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Disability Caused by Minor Head Injury

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The authors studied 538 patients who had sustained minor head trauma, which was defined as a history of unconsciousness of 20 minutes or less, a Glasgow Coma Scale score of 13 to 15, and hospitalization not exceeding 48 hours. Of these patients, 424 were evaluated 3 months after injury. The follow-up evaluation included a history of events since the accident, assessment of subjective complaints and objective measures such as employment status, a neurological examination, a psychosocial assessment designed for estimating life stress, and a neuropsychological test battery to measure higher cortical function. Of these 424 patients, 79% complained of persistent headaches, and 59% described problems with memory. Of the patients who had been gainfully employed before the accident, 34% were unemployed 3 months later. Comparisons were then made between the employed and the unemployed groups. Three explanations for the high rate of unemployment were examined. (*a*) *Evidence of organic brain damage:* Although the neurological examination was completely normal in nearly all patients, neuropsychological testing demonstrated some problems with attention, concentration, memory, or judgment in most of the 69 patients evaluated. (*b*) *Psychological responses to the injury:* Emotional stress caused by persistent symptoms seems to be a significant factor in the long term disability of these patients. (*c*) *Litigation and compensation:* These factors have a minimal role in determining outcome after minor head injury. In conclusion, the most striking observations of these studies are the high rates of morbidity and unemployment in patients 3 months after a seemingly insignificant head injury and the evidence that many of these patients may have, in fact, suffered organic brain damage. (*Neurosurgery* 9:221–228, 1981)

Key words: Emotional stress, Employment status, Minor head injury, Neuropsychological testing, Organic brain damage, Psychosocial outcome, Trauma

INTRODUCTION

Minor head injury can be defined in many ways, ranging from a loss of consciousness requiring hospitalization to lacerations of the scalp and face that clearly do not affect the brain. In a study conducted by the National Center for Health Statistics, the total number of injuries to the head of all kinds in the United States was estimated to be in excess of 8 million per annum (35). Of that number, some 200 per 100,000 of population (a total of approximately 400,000 patients) are hospitalized each year (1). Although it can be assumed that nearly all patients who are hospitalized with a diagnosis of head injury have experienced loss of consciousness, the number of patients who are rendered unconscious briefly and are not admitted to a hospital is unknown. Therefore, the total number at risk for sequelae after head injury is somewhere between the number of patients hospitalized and the millions of people who suffer a minor head injury of unknown severity each year. For this study, we elected to limit our subjects to patients who had been hospitalized for their injuries, although we recognize that significant numbers of people who were never hospitalized may also be suffering the residue of a minor head injury.

The emotional, psychological, and intellectual problems experienced by patients with severe head injuries (5–7, 15, 19) and the great difficulties that these patients encounter in their return to society (18, 21, 32) have been well documented. There is clinical evidence that some patients with minor head injury also have organic brain damage, manifested by difficulty processing information at a normal rate (8). Also, neuronal loss has been found during postmortem examination of patients in whom the only known head injury was a concussion and in whom there was no obvious clinical evidence of brain damage (16, 23, 30). Nevertheless, most of the attention in patients with minor head injury has been directed toward the roles of compensation, litigation, and malingering (5, 11, 17).

The purposes of this study were to obtain a profile of a large group of patients with minor head injury in terms of neurological status on admission and premorbid factors that might contribute to outcome and then to assess the overall status of the patients 3 months later, without any form of intervention during the interval between injury and follow-up examination. The morbidity experienced by patients 3 months after minor head injury was an unexpected and interesting finding. A longer follow-up was precluded by a limitation of the resources available to examine such a large number of patients over a long period. The observations at 3 months seemed to be of sufficient interest to warrant description. We do not know what difficulties these patients experience after 3 months and, as part of a much larger research effort that is in the implementation stages, we will be able to evaluate the recovery of these patients over time. When it became evident that a large number of these patients with "minor head injury" were unemployed

3 months after injury, the implied enormous socio-economic impact emphasized the need for a better description of the problem and its possible causes.

METHODS

Patient population

During a 20-month period from October 1, 1977, to May 30, 1979, a prospective study of all patients admitted to the University of Virginia Medical Center with head trauma was conducted. For this study, minor head injury was defined as cranial trauma resulting in a loss of consciousness of 20 minutes or less, an admission Glasgow Coma Scale score of 13 or better, and the need for 48 hours or less of hospitalization. Briefly, the Glasgow Coma Scale is a 13-point scale, ranging from 3 through 15, divided into three categories of neurological responsiveness: eye opening, verbal responses, and motor responses (31). This scale has become a standardized method of grading the severity of neurological deficit with reproducibility between observers (26). A score of 15 is normal. Our requirement for 48 hours or less of hospitalization excluded patients with severe extracranial associated injuries or medical complications and, in general, reflected the neurosurgeons' assessment that the included patients had sustained minor head injuries not requiring treatment or additional observation.

Hospital management

The University of Virginia is located in Central Virginia and provides the only neurosurgical service for a 14-county area. All head injuries requiring neurosurgical care are treated at one center, thus providing an opportunity for population-based studies where the bias of selection factors is minimized. Five small community hospitals are located within the catchment area, and a quarterly review of patient records and emergency room logs supported the assumption that all head-injured patients who were thought to require neurosurgical management were referred to the University of Virginia. During the 20-month period, 1248 patients with head trauma were admitted, and 538 of the 1248 met the criteria outlined for minor head injury.

Our admission policy for head trauma requires that all patients sustaining trauma that results in loss of consciousness are admitted for observation. At the time of admission, each patient with minor head injury was seen by a member of the neurosurgical staff and was given a neurological evaluation and a score on the Glasgow Coma Scale. Skull films and blood alcohol levels were obtained. Other diagnostic tests were ordered as indicated. Computed tomographic (CT) scans were obtained only in those patients in whom assessment of the severity of head injury was complicated by blood alcohol levels. Six per cent of the patients with minor head injury were studied by CT scanning, and all scans were normal.

Data collection

In most cases the length of the period of unconsciousness was determined through an interview with the family or the rescue squad personnel. Occasionally, however, this information could be obtained only from the patient. Before discharge from the hospital, data were collected from each patient on premorbid descriptive factors, the mechanism of injury, and (when possible) a Schedule of Recent Events (SRE), which elicits information about stressful situations in the patient's life during the previous 12 months (10). Premorbid description data included age, sex, education, and employment. Occupations were categorized according to the Two-Factor Index of Social Position (9, 20), and additional categories were added for students, housewives, preschool children, retired people, and the unemployed to provide a better description of the population. The family income for each patient was also recorded to assess social status, but some patients refused to supply this information, and difficulties were encountered in categorizing students, retired people, and families with multiple incomes. Therefore, greater emphasis was placed on the Hollingshead Scale for Social Class, which utilizes education and occupation to reach a numerical value for socio-economic status (SES). The SES is calculated by multiplying a designated occupation category score (unskilled laborers are given a higher score than executives) by 7 and an appropriate education category score (the greater the years of formal education, the lower the category score) by 4. SES scores are scaled in five groups: Group I, SES 11–17; Group II, SES 18–27; Group III, SES 28–43; Group IV, SES 44–60; and Group V, SES 61–77. Highly educated individuals employed as executives are in Group I and individuals with minimal education who are employed as laborers are in Group V.

Information was also obtained on the possession of health and disability insurance, factors that might lead to litigation, and the history of previous head trauma. At discharge, the patients were told to resume their premorbid activities as soon as possible and to return to the hospital only for persistent problems.

Assessment at 3 months

All patients were sent an appointment for the follow-up clinic at 3 months after injury. If they failed to appear, they were sent an appointment for the following week. If they failed to keep the appointment again, they were contacted by telephone and, if this effort was not successful, the follow-up interview was conducted over the telephone at a subsequent call. Telephone interviews were required with 27 patients. The overall response rate for the study was 79% (424 of 538). During the follow-up assessment, data were collected on physical, social, and emotional complaints and on financial and marital status and employment. A neurological examination was performed by a neurosurgeon, and in some patients a neuropsychological assessment was carried out by a neuropsychologist. The employment status of patients at 3 months provided an objective measure of outcome after injury and a framework for analysis of much of the data.

Psychosocial assessment. Psychosocial data were collected on 221 patients of all ages who returned with a significant other person (family member or close friend) to the 3-month follow-up clinic. Those patients not returning with a significant other person (203) are excluded in this discussion. In a prospective effort, additional staff could be utilized for contacting the significant other person of those patients returning to the clinic alone to alleviate any bias in selection that this might impose. Fifty-nine patients were gainfully employed before injury, and their psychosocial data are presented under "Results." The tests administered included a SRE for the period since the hospitalization and a brief physical recovery checklist for the assessment of physical disability, pain, intellectual impairment, and emotional problems. The recovery scale ranges from 1 (no complaints) to 4 (severe changes after injury).

Neuropsychological assessment. A total of 133 patients received a detailed neuropsychological test battery, including the Halstead Neuropsychology Battery (2, 3, 24), the Wechsler Scales of Intelligence (33) and Memory (34), and the Wide Range Achievement Test (12). These subjects were recruited by a project psychologist at follow-up and are a subset of the 424 patients evaluated at 3 months. They reflect the amount of time available for testing during the study period. We evaluated

a subset of 69 of these patients who met the following criteria: between 15 and 55 years of age, more than 6 years of education, and the inclusion criteria for the entire minor head injury population. It was decided that such a sample would minimize any possible age effects on the neuropsychological test variables. These patients did not differ statistically from the total study population in terms of sex, education, or employment.

Statistical analysis

For all data presented, whenever a statistical inference is made with categorical variables, a chi square test was used. Whenever a statistical inference is made between two sample means, Student's *t*-test was used.

RESULTS

During the 20-month period of study, 1248 patients with a diagnosis of head injury were admitted to the University of Virginia Hospital (Table 1). Of these, 260 had severe head injuries (defined as a Glasgow Coma Score of 8 or worse). The minor head injury criterion of a Glasgow Coma Score of 13 to 15 was met by 684 patients, and 146 of these patients remained in the hospital for more than 48 hours. Of the remaining 538 patients who were included in this study, 424 were evaluated at 3 months (Table 2). There were no significant differences between this group and the 114 patients lost to follow-up in terms of premorbid characteristics and severity of injury. During the same period, 117 patients with minor head injury were admitted to referring hospitals in the University of Virginia head injury catchment area. The records of all of these patients were examined, and they seemed to be representative of the patients admitted to the University of Virginia Hospital. However, follow-up data were not obtained and, in another study now in the design stages, patients managed at local hospitals will be compared to patients managed in Charlottesville.

Premorbid descriptors

A description of the patients with minor head injury is presented in Table 3. The mean age was 27 years, and the largest number of patients were in the 11 to 20 age group. Sixty-six per cent of the patients were male. The distributions by class of employment, family income, and number of years of education for the patient group were compared with data on the population as a whole in Central Virginia obtained from the Taylor-Murphy Institute and from the Charlottesville Chamber of Commerce. The Taylor-Murphy Institute of the University of Virginia is part of the Graduate School of Business Administration and provides much of the State of Virginia's information on economic and descriptive statistics for planning and research. The minor head injury group contained a larger percentage of students and unskilled laborers and a much smaller number of persons classed as executives within the Hollingshead Employment Scale. The mean SES fell within Group V because of the many students and laborers. Seventy-three per cent of all patients were in Group V, but when all previously unemployed persons were excluded the percentage dropped to 57% (Table 3). A surprising 31% of all patients had been hospitalized previously for head injury, a significant observation for the study of the epidemiology of head injury.

Slightly less than half of the minor head injuries were sustained as a result of road traffic accidents (Table 4). A significant number of injuries were due to sports accidents, probably a reflection of the large proportion of college students in Charlottesville. A very significant contributing factor in this group of patients was alcohol use. Some alcohol was present in the blood of 43% of the patients, in 39% the test was negative, and information was not available in 18% of the patients. Thirty-five per cent of the patients had a blood alcohol level in excess of the 0.10-g/dl value for legal intoxication in the State of Virginia. It is interesting, however, that both the incidence and the degree of intoxication were less than in patients with more severe head injuries. During the same period of study, 84% of all patients admitted to the hospital with a Glasgow Coma Score of 8 or less had alcohol in the blood, and the mean level was 0.19 g/dl compared to 0.08 g/dl in patients with minor head injuries. One important question is how the injury and the subsequent problems encountered by patients during recovery might affect their drinking patterns. An attempt was made to collect such information; however, the data were not thought to be reliable by the investigators. This question remains as a topic for future research.

TABLE 1
Glasgow Coma Scale: All Head Injury Admissions (n = 1248)

Glasgow Coma Scale	No. Patients	% of Population
3–8	260	21%
9–12	304	24%
13–15	684*	55%

* 164 patients remained hospitalized >48 hours after injury and are not included in the study.

TABLE 2
Minor Head Injury Study Population

Total number of patients with minor head injury	538
Number of patients assessed after 3 mo	424
Number of patients assessed after 3 mo who had been gainfully employed before injury	310
Number of patients administered the neuropsychological battery	69
Number of patients administered the 3-mo outcome family psychological assessment who had been gainfully employed before injury	59

Severity of injury

Seventy-six per cent of the patients had a reported loss of consciousness of 10 minutes or less (Table 5). The Glasgow Coma Scale score was based on examination by the admitting neurosurgical resident. In all patients with a score of 14, the verbal response was reported as the abnormal subtest. These patients were confused but conversant, with normal motor responses and eye opening. In the 177 patients with a score of 13, 113 patients had normal scores on motor response and eye opening and a score of 3 on the verbal scale because of an inability to engage in a coherent conversation. Seventy-six of these 113 patients had a positive blood alcohol level. The remaining 64 patients with a score of 13 had a 1-point deficit on verbal response and on eye opening, with no motor deficit. Forty-one of these patients had a positive blood alcohol level. Although it is clear that alcohol contributed to the deficits in many of these patients, the more important observation is that a large number of patients had significant clouding of the sensorium with no or a minimal level of alcohol in the blood.

Eight per cent of the patients had some neurological abnormality on admission. The most frequent deficit was pupillary asymmetry (5%). Other abnormalities included reflex changes (3%), cranial nerve findings other than unequal pupils (4%), and unequal motor strength (1%). Two such findings was the maximum demonstrated in any one patient, and two deficits

TABLE 3
Premorbid Description of Patients (n = 538)

AGE (yrs.)	Mean 27	0-10 8%	11-20 38%	21-30 24%	31-40 11%	41-50 8%	51-60 7%	>60 4%
SEX		Male 66%			Female 34%			
EDUCATION (yrs. completed)	9.6 years	None 1%	Preschool 3%	Primary Ed. 1-8 34%	Secondary Ed. 9-12 45%	College 13-16 14%	Grad. Students 3%	
INCOME	$8,500	$6,000 13%	$6,000 - 9,999 27%		$10,000 - 20,000 43%	>$20,000 17%		
SOCIO-ECONOMIC STATUS	66.5	Group I (11-17) 1%	Group II (18-27) 2%	Group III (28-43) 6%	Group IV (44-60) 18%	Group V (61-77) 73%		
SOCIO-ECONOMIC STATUS*	54.8	2%	3%	10%	27%	57%		
EMPLOYMENT		Executives 1%	Business manager 2%	Minor professional 3%	Clerical & sales workers 7%	Skilled laborers 10%	Machine operators 11%	
		Unskilled laborers 23%	Students 32%	Housewife 2%	Unemployed 2%	Retired 3%	Preschool 3%	
HEALTH INSURANCE		Medicare/Medicaid/V.A. 9%			Private 3rd. Party Insurance 62%	None 29%		
PREVIOUS CNS TRAUMA		Yes 31%			No 69%			

*Patients gainfully employed prior to injury (excludes students, housewives, unemployed, retired and pre-schoolers)
N=310

TABLE 4
Information about Accident (n = 538)

Mechanism of Injury	% Patients	Blood Alcohol Level (Mean, 0.08 g/dl)	% Patients
Vehicular accidents	46%	Negative	39%
Falls	23%	0.01–0.09 g/dl	8%
Sports (including bicycle accidents)	18%	0.10–0.20 g/dl	16%
		>0.20 g/dl	19%
Assaults	10%	Not done	18%
Other	3%		

were present in 3% of the population. Another measure of the severity of injury was the presence of a skull fracture in 5% of the population, but none of the patients had a depressed or open fracture. Fifteen per cent of the patients had an associated injury, most frequently an upper extremity fracture (9%).

At the time of discharge, all patients had a normal neurological examination, a score on the Glasgow Coma Scale of 15, and no problems requiring further hospitalization. Patients were given instructions to return if they developed headache, vomiting, or neurological symptoms. Only six patients returned for evaluation, and one was admitted for overnight observation.

Description of outcome at 3 months

Among the 424 patients assessed 3 months after injury, the most frequent subjective complaint was persistent headaches (78%), which varied greatly in both frequency and duration (Table 6). Fifty-nine per cent of the patients had noted a change in their memory since the accident. In general, the "significant others" indicated an even greater problem with the patients' memory than the patients recognized or were willing to admit. About one-sixth of the patients described difficulty with household chores and the activities of daily living, or there had been a change in the means of transportation that they had used since their injury, which meant, in most cases, that these patients no longer felt competent in driving. Seventy-nine per cent of the patients had at least one complaint, and 5% had two or more complaints. Perhaps the most significant observation is that only one-sixth of the patients were complaint-free.

Data on objective measures of outcome are presented in Table 7. The facts that 8% of the patients had some neurological abnormality on admission, all seemed to be neurologically normal on discharge, and 2% again had some abnormality 3 months after injury are not easy to explain. As the abnormalities were slight in all patients, some of the difference is probably due to observer variability. Although 1% of the patients described symptoms that were attributed to seizure activity, the electroencephalogram (EEG) was compatible with seizure in only one patient. Approximately half of the patients were experiencing financial problems, mostly due to a decrease in income or the loss of a job because of the injury.

Employment. Probably the most striking evidence of significant morbidity in these patients is an unemployment rate of 24% at 3 months (Table 7). When students, retired persons, and others who were not employed before the injury were excluded, the unemployment rate increased to 34%. The data were then examined in an attempt to determine the cause of unemploy-

TABLE 5
Severity of Injury (n = 538)

LENGTH OF UNCONCIOUSNESS MEAN = 9.5 min.	1-5 min 22%	6-10 min 54%	11-15 min 17%	16-20 min 7%
ADMISSION GLASGOW COMA SCALE	13 33%	14 50%	15 17%	
NEUROLOGIC ABNORMALITIES	Unequal		Equal	
Pupillary Asymmetry	5%		95%	
Reflex Changes	Positive 3%		Negative 97%	
Cranial Nerve Findings	4%		96%	
Motor Strength	Unequal 1%		Normal 99%	
SKULL FRACTURE	Yes 5%		No 95%	
ASSOCIATED EXTRA-CRANIAL TRAUMA	Yes 15%		No 85%	
Type of Associated Trauma	Upper Ext. Fracture Lower Ext. Fracture Facial Fracture Rib Fracture		9% 4% 1% 1%	

TABLE 6
Outcome at 3 Months: Subjective Complaints (n = 424)

Complaint	% Patients
Persistent headaches	78%
Memory deficit	59%
Difficulty with household chores (activities of daily living)	14%
Change in transportation	15%
Number of complaints	
None	16%
One complaint	79%
Two or more complaints	5%

TABLE 7
Outcome at 3 Months: Objective Measures (n = 424)

Objective Measure	% Patients
Positive neurological findings	2%
Pupillary	1%
Cranial nerve deficit	0.1%
Seizures	1%
Reported change in financial status	49%
Change in marital status	0.1%
Total patients unemployed	24%
Unemployed patients gainfully employed before injury (n = 310)	34%
Change in employment due to injury	3%

ment. Particular attention was paid to premorbid factors, the incidence of subjective complaints, litigation and compensation issues, and evidence of organic brain damage from the neuropsychological assessment in unemployed compared to employed individuals.

TABLE 8
Relation between Premorbid Factors and Return to Work 3 Months after Injury (n = 310)

Employed patients significantly	
Older	$P < 0.05$
Higher level of education	$P < 0.001$
Higher level of employment	$P < 0.005$
Greater income	$P < 0.01$
Higher SES	$P < 0.001$
Employed patients were not significantly different than unemployed in	
Sex	
Possession of health or disability insurance	
History of head trauma	
Length of unconsciousness	
Glasgow Coma Scale score	
Associated injuries	

Premorbid factors of significance that influenced return to work included age, education, employment, income, and SES (Table 8). Factors that were not significant in influencing return to work were the presence of health and disability insurance and a history of previous head trauma. Surprisingly, only six patients stated that they were involved in litigation. Three of these patients had returned to work, two had been unemployed before their injury, and only one patient had not returned to work. The severity of injury measured by length of unconsciousness, the Glasgow Coma Scale, and associated extracranial injury did not differ between the two groups of patients.

Table 9 presents the relationship of socio-economic status

TABLE 9
Relationship of Socio-economic Status and Occupational Level to Continued Employment 3 Months after Injury

	No. Patients	% Employed
Socio-economic Status		
Group I	7	100%
Group II	10	100%
Group III	29	86%
Group IV	86	75%
Group V	178	56%
Occupational Level		
Executive	7	100%
Business manager	11	100%
Minor professional	18	83%
Clerical/sales worker	38	79%
Skilled laborer	53	68%
Machine operator	60	63%
Unskilled laborer	123	57%

TABLE 10
Neuropsychological Assessment: Mean Scores for Patients with Mild Head Injury and Standard Cutoff Scores on Halstead-Reitan Test Procedures (n = 69)

Test	Score	Cutoff
Imp. I	0.5	>0.3
Category	54.7	>51
Speech (e)	11.1	≥8
Rhythm (c)	24.8	≤25
TPT time	20.5	≥15.7
TPT memory	6.7	≤6
TPT Loc.	4.2	<5
Tapping (D)	47.0	<50
Tapping (N)	41.8	≤45
Trails A	34.7	≥38
Trails B	116.0	>88
Grip (D)	37.5	—
Grip (N)	34.3	—
Sensory	Normal	—

and occupation level to continued employment. All executives and business managers had returned to work, there was significant unemployment in the midportion of the scale, and nearly half of the unskilled laborers were unemployed.

Psychosocial and neuropsychological assessment. A representative sample of 69 patients with minor head injury underwent neuropsychological testing. The patients did not differ from the minor head injury population with respect to premorbid descriptors and yielded no significant differences from established norms for intelligence and academic achievement tests. However, mild neuropsychological impairment was evident on the vast majority of the Halstead-Reitan Neuropsychological Test Procedures, including the tests of higher level cognitive functioning, new problem-solving skills, and attention and concentration (Table 10). A full explanation of how neuropsychological procedures relate to deficits in particular areas of functioning can be found in Reference 2.

A detailed psychosocial assessment with the significant other person was performed with 59 patients who had been gainfully employed before injury, 34% of whom were unemployed at follow-up. These patients were a representative sample of the 424 patients studied with respect to premorbid descriptors and employment status. The initial SRE taken while the patient was still hospitalized revealed that patients who lost their job had experienced significantly greater life stress before injury than had those who remained employed ($P < 0.03$). Although no differences were found for the patients' SRE at the 3-month follow-up assessment, life stress for the significant other person during this same period was found to be significantly greater if the patient had lost his or her job ($P < 0.03$). On the recovery checklist, the unemployed patients described more problems overall than did the employed patients ($P < 0.03$). The "significant others" of the unemployed patients also confirmed these observations when rating the patients ($P < 0.02$) and further described specifically more limitation for these patients in physical activities and somatic complaints.

DISCUSSION

The most important finding from this study is the large number of patients with minor head injury who were experiencing difficulties with their lives 3 months after injury. The majority of patients had headaches, but the frequency and intensity of the headaches were not evaluated in sufficient detail to estimate their importance. More than half of the patients complained of memory deficit. These observations are consonant with those of Rutherford et al., who found that half of 131 patients with minor head injury had at least one symptom 6 weeks after the injury (28, 29). One-third of our patients who were gainfully employed before injury were unemployed 3 months later.

Three reasons for persistent problems in these patients bear discussion: (*a*) the residue of organic brain damage produced by the injury, (*b*) psychological reactions to the injury, and (*c*) a quest for secondary gain. Most patients scored lower than their expected norms on the neuropsychological battery, with the principal problems being cognitive deficits in the spheres of attention, concentration, memory, and judgment. This raises the question of the extent to which the intellectual and other impairments demonstrated on the neuropsychological tests in the unemployed patients were due to the consequences of the minor head injury and were responsible in part, at least, for the unemployment noted in this study population and to what extent they were a reflection of the large influences that education and motivation seem to have on the return to work. Preliminary data from this study suggest that a number of the differences in the results on the neuropsychological tests may in fact have been caused by the injury and are not the result of differences in premorbid backgrounds. One of the most important questions raised by this study was the incidence and importance of organic brain damage in patients who are rendered unconscious briefly by a blow to the head.

The neurological examination did not contribute much to the solution of this question. Aside from the score on the Glasgow Coma Scale, only a very small number of patients had a slightly abnormal neurological examination on admission, all were normal at discharge, and very few patients had an abnormality at follow-up and an EEG compatible with that diagnosis. It would have been interesting to have had an EEG on all patients at follow-up as another assessment of brain dysfunction. This was precluded by the expense and is planned in future research efforts with these patients.

Although it has been suggested that there is a correlation between premorbid socio-economic status and postinjury employment in patients with severe head injury (4), to our knowledge this is the first clear demonstration of that relationship in patients with either severe or minor head injury. Two explanations can be considered. Perhaps patients with lower level jobs are less motivated and use their injury as an excuse not to

return to work but, on the other hand, people with professional jobs generally have more resources to buffer the effects of their injuries in their return to work. Our data do not allow a choice between these two explanations.

The second potential cause for so much disability in these patients and for even greater disability in the unemployed compared to the employed patients is emotional stress caused by persistent symptoms and the psychological responses to those symptoms. Many patients described significant life stress before the injury, but it is difficult to know whether these patients were having more problems than their non-head injured fellow citizens from similar backgrounds. When the SRE on admission was compared in patients who were employed and unemployed at 3 months, it was found that the unemployed group had described greater life stress during the 12 months before admission but, on follow-up, the two groups did not differ in the amount of life stress during the interval between injury and follow-up. However, the significant other person of unemployed patients did describe greater postinjury stress.

A major part of the morbidity in patients with minor head injury as a whole was due to persistent complaints, mainly headache and problems with memory. Subjective complaints of memory impairment were supported by objective tests, and memory deficits were much greater in the unemployed compared to the employed patients. Difficulty coping with these problems could be responsible for a considerable amount of stress in the lives of these patients.

A third possible reason for persistent morbidity and a failure to return to work is litigation related to the accident itself and compensation for the injuries. These factors seemed not to be very significant in this group of patients. Only 6 of 424 patients were involved in litigation 3 months after the accident. Despite the large amount of discussion about these factors, there is some evidence that insurance claims are not a significant factor in the return to work after a head injury (11). In one study, even when claims were in process, they did not have an adverse effect on the return to work or on general social recovery (22). Nevertheless, the effects of these issues on recovery from minor head injury require further investigation.

The findings of this study provide evidence for a sequence of events after minor head injury that has been suggested by other investigators. According to our hypothesis, the head injury in many of these patients is much more significant than was assumed in the past. The patients sustain organic brain damage that causes problems in attention, concentration, memory, and judgment. For the most part they recognize these deficits and are disturbed by them. The disturbance is all the greater because the patients were assured at discharge that the injury was inconsequential and that therefore recovery should be immediate and complete. Neither the patients nor their families understand why they are continuing to have so much difficulty, and the harder the patients try, the more anxious and frustrated they become. In time the patients may become incapacitated by the psychological responses to their injuries even though the organic effects may have largely disappeared.

This hypothesis is in line with Russell's proposal that the organic symptoms produced by head injury are prolonged by the patient's psychological responses to those symptoms (27). Others have recognized the importance of the psychological components and have proposed ways to ameliorate them, including "active treatment" (5, 25), encouragement (5), and sympathetic reassurance (13). It has also been suggested that, through "better doctoring" throughout the management of patients with minor head injury, considerable morbidity can be prevented (14).

Minor head injuries outnumber severe head injuries manyfold. Considering the amount of disability that a minor head injury can cause in the individual patient, in the aggregate it may rank alongside severe head injury as a public health problem. In fact, our observations tend to support Sir Charles Symonds' statement that "It is questionable whether the effects of concussion, however slight, are ever completely reversible" (30).

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REFERENCES

1. Anderson DW, McLaurin RL (eds): Report on the National Head and Spinal Cord Injury Survey. J Neurosurg 53(suppl to Nov issue):S1–S43, 1980.
2. Boll TJ: Diagnosing brain impairment, in Wolman BB (ed): *Clinical Diagnosis of Mental Disorders.* New York, Plenum, 1978, pp 601–675.
3. Boll TJ: Behavioral assessment of neurological disorders, in Barlow D (ed): *Behavioral Assessment of Adult Disorders.* New York, Guilford Press (in press).
4. Bond MR: Assessment of the psychosocial outcome after severe head injury. Ciba Found Symp 34:141–159, 1975.
5. Bremner DN, Gillingham FJ: Patterns of convalescence after minor head injury. J R Coll Surg Edinb 19:94–97, 1974.
6. Dikmen S, Reitan RM: Emotional sequelae of head injury. Ann Neurol 2:492–494, 1977.
7. Fuld PA, Fisher P: Recovery of intellectual ability after closed head-injury. Dev Med Child Neurol 19:495–502, 1977.
8. Gronwall D, Wrightson P: Delayed recovery of intellectual function after minor head injury. Lancet 2:605–609, 1974.
9. Hollingshead AB, Redlich FC: *Social Class and Mental Illness: A Community Study.* New York, John Wiley, Inc, 1958.
10. Holmes TH, Rahe RH: The social readjustment scale. J Psychosom Res 11:213–218, 1967.
11. Irving JG: Impact of insurance coverage on convalescence and rehabilitation of head-injured patients. Conn Med 36:385–391, 1972.
12. Jastak JF, Jastak SR: *The Wide Range Achievement Test.* Wilmington, Delaware, Guidance Associates of Delaware, 1965.
13. Jennett B: Early complications after mild head injuries. NZ Med J 84:144–147, 1976.
14. Jennett B: The problem of mild head injury. Practitioner 221:77–82, 1978.
15. Levin HS, Grossman RG, Rose JE, Teasdale G: Long-term neuropsychological outcome of closed head injury. J Neurosurg 50: 412–422, 1979.
16. Lidvall HF: Recovery after minor head injury. Lancet 1:100, 1975.
17. Lishman WA: The psychiatric sequelae of head injury: A review. Psychol Med 3:304–318, 1973.
18. Lundholm J, Jepsen BN, Thornval G: The late neurological, psychological, and social aspects of severe traumatic coma. Scand J Rehabil Med 7:97–100, 1975.
19. Mandleberg LA, Brooks DN: Cognitive recovery after severe head injury: 1. Serial testing on the Wechsler adult intelligence scale. J Neurol Neurosurg Psychiatry 38:1121–1126, 1975.
20. Myers JK, Bean LL: A decade later: A follow-up of social class and mental illness. New York, John Wiley and Sons, Inc, 1968.
21. Oddy M, Humphrey M, Uttley D: Stresses upon the relatives of head-injured patients. Br J Psychiatry 133:507–513, 1978.
22. Oddy M, Humphrey M, Uttley D: Subjective impairment and social recovery after closed head injury. J Neurol Neurosurg Psychiatry 41:611–616, 1978.
23. Oppenheimer RD: Microscopic lesions in the brain following head injury. J Neurol Neurosurg Psychiatry 31:299–306, 1968.
24. Reitan RM, Davison LA (eds): *Clinical Neuropsychology: Current Status and Applications.* Washington, District of Columbia, Winston, 1974.
25. Relander M, Troupp H, Björkesten G: Controlled trial of treatment for cerebral concussion. Br Med J 4:777–779, 1972.
26. Rimel RW, Jane JA, Edlich RF: An injury severity scale for

comprehensive management of central nervous system trauma. JACEP 8:64–67, 1979.
27. Russell WR: Recovery after minor head injury. Lancet 2:1315, 1974.
28. Rutherford WH, Merrett JD, McDonald JR: Sequelae of concussion caused by minor head injuries. Lancet 1:1–4, 1977.
29. Rutherford WH, Merrett JD, McDonald JR: Symptoms at one year following concussion from minor head injuries. Injury 10: 225–230, 1979.
30. Symonds C: Concussion and its sequelae. Lancet 1:1–5, 1962.
31. Teasdale G, Jennett B: Assessment of coma and impaired consciousness: A practical scale. Lancet 2:81–84, 1974.
32. Walker AE: Long term evaluation of the social and family adjustment to head injuries. Scand J Rehabil Med 4:5–8, 1972.
33. Wechsler D: *Manual for the Wechsler Adult Intelligence Scale.* New York, The Psychological Corp, 1955.
34. Wechsler D, Stone CP: *Manual for the Wechsler Memory Scale.* New York, The Psychological Corp, 1948.
35. Wilder CS: *Data from Health Interview Survey.* Rockville, Maryland, National Center for Health Statistics, Department of Health, Education and Welfare, 1976.

COMMENTS

This is an important paper. It is well written, and the experimental design and patient follow-up are well conceived. It is somewhat unfortunate that only a limited number of patients could be studied because of the availability of funds, but the data that were generated are convincing evidence that a considerable amount of disability occurs after so-called "minor head injury." It is clear to many neurosurgeons that patients who suffer only minor injuries (defined, as in this case, by the limited time of hospitalization) often are disabled for significant periods. The observation that memory loss is terribly disabling to these patients is not new, but has been detailed and described in an objective and scientific fashion. The authors make one observation regarding the tendency of those patients holding lower level jobs to have a higher rate of unemployment after injury and suggest that people with professional jobs have more resources to buffer the effects of their injuries. Although this is undoubtedly the case in certain socioeconomic settings, there are suggestions from other countries that quite the contrary occurs, and a much larger set of patients must be studied to answer this question more completely. The conclusion that it is questionable whether the effects of concussion, however slight, are ever completely reversible is certainly correct, and this study goes a long way to support the recently recognized need for extensive investigation, not only into the sequelae of mild and severe head injury, but also toward the development of future programs for the treatment of these disturbances.

Also of interest is the observation that a significant percentage of the patients (in fact, almost one-third) gave a history of previous head injury. The significance of this observation in this particular study is not clear, but it seems that patients who have suffered previous trauma are more likely to suffer significant sequelae from the second injury; this, in fact, has been demonstrated recently in professional athletes.

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The difficulties in assessing the disabilities of individuals who have suffered minor head injuries have presented problems for years. The identification of those factors that are organically based and those psychologically founded has perplexed many clinicians. This paper is a preliminary report of the results of a study designed to examine this problem with modern instruments for evaluating factors that may be responsible for the post-traumatic syndrome.

Of the 424 patients included in this study out of the total group of 539, one-third of the head-injured group were between the ages of 11 and 20 years, and 82% of the patients examined at the time of the accident had significant amounts of alcohol in their blood. After 3 months, many of these subjects with minor head injuries were still complaining of headache (78%) and memory disturbances (59%). At that time, 33% of the group were unemployed; among the laborers, the figure was 40%, and among the white collar workers it was 20%. The small subsample (69 patients) administered the neuropsychological test battery had scores on many of the Halstead-Reitan tests that were above the cutoffs for normals. Similarly, the psychosocial assessment suggested that the unemployed had greater life stresses.

These findings in a heterogenous head-injured population raise a number of questions that may be answered by a well-controlled study. Certainly, the role of alcohol and perhaps other drugs may be an important factor in the convalescence of head-injured patients. The therapy—both physical and psychological—may be an important factor in the convalescence, especially if the patient has made only borderline social and economic adjustment. Future studies with these modern techniques may give a new insight into the problem of head injury.

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