DOS) were administered by the same observer raises the question of whether the measurements were entirely independent. However, the scales have different procedures for administration. The GOS-E is based on a standardized interview of the patient, whereas the DOS includes physical examination combined with an interview of the patient and a caretaker or relative. A disadvantage of the GOS-E is that information is obtained solely from the patient and therefore can be biased by lack of awareness of impairments.

Another limitation of the study is that the cognitive scale of the DOS is not based on cognitive test results, but on assessment by an observer. In general, the relation between subjective concerns and objective cognitive disorders (as determined by tests) is questionable. Nevertheless, in patients with a favorable outcome according to the commonly used outcome scale, the GOS-E results of the DOS still indicate cognitive or behavioral disabilities. These results could be used to perform a neuropsychological evaluation in this subgroup of patients, especially when problems with RTW are involved.

CONCLUSIONS

It is important to realize that a substantial portion of patients with TBI, although resuming previous activities, still encounter various problems in the chronic phase after injury. Application of a more detailed outcome scale, the DOS, reveals more information about impairments in different domains, which is necessary to decide the type of treatment patients need. Cognitive and/or behavioral impairments interfere more with RTW than physical limitations. More research has to be done exploring cognitive and behavioral outcomes separately in different categories of injury severity.

References

Supplier
a. SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.