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A comparison of neuropsychological and functional outcome, and uptake of rehabilitation services, following severe and moderate head injury

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We undertook a prospective outcome study of 61 patients with head injuries of differing severities who had been admitted to a neurosurgical unit and who survived for six months or more. Patients and relatives were interviewed and patients were neuropsychologically assessed six months from the time of injury. Details of the uptake of rehabilitation services were also collected. Three-quarters of the patients with severe head injury and two-thirds of those with moderate head injury remained severely or moderately disabled at follow-up. Both groups showed evidence of cognitive impairment and were reported by relatives to be suffering emotional and psychological problems. Whereas 54% of the severely head injured received inpatient rehabilitation, this was true of only 23% of those with moderate head injury.

Introduction

Each year about 300 per 100 000 of the British population sustain a head injury of sufficient severity to warrant hospitalization: most are males under 40 years; 10% of these injuries are severe, 10 to 15% moderate and the remainder minor, based on the Glasgow Coma Scale. At any time, 150 of 100 000 of the population will be disabled as a result of such injuries.[1] The long-term consequences for the survivors of severe head injury are cognitive and neurobehavioural rather than physical or neurological in nature.[2] Moderate head injury is at least as common as severe head injury.[3] Of 113 patients with moderate head injury almost 70% were found unfit for work three months later,[4] and 20% of a group of 55 such patients did not return to their premorbid level of employment.[5] Many studies of moderate head injury lack the detailed information about the nature of the injuries sustained that appears in studies of severe injury. In this prospective study we compare outcome of severe and moderate traumatic brain injuries in patients drawn from the same population. The study was set up to examine the neuropsychological and functional outcome at six months post-injury in patients surviving severe or moderate head injury, all of

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whom had been studied and managed by the same protocol,[6] and to identify whether patients with moderate head injury were as likely or less likely to have rehabilitation.

Method

Patients

Eighty-eight adult patients, 53 with severe head injury (SHI) and 35 with moderate head injury (MHI), who were admitted to our neurosurgical intensive care unit were prospectively studied as part of a larger ongoing head injury research programme involving computerized monitoring in the acute stage.[7] The unit is part of a regional service with a referral population of 1.3 million which admits all SHI and MHI patients in the area. The patients were allocated to two severity groups using the Glasgow Coma Scale[8] (GCS) which stratifies patients according to their level of response in terms of eye opening, motor response and verbal response. Patients categorized as SHI score between 3 and 8 points; they fail to open their eyes, even after the application of painful stimuli, and do not obey commands or utter recognizable words. Patients with MHI obtain a score of 9 to 12 on the scale or greater than 12 if computerized tomography (CT) scanning has shown an intracranial haematoma requiring neurosurgical evacuation.

Assessment techniques

The patient and a relative were interviewed and outcome assessed six months from the time of injury. By this time 20 patients (17 with SHI and three with MHI) had died. No patients remained in a persistent vegetative state. Six patients with MHI and one with SHI were not available for testing. The remaining 61 patients (35 with SHI and 26 with MHI) were assessed fully. Their premorbid and injury details are presented in Table 1. A Glasgow Outcome Scale score (GOS) was assigned to each patient after interview with the patient and a relative.[9]

A Relatives Questionnaire (RQ),[10] which gathers details of a wide range of problems commonly reported after head injury, was completed for each patient. Additional details about the patient's social behaviour and functioning were obtained. The 62 questions were combined for analysis into eight categories: physical disability, speech and language problems, affective disorder, dependence, subjective complaints, memory problems, disturbed or antisocial behaviour and reduced social functioning, and the scores converted to a proportional score out of 10. The relative also rated the amount of stress which he or she was experiencing as a result of the patient's injury on an analogue scale ranging from 0 (no stress) to 10 (maximum stress).

Earlier research identifying memory, concentration, information processing, visuospatial skills and concept formation as the most common problem areas following closed head injury determined the choice of test measures used.[11,12] Patients were screened for disorientation and dysphasia using the Temporal Orientation Test[13] and the Frenchay Aphasia Screen Test[14]; premorbid IQ were estimated using the National Adult Reading Test (NART)[15] and then immediate and delayed recall of a paragraph from the Logical Memory subtest of the Wechsler Memory Scale (WMS),[16] copy and immediate recall of the Rey Osterrieth Complex Figure,[17] a slow version of the Paced Auditory Serial Addition Test (PASAT),[18] and a version of the Wisconsin Card Sorting Test (WCST), based on Nelson,[19] were completed.

Results

Patient characteristics

Distribution of age, sex and premorbid IQ as estimated on the NART were similar in the two groups of patients. Other details of SHI and MHI patients are given in Table 1.

To examine whether our study patients differed from other head-injured patients admitted to the unit, the 61 patients were compared with 96 surviving patients (29 SHI and 67 MHI) admitted to the unit over the same time interval but not subjected to computerized monitoring.[7] While the study patients with SHI were similar to the nonstudy SHI patients in terms of sex, age and six-month outcome as assessed by the GOS, the study group with MHI were more likely to be male and to have undergone a period of ICP monitoring than nonstudy MHI patients, and were also subsequently found to have higher morbidity at six months post-injury as assessed by the GOS.

Functional outcome

Six months after injury almost three-quarters of SHI patients and two-thirds of MHI patients remained severely or moderately disabled (Table 2). The distributions of GOS scores were not significantly different in the two patient groups (chi square = 0.77; $p > 0.05$). Similarly the numbers of patients who were judged to be unfit for work by their relative did not differ (chi square = 0.096; $p > 0.05$).

The majority of patients in both groups were reported by relatives as having little physical disability; 74% of all patients were mobile and required no aids and 79% required no help with self care. However, 74% of the SHI and 54% of the MHI patients were reported as having reduced employment prospects as a result of the injury, and half of each group had suffered a deterioration in their leisure and social life since the injury. The particular problems commonly reported (percentage of the 61 patients reporting each in parentheses) were as follows: tiredness (61%), slowness (56%), anxiety (52%), impatience (56%), irritability (54%), reduced concentration (52%), personality change (56%), and memory impairment (59%). There were no significant differences between the patients with SHI and those with MHI in their relatives' reports of

Table 1 Characteristics and injury details of patient groups

Grade on admission	Severe head injury ($n = 35$)	Moderate head injury ($n = 26$)
Sex		
Male	30 (86%)	24 (92%)
Female	5 (14%)	2 (8%)
Age at injury		
Mean	30 years	34 years
Range	15–63 years	15–68 years
Premorbid IQ (NART)		
Mean (SD)	105 (8.5)	104 (7.0)
Glasgow Coma Scale: mean (SD)	5.7 (1.5)	10.1 (2.0)
Diagnosis (% of group)	%	%
Haematoma evacuated	37	46
Haematoma nonevacuated/contusion	20	31
Diffuse injury	43	15
Other	0	8*
Cause of injury (% of group)		
Driver of vehicle	49	12
Pedestrian	14	23
Fall/jump	26	35
Assault/hit on head	8	19
Other	3	11
ICP monitoring (% of group)	80	61
Alcohol on admission (% of group)	20	38

*Patient with no abnormality apparent on CT scan

Table 2 Glasgow Outcome Scale (GOS) at six months for patients with severe head injury and moderate head injury

Admission grade	Number of patients in each GOS category			
	Severely disabled	Moderately disabled	Good recovery	Total
Severe head injury	11 (31%)	15 (43%)	9 (26%)	35
Moderate head injury	6 (23%)	11 (42%)	9 (35%)	26

Chi square = 0.77; $p > 0.05$ for difference in distribution of outcomes following moderate and severe head injury these common problems. The SHI group showed more problems with balance, tactless behaviour and increased sensitivity to noise, and the MHI group had more problems with disturbed sleep and lethargy than before the injury.

The average reported stress scores on the 0 to 10 scale were 6.0 (SD 3.4) for relatives of the SHI patients and 5.5 (SD 4.0) for relatives of the MHI patients. This difference was not significant ($t[59] = 0.59; p > 0.05$).

Neuropsychological tests

All 61 patients were fully oriented at time of testing and showed no evidence of gross language impairment. Table 3 shows the neuropsychological test scores. On five of the eight tests, the patients with moderate head injury performed as poorly as those with severe head injury.

Relationship between neuropsychological test scores and functional status

All the neuropsychological tests, other than the NART which estimates premorbid IQ, were related in the expected direction to the patients' functional status as assessed by the GOS. Patients who functioned at a higher level achieved significantly better test scores. In the case of the PASAT test this relationship was highly significant. PASAT scores were also significantly related to the level of stress reported by relatives ($r = -0.46; p < 0.001$ for raw score, $r = -0.49; p < 0.001$ for longest string correct) (Table 4).

The neuropsychological test scores for the patients who had returned to work and those who were described as being unfit to work showed significant differences in four of the eight tests (Table 5), again in expected directions.

Few significant relationships emerged between

Table 3 Neuropsychological test scores at six months – means and standard deviations for patients with severe and moderate head injury

	Neuropsychological test scores Mean (SD)	Mean (SD)
	Severe head injury ($n = 35$)	Moderate head injury ($n = 26$)
Logical memory (immediate)	8.2 (5.1)	7.0 (3.1)
Logical memory (delayed)	7.0 (4.9)	4.8 (3.2)
Rey Osterrieth (copy)	30.9 (9.6)	32.2 (4.0)
Rey Osterrieth (recall)	18.6 (9.2)	22.0 (6.8)
PASAT (number correct)	43.0 (14.4)	43.2 (11.8)
PASAT (longest string)	17.5 (16.1)	14.9 (12.8)
WCST (errors)	12.1 (10.9)	15.1 (9.6)
WCST (perseverative errors)	4.2 (6.4)	4.6 (6.5)

There were no significant differences between the two groups (unpaired *t*-test; $p>0.05$)

Table 4 Correlations of neuropsychological test scores with Glasgow Outcome Scale (GOS) and relatives' stress at six months (all patients: $n = 61$)

	GOS	Relatives' stress score
Logical memory (immediate)	0.43*	−0.24
Logical memory (delayed)	0.36*	−0.15
Rey Osterrieth (copy)	0.34*	−0.18
Rey Osterrieth (recall)	0.42*	−0.15
PASAT (number correct)	0.59**	−0.46**
PASAT (longest string)	0.41*	−0.49**
WCST (errors)	−0.38*	0.13
WCST (perseverative errors)	−0.40*	0.27
NART	0.06	−0.17

Pearson correlation coefficients *$p<0.01$; **$p<0.001$

the category scores for the relatives questionnaire and the neuropsychological test data. The problem areas most closely related to poor test performance were dependence and memory. PASAT raw scores and the WCST error scores were significantly related to increased dependence ($r = -0.43$; $p < 0.01$ and $r = 0.43$; $p < 0.01$). PASAT raw scores and WCST perseverative error scores were related to memory impairment ($r = -0.41$; $p < 0.01$ and $r = 0.51$; $p < 0.001$). Problems with social behaviour were also related to increased error score on the WCST ($r = 0.36$; $p < 0.01$).

Rehabilitation services

Nineteen of the 35 patients (54%) with SHI received inpatient rehabilitation whereas only six of the 26 with MHI (23%) received such rehabilitation (chi square = 4.79; $p < 0.03$).

Discussion

Whereas there were major differences in mortality between patients with SHI (32%) and MHI (8%), morbidity in both groups of surviving patients was high at six months after injury. Only 35% of the surviving MHI patients and 26% of the SHI patients had attained a good recovery according to the GOS criteria, similar to the findings of Rimel *et al.*[4] at three months post-injury. However, it is probable that they were studying a less severely injured group of patients in that only 33% of their group had a GCS score of ten or less in comparison with 73% of our study patients. Fifty-eight per cent of the MHI group and 66% of the SHI group in our study were unfit for work at six months.

Whereas our group with MHI were functioning at a slightly higher level than the patients with SHI in terms of global functioning, return to work rates and most areas addressed in the RQ, their mean scores on neuropsychological testing were relatively low. Sixty-one per cent of those with MHI were suffering from reduced drive and lethargy in contrast with only 43% of the patients with SHI: lethargy and passive behaviour have been shown to be amongst the most significant predictors, together with cognitive factors, of whether the patient can eventually return to work.[20] It is possible that the problems of the MHI are mainly cognitive and behavioural whereas physical and neurological sequelae add to these difficulties in the group with SHI, especially since patients with SHI are more likely to sustain other injuries concurrent with their head injury.[3] Thirty-four per cent of the SHI group still required the help of mobility aids, but only 15% of the MHI group, and over half of the SHI group still had balance deficits while only 11% of the MHI group had such problems.

Physical and neurological symptoms are more commonly reported in the early stages of recovery but with increasing time from injury, psychologi-

Table 5 Neuropsychological test scores – means and standard deviations at six months for patients working or unfit to work

	Neuropsychological test scores Mean (SD)	Mean (SD)
	Working full or part-time	Unfit to work
Logical memory (immediate)	9.8 (4.0)*	6.7 (4.4)*
Logical memory (delayed)	8.0 (4.4)	5.4 (4.3)
Rey Osterrieth (copy)	33.0 (2.8)	30.3 (9.5)
Rey Osterrieth (recall)	25.0 (4.7)**	18.5 (9.1)**
PASAT (number correct)	50.4 (5.8)***	38.8 (14.4)***
PASAT (longest string)	20.7 (14.9)	13.8 (14.1)
WCST (errors)	8.7 (7.8)*	15.8 (10.6)*
WCST (perseverative errors)	2.2 (4.5)	5.7 (7.0)
NART	106.2 (8.2)	104.1 (8.6)

Unpaired *t*-test *$p<0.05$; **$p<0.01$; *** $p<0.001$

cal problems come to the fore.[10] If psychological and cognitive impairment predominate after MHI in the context of relatively good early physical and neurological recovery, handicaps may only become apparent on attempting to resume a normal lifestyle. Demands placed on patients who have sustained less severe head injuries will also be greater than for those who have had lengthy periods of coma, particularly if the sequelae are less obvious to others as suggested above and if physical recovery is complete. Patients with such 'invisible disability' are likely to suffer particular strains not experienced by groups with more overt symptomatology.[21]

The relative lack of rehabilitation received by the patients with MHI is of importance given the high level of residual disability. Various factors may account for this finding. Physical function of these patients was significantly better than that of the patients with SHI soon after injury. More patients with SHI were severely disabled one month after head injury than patients with MHI, whereas by six months the differences in outcome between the two groups had lessened. Patients with predominantly cognitive and emotional problems in the context of good physical recovery appear less disabled in the acute hospital setting and are more likely to be judged fit for discharge home. Even at three-month follow-up, difficulties may still not be obvious so that the patient is discharged from the outpatient clinic.

Despite the low mortality rates for patients sustaining MHI there can be a high level of morbidity in these patients. Their substantially reduced functioning is due primarily to cognitive and psychological impairment but they are currently less likely to be offered rehabilitation.

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References

1 Medical Disability Society. *The Management of traumatic brain injury*. London: Development Trust for the Young Disabled, 1988.
2 Brooks N ed. *Closed head injury: psychological social and family consequences*. Oxford: Oxford University Press, 1984.
3 Miller JD, Jones PA, Dearden NM, Tocher JL. Progress in the management of head injury. *Br J Surg* 1992; **79**: 60–64.
4 Rimel RW, Giordani B, Barth JT, Jane JA. Moderate head injury: completing the clinical spectrum of brain trauma. *Neurosurgery* 1982; **11**: 344–51.
5 Stambrook M, Moore AD, Peters LC, Deviaene C, Hawryluk GA. Effects of mild, moderate and severe closed head injury on long-term vocational status. *Brain Inj* 1990; **4**: 183–90.
6 Chan KH, Miller JD, Dearden NM, Andrews PJD, Midgley S. The effect of changes in cerebral perfusion pressure upon middle cerebral artery blood flow velocity and jugular bulb venous oxygen saturation after severe head injury. *J Neurosurg* 1992; **77**: 55–61.
7 Jones PA, Andrews PJD, Midgley S *et al.* Measuring the burden of secondary insults in head-injured patients during Intensive Care. *J Neurosurg Anesth* 1994; **6**: 4–14.
8 Teasdale GM, Jennett B. Assessment of coma and impaired consciousness. A practical scale. *Lancet* 1974; **ii**: 81–84.
9 Jennett B, Bond M. Assessment of outcome after severe brain damage. A practical scale. *Lancet* 1975; **1**: 480–84.
10 Brooks DN, Campsie L, Symington C, Beattie A, McKinlay WW. The effects of severe head injury on patient and relatives within seven years of injury. *J Head Trauma Rehabil* 1987; **2**: 1–13.
11 Levin HS, Grossman RG, Rose JE, Teasdale GM. Long-term neuropsychological outcome of closed head injury. *J Neurosurg* 1979; **50**: 412–22.
12 Mandleberg IA. Cognitive recovery after severe head injury. 3. WAIS verbal and performance IQs as a function of post-traumatic amnesia duration and time from injury. *J Neurol Neurosurg Psychiatry* 1976; **39**: 1001–1007.
13 Benton AL, Hamsher K deS, Varney N, Spreen O. *Contributions to neuropsychological assessment*. New York: Oxford University Press, 1983.
14 Enderby P, Wood V, Wade D. *Frenchay aphasia screening test manual*. Windsor: NFER-Nelson, 1987.
15 Nelson HE. *National adult reading test (NART)*. Windsor: NFER-Nelson, 1982.
16 Wechsler D. A standardised memory scale for clinical use. *J Psychol* 1945; **19**: 87–95.
17 Rey A. L'examen psychologique dans les cas d'encephalopathie traumatique. *Arch Psychol* 1942; **28**: 112.
18 Gronwall D, Wrightson P. Delayed recovery of intellectual function after minor head injury. *Lancet* 1974; **2**: 605–609.
19 Nelson HE. A modified card sorting test sensitive to frontal lobe defects. *Cortex* 1976; **12**: 313–24.
20 Brooks N, McKinlay WW, Symington C, Beattie A, Campsie L. Return to work within the first seven years of severe head injury. *Brain Inj* 1987; **1**: 5–19.
21 Falvo DR, Allen H, Maki DR. Psychosocial aspects of invisible disability. *Rehabil Lit* 1982; **43**: 2–6.