Unconsciousness, amnesia and psychiatric symptoms following road traffic accident injury

RICHARD A. MAYOU, JOHN BLACK and BRIDGET BRYANT

Background Although road traffic accident injury is the most common cause of traumatic brain injury, little is known of the prevalence of psychiatric complications or the significance of unconsciousness and amnesia.

Aims To describe amnesia and unconsciousness following a road traffic accident and to determine whether they are associated with later psychological symptoms.

Method Information was obtained from medical and ambulance records for 1441 consecutive attenders at an emergency department aged 17–69 who had been involved in a road traffic accident. A total of 1148 (80%) subjects completed a self-report questionnaire at baseline and were followed up at 3 months and 1 year.

Results Altogether, 1.5% suffered major head (and traumatic brain) injury and 21% suffered minor head injury. Post-traumatic stress disorder (PTSD) and anxiety and depression were more common at 3 months in those who had definitely been unconscious than in those who had not, but there were no differences at 1 year.

Conclusions PTSD and other psychiatric complications are as common in those who were briefly unconscious as in those who were not.

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This paper presents findings from a prospective study of consecutive attenders at an emergency department following a road traffic accident (Ehlers *et al*, 1998), who were recruited for a self-report study of psychological consequences. It considers two main issues:

(a) the prevalence of head injury and features of possible traumatic brain injury such as unconsciousness and amnesia;

(b) the prevalences of immediate psychological distress and of psychological complications at 3 months and 1 year – post-traumatic stress disorder (PTSD), travel anxiety, anxiety and depression, post-concussional symptoms – in those who were briefly unconscious (minor head injury) as compared with those who did not lose consciousness.

METHOD

The sample was based on 1534 consecutive patients aged 17–69 who attended the emergency department of the John Radcliffe Hospital, Oxford, after a road traffic accident. We excluded those who were unconscious for more than 15 minutes.

Data collection

Information about the accident and injuries was collated on standard data sheets from ambulance, triage and emergency department records, and any in-patient notes, by a research worker who had previously been a senior trauma nurse in the department. Where possible, subjects were approached by a nurse and invited to take part; the remainder were sent information and questionnaires by post.

Patients completed a questionnaire which included questions on their initial emotional reactions to and memory of the accident, whether they thought they had been unconscious, or to blame for the accident, previous travel, and emotional and social adjustment. At 3 and 6 months after the accident they were also sent postal follow-up questionnaires, which included the Post-Traumatic Stress Symptom (PSS) scale (Foa *et al*, 1993), the Hospital Anxiety and Depression (HAD) scale (Zigmond & Snaith, 1983) and questions about phobic travel anxiety derived from previous research (Mayou *et al*, 1993).

Measures

Unconsciousness

This was rated by an emergency medicine physician (J.B.), who examined all available information from the medical records for all patients for whom there was any indication that they might have been unconscious, reported impaired memory of the accident, or had been recorded as suffering an injury to the head (above the hairline) or face.

Three categories were devised:

(a) definitely unconscious: a witnessed statement of unconsciousness;

(b) probably unconscious; not witnessed; the nature of the injury and other reports strongly suggested that the patient was unconscious – a high degree of probability;

(c) not unconscious: no evidence for unconsciousness, and in many cases specific comments that the patient had not been unconscious.

Head injury

Having excluded major head injury, we classified all cases with head injury and unconsciousness of less than 15 minutes as minor. The emergency physician also noted whether patients had suffered a soft tissue or fracture head injury. Injuries to the head above the hairline were distinguished from those to the face. Evidence of brain injury from abnormal computed tomography (CT) scans was noted.

Self-report rating of loss of consciousness and memory of the accident

On the questionnaire, subjects were asked to say whether they thought they had been unconscious or not, or were not sure. Similarly, they were asked to rate their memory of the accident as 'clear', 'patchy' or 'no memory'.

Psychological outcome measures

(a) PTSD: this was the minimum number of symptoms on the PSS scale required by DSM–IV (American Psychiatric Association, 1994) criteria.

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(b) Anxiety or depression case: the recommended cut-off score of 10 or more on the HAD sub-scales of anxiety and depression.

(c) Phobic travel anxiety: a measure combining increased nervousness and avoidance of travel situations, with cut-off points consistent with the DSM–IV criteria for phobia.

(d) Post-concussional syndrome symptoms: self-ratings of the frequency of loss of concentration or irritability in the previous two weeks, from 0, 'not at all', to 3, 'very often (5+ times a week)'.

Statistical analysis

The relationship between unconsciousness and categorical variables was tested using the χ^2 test. Analysis of variance was used for the continuous variable 'age'. Most of the scores on the variables measuring emotional reaction to the accident were rather skewed, so the Kruskal–Wallis one-way analysis of variance was used.

RESULTS

Figure 1 shows how many of the consecutive series were excluded for various reasons, and how many participated at various stages. Seven people died in the emergency department. Another 23 (1.5%) were excluded because they were unconscious for longer than 15 minutes; all these subjects were admitted, suffered prolonged unconsciousness (all more than five days) and satisfied clinical criteria for 'major traumatic brain injury'.

A total of 1441 patients were eligible for the study and were given the questionnaire; their characteristics are summarised in Table 1. There were 309 (22%) who were diagnosed as having had minor head injury (which we defined as unconsciousness of less than 15 minutes), of whom 34% were admitted and 25% were rated as having been definitely or probably unconscious. The great majority of these injuries were abrasions or lacerations, but five people had skull fractures and 21 had facial fractures (one had both).

The remainder of this paper concentrates on data on the 1148 (80%) of those eligible patients who completed the initial assessment, of whom 865 (75%) replied at 3 months and 773 (67%) at 1 year. Those who responded were significantly more likely to be women, to be older, to have suffered fracture and been admitted to hospital. Neither minor head injury nor loss of consciousness was associated with response.

Head injury

Of the 1148 respondents, 261 (23%) were rated as having a minor head injury and 25 (2%) had had fractures. Twelve were investigated by computed tomography (CT) scan, of whom four were reported as abnormal.

Evidence of minor traumatic brain injury

Loss of consciousness

There were 124 respondents (11%) who reported they had been unconscious and 144 (13%) who were not sure – a total of 268. Review of the records suggested that only two of the 874 patients who indicated on the self-report questionnaire that they had not been unconscious had, in fact, been observed by others to be unconscious. Of those who said they had been unconscious, only 19 (15%) had been definitely, and 29 (23%) probably, unconscious as indicated by recorded evidence from bystanders and rescuers. In most of the remainder, rescue and emergency department notes clearly cited evidence that subjects had not lost consciousness although there were some comments about 'confusion' (Table 2).

Subjects classified as having been unconscious reported the accident as less frightening, felt less angry and were less likely to accept blame for the accident (Table 3). These subjects were also more likely to report themselves as numb and dazed in the first questionnaire immediately after the accident.

Unconsciousness was not associated with subsequent involvement in compensation proceedings. Claims were pursued by 36% of those definitely unconscious, 52% of those probably unconscious and 45% of those not unconscious.

Amnesia

Many of those for whom there was definite medical evidence of unconsciousness reported that they had no memories of the accident (44%), but two (7%) reported that they could remember the accident clearly and 13 (48%) described patchy memories (Table 2). Most reported continuing amnesia for parts of the accident at 3 months and 1 year (Table 4). Emergency department medical records rarely recorded the duration of post-traumatic amnesia, but review of medical notes and subjects' comments suggest that amnesia was usually brief and that many subjects had memories for events shortly before and after the road accident. Amnesia was also less frequent in those who had not suffered any head injury.

Amnesia without traumatic loss of consciousness

It was common for patients who had not suffered any head injury to report that their memories of the accident were 'patchy'. There were 28 subjects (2% of the eligible sample) who had no memory of the accident but who were thought not to have suffered any unconsciousness; only two-thirds were drivers. Five of these had suffered head injury above the hairline; of these it is possible that at least two subjects

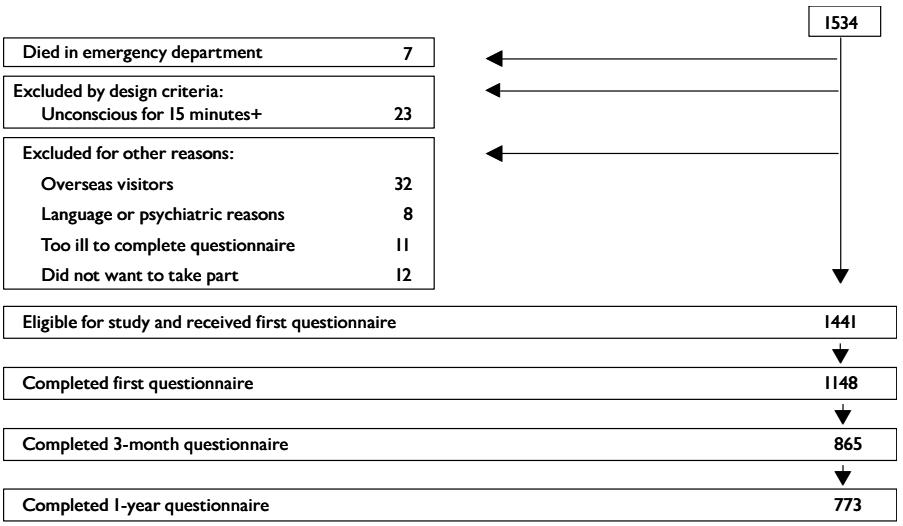

Fig. 1 Consecutive road traffic accident attenders at accident and emergency department aged 17–69.

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Table 1 Demographic and hospital factors by loss of consciousness (eligible sample $n=1441$)[1]

	Definitely unconscious		Probably unconscious		Not unconscious		χ^2 P
	n	(%)	*n*	%	*n*	%	
Gender							<0.01
Male	19	(58)	45	(80)	749	(55)	
Female	14	(42)	11	(20)	603	(45)	
Age, mean (s.d.)	27.6	(8.6)	33.7	(12.9)	32.1	12.8	<0.1
Social class							NS
Non-manual	14	(61)	28	(65)	609	(60)	
Manual	9	(39)	15	(35)	415	(40)	
Accident group							NS
Driver	15	(46)	32	(57)	704	(52)	
Passenger	6	(18)	10	(18)	291	(22)	
Motorcyclist	6	(18)	5	(9)	160	(12)	
Cyclist	2	(6)	6	(11)	138	(10)	
Pedestrian	4	(12)	3	(5)	59	(4)	
Admitted							<0.01
Yes	26	(79)	37	(66)	251	(19)	
No	7	(21)	19	(34)	1101	(81)	
Injury							<0.001
Bony	12	(36)	16	(29)	219	(16)	
Soft tissue	19	(58)	36	(64)	844	(63)	
None	2	(6)	4	(7)	288	(21)	
Head injury							<0.001
Head only (above hairline)	13	(39)	24	(43)	96	(7)	
Face only	8	(24)	18	(32)	105	(8)	
Head and face	4	(12)	9	(16)	32	(2)	
Neither	8	(24)	5	(9)	1118	(82)	
Not known					1		
Drunk							<0.001
Definite/probable	5	(15)	6	(11)	47	(4)	
No/not known	28	(85)	50	(89)	1301	(97)	
Seat belt/helmet[2]							<0.001
Yes	16	(62)	37	(86)	972	(90)	
No	10	(39)	6	(14)	107	(10)	
Not known	1		4		72		

1. Hospital notes were missing for one person.
2. Vehicle occupants/motorcyclists ($n=1229$).

had been briefly unconscious, and three were described in notes as having been 'confused'. Six more suffered facial injuries, one of whom may have been unconscious and two of whom were 'confused'. In 17 there were clear written ambulance or emergency department records of their not being unconscious at any time. In these cases, examination of records suggested that other reasons – medical, psychological dissociation, alcohol intoxication and concerns about prosecution – could have been important causes: medical (diabetes, epilepsy), 2; fell asleep, 1; alcohol intoxication, 3; alcohol intoxication+later conviction, 8; alcohol+'confusion', 1; prosecution+'confusion', 2.

Twenty-one of the 28 subjects who, without loss of consciousness, had no memory of the accident at baseline replied at 3 months; three said they could now clearly remember the accident. At one year four out of the 19 who replied had full memories.

Psychological complications at 3 and 12 months

Post-concussional syndrome symptoms

Poor concentration was more commonly reported by those who had been definitely or probably unconscious, but other symptoms usually said to be part of the post-concussional syndrome (and also of anxiety disorder, PTSD and depression) – for example, irritability, anxiety, lack of energy and depression – were not associated with unconsciousness. Table 4 includes the prevalence at 3 months and 1 year of two symptoms often associated with concussional syndrome.

Post-traumatic stress disorder

Table 5 shows the main psychiatric syndromes at 3 months and 1 year in those who were definitely and probably unconscious and those who were not unconscious. PTSD was significantly more common at 3 months among those who had been definitely unconscious than in the remainder. Specific symptoms in each category of PTSD criteria were checked in those who had been unconscious as well as the symptoms of being unable to remember the accident. However, there was no significant difference at 1 year. Examination of comments on questionnaires, the information from an interview subgroup and medical records all suggest that the intrusive memories of the unconscious patients usually related to events just before or shortly after the accident, including being rescued, receiving emergency treatment and then being rushed to hospital. Eleven of the 21 subjects who were amnesic without being unconscious and who replied at follow-up suffered PTSD during the year.

When we compared those with minor head injury (i.e. unconsciousness of less than 15 minutes) with those who had no head injury, there were no differences in psychological consequences.

We examined case notes for the 23 subjects with major brain injury (i.e. prolonged unconsciousness) excluded from the self-report study, of whom 14 had been assessed by the specialist neurological rehabilitation service and two by the psychiatric consultation service. Both these services routinely assess for symptoms of PTSD and travel anxiety. There were three clearly described cases of subsequent travel anxiety but no evidence that any subject had suffered PTSD. The numbers were too small for statistical analysis.

Other psychiatric complications

Those who had been unconscious were also significantly more likely to score as psychiatric cases of anxiety and depression on the

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Table 2 Patients' reports of unconsciousness and clarity of memories by emergency medicine specialist's rating of loss of consciousness (participants at baseline n=1148)

Emergency physician's rating	Definitely unconscious		Probably unconscious		Not unconscious	
	n	(%)	*n*	(%)	*n*	(%)
Patient thought he/she had been unconscious						
Yes	19	(70)	29	(64)	76	(7)
Not sure	6	(22)	13	(29)	125	(12)
No	2	(7)	3	(7)	869	(81)
Not known					6	
Patient's memory of the accident						
Clear	2	(7)	5	(11)	791	(74)
Patchy	13	(48)	24	(53)	249	(23)
None	12	(44)	16	(36)	28	(3)
Not known					8	

HAD scale at 3 months, although there were no differences at 1 year (Table 5).

DISCUSSION

This prospective study is the first of its kind for road accident victims. It also provides a different kind of evidence from other published traumatic brain injury series in that it enables a comparison to be made in a large representative sample between those who were and were not briefly unconscious. Most cases in which there is evidence of brain injury are medically minor, but fundamental difficulties are that there is no agreed definition of minor head injury or of minor traumatic brain injury (McMillan, 1997; Kushner, 1998) (a term which refers to trauma to the head with no major brain damage but associated with symptoms or signs of brain injury as indicated by impairment of consciousness and post-traumatic amnesia) and that definitions are difficult to apply in emergency clinical care.

The principal limitations are:

(a) The lack of reliable evidence about post-traumatic amnesia (the most useful clinical indication of traumatic brain injury), which was not routinely recorded in the case notes. However, emergency department evidence was reviewed at the time of the accident by a senior and experienced research nurse and subsequently by a specialist in emergency medicine.

(b) The reliance on self-report data.

Frequency of head injury and unconsciousness

By combining figures for different numbers of subjects for the various categories of available data we can summarise prevalences.

Major or minor head injury occurred in 23% of all attenders between the ages of 17 and 69 over the 1-year period, of whom 39% were admitted.

Major traumatic brain injury with prolonged unconsciousness (in all cases five days or more) and post-traumatic amnesia occurred in 1.6%.

Minor traumatic brain injury, as defined by loss of consciousness of less than 15 minutes, was medically rated as definitely occurring in 2% of subjects and probably in a further 4%. Within this group unconsciousness and amnesia were usually very brief – seconds rather than minutes.

Minor traumatic brain injury

In accordance with clinical experience, the definition of minor traumatic brain injury with evidence of impairment of consciousness and post-traumatic amnesia was not easy. Patients were frequently uncertain about whether they had lost consciousness, and they substantially overestimated this as compared with evidence in emergency service records. It is clearly very difficult for subjects to distinguish brief unconsciousness, acute concussion and peritraumatic psychological dissociation. However, although most clinical records did refer specifically to lack of evidence of impaired consciousness, they inevitably underestimate transient impairment of consciousness which may not be witnessed or clearly described by the subject.

Brief amnesia is difficult to assess and may not always be due to brain injury. Memories were frequently reported as 'patchy' by those in whom there was no question of head injury, a probable reflection of psychological dissociation which is a frequent accompaniment of road accidents and other trauma

Table 3 Post-accident reactions of participants by loss of consciousness

Post-accident reaction	Definitely unconscious			Probably unconscious			Not unconscious			P[1]
	Mean	s.d.	CI	Mean	s.d.	CI	Mean	s.d.	CI	
Memory of accident (1–3)	2.37	0.63	2.1–2.6	2.24	0.65	2.1–2.4	1.29	0.5	1.26–1.32	<0.001
Unconscious (pt) (1–3)	1.37	0.63	1.1–1.6	1.42	0.62	1.2–1.6	2.74	0.58	2.71–2.78	<0.001
Frightening (1–4)	2.30	1.35	1.8–2.8	2.11	1.21	1.8–2.5	2.90	1.04	2.8–3.0	<0.001
Not to blame (1–3)	2.31	0.79	2.0–2.6	2.46	0.81	2.2–2.7	2.59	0.70	2.5–2.6	<0.05
Angry (0–4)	0.85	1.38	0.3–1.4	0.83	1.05	1.2–1.4	1.29	1.43	1.2–1.4	<0.05
Guilty (0–4)	0.73	1.31	0.2–1.3	0.66	1.09	0.3–1.0	0.43	0.94	0.4–0.5	NS
Numb (0–4)	1.62	1.47	1.0–2.2	1.20	1.08	0.8–1.5	0.86	1.11	0.8–0.9	<0.01
Dazed (0–4)	1.38	1.20	0.9–1.9	0.95	1.05	0.6–1.3	0.63	0.93	0.6–0.7	<0.001
Anxious (0–4)	1.08	1.02	0.7–1.5	1.39	1.36	1.0–1.8	1.32	1.29	1.2–1.4	NS

1. Test of significance Kruskal–Wallis one-way analysis of variance.

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Table 4 Frequency of psychological symptoms at 3 months and 1 year by loss of consciousness

Symptom (0–3)	Definitely unconscious			Probably unconscious			Not unconscious			P^1
	Mean	s.d.	CI	Mean	s.d.	CI	Mean	s.d.	CI	
3 months										
Cannot remember bits	2.48	0.87	2.1–2.9	1.69	1.15	1.3–2.1	0.50	0.91	0.4–0.6	<0.001
Irritability	0.90	1.09	0.4–1.4	0.38	0.55	0.2–0.6	0.54	0.87	0.5–0.6	NS
Loss of concentration	1.33	1.35	0.7–2.0	0.56	0.80	0.3–0.9	0.48	0.80	0.4–0.5	<0.01
1 year										
Cannot remember bits	1.48	1.29	0.9–2.1	1.38	1.21	0.9–1.8	0.36	0.79	0.3–0.4	<0.001
Irritability	0.67	1.02	0.2–1.1	0.41	0.80	0.1–0.7	0.44	0.79	0.4–0.5	NS
Loss of concentration	1.10	1.22	0.5–1.7	0.56	0.91	0.2–0.9	0.42	0.77	0.4–0.5	<0.01

1. Test of significance Kruskal–Wallis one-way analysis of variance.

(Murray, 1997). There were no differences in psychological outcomes between those who had injury above the hairline and those with facial injury.

Despite the difficulties, we have defined a subgroup who suffered minor traumatic brain injury. Any failure to identify a small number of other patients who were unconscious is unlikely to have significantly affected our findings about the prevalence of later psychological complications.

Psychiatric complications

Discussion of the psychiatric complications needs to consider the considerable overlap in the symptom criteria for the disorders considered in this paper. Thus, many of the symptoms associated with the syndrome of chronic concussion are also symptomatic of other psychiatric disorders, including PTSD, anxiety and depression. It should be noted that being unable to remember parts of the accident was one of the 17 symptoms of PTSD. There were no differences in prevalence at 1 year in those symptoms often associated with concussion included in the HAD scale and the PSS scale, with the exception of difficulty in concentrating.

There were no documented cases of PTSD and only two cases of travel anxiety among the 23 subjects with major head injury who suffered prolonged unconsciousness (and were therefore excluded from our postal study). However, we found clear evidence that PTSD is at least as common in those who suffer brief unconsciousness as in those who were not unconscious.

Several explanations have been suggested in relation to subjects with clear evidence of post-traumatic amnesia. The intrusive memories may relate to events before or after the period of amnesia, there may be islands of preserved memory (Parker, 1996), or it may be that there are 'implicit' memories which result in "intensive psychological distress on exposure to internal or external cues that symbolise or resemble an aspect of a traumatic event" (DSM–IV) (Bryant *et al*, 2000). The higher prevalence of PTSD in our 'definitely unconscious' group suggests that 'concussion' may hinder information processing.

We should consider two further issues in relation to the present series. We should note that those who were definitely or probably unconscious differed from the remainder in terms of variables which we have found to predict later PTSD and other psychological consequences: the severity of injury and in several aspects of their initial response, including the degree to which the accident was seen as frightening, blame, anger and feeling guilty.

It is also important to note the small subgroup of patients who had not suffered unconsciousness but had no memories of the accident and who later suffered higher prevalences of PTSD than other subjects. A major factor appeared to be alcohol, which may impair memory and perhaps information processing. It also seemed probable that denial (conscious or

Table 5 Psychological outcomes by loss of consciousness

	Definitely unconscious		Probably unconscious		Not unconscious		χ^2 P
	n	(%)	*n*	(%)	*n*	(%)	
PTSD at 3 months							<0.05
No	11	(52)	30	(77)	617	(81)	
Yes	10	(48)	9	(23)	179	(23)	
PTSD at 1 year							NS
No	14	(67)	32	(86)	594	(83)	
Yes	7	(33)	5	(14)	116	(17)	
Travel anxiety at 3 months							NS
No	15	(71)	33	(85)	621	(78)	
Yes	6	(29)	6	(15)	173	(22)	
Travel anxiety at 1 year							NS
No	15	(68)	32	(86)	596	(84)	
Yes	7	(32)	5	(14)	115	(16)	
HAD case at 3 months							<0.05
No	13	(62)	35	(90)	638	(81)	
Yes	8	(38)	4	(10)	146	(19)	
HAD case at 1 year							NS
No	16	(76)	26	(70)	567	(80)	
Yes	5	(24)	11	(30)	139	(20)	

PTSD, post-traumatic stress disorder; HAD, Hospital Anxiety and Depression scale.

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unconscious) was common among those at risk of legal proceedings. This was most obvious in the case of complete amnesia reported by a driver who had been responsible for the death of a child and for whom there was extensive neurological and psychiatric documentation of clear consciousness throughout.

Psychological symptoms following traumatic amnesia/unconsciousness

Our findings can be compared with those in other reports. The conclusions are clearly at variance with our own previous conclusions from a series in which there were no cases of PTSD among the few subjects who were briefly unconscious. This should be seen as a chance finding in a much smaller series. Blanchard and colleagues (Hickling *et al*, 1998) recruited subjects a number of weeks after accidents and relied on cognitive testing and self-report of unconsciousness. They found similar rates of PTSD among those who believed they had been unconscious and those who had not. Bryant and Harvey (Bryant & Harvey, 1998; Harvey & Bryant, 1998) studied admitted patients (not all of whom had suffered road accidents) who were assessed as having suffered transient brain injury, and found that 14% satisfied criteria for acute stress disorder, and 24% sastisfied criteria for PTSD among subjects whose amnesia lasted up to 24 hours. Post-concussive symptoms were more frequent in subjects who suffered PTSD (Bryant & Harvey, 1999). Bryant *et al* (2000) have recently reported PTSD following severe traumatic brain injury.

We have demonstrated the particular problems of assessment of minor impairment of consciousness and of brief periods of amnesia and raised issues which require further, more specific research. However, it is apparent that a significant subgroup of road traffic accident victims suffer minor traumatic brain injury and that the risk of subsequent psychiatric complications – including travel anxiety and PTSD – is at least as great as for those who do not suffer brain injury. Many symptoms are not specific for any particular psychiatric disorder. Symptoms associated with chronic concussion were not more common in the subjects with traumatic brain injury but were associated with the other psychiatric complications.

The findings indicate the need for routine recording of post-traumatic amnesia and have clinical implications for the understanding of the complexity of psychological complications.

They also contribute to the evidence base for medico-legal reporting on the significance of evidence of possible minor brain injury, unconsciousness and amnesia in relation to the aetiology of long-term psychological consequences.

CLINICAL IMPLICATIONS

- Patient report of brief unconsciousness is unreliable.
- Clinical recording of post-traumatic amnesia should be routine in all attenders with possible head injury.
- Brief unconsciousness is associated with increased risk of post-traumatic stress disorder.

LIMITATIONS

- No research assessment of head injury or post-traumatic amnesia at hospital attendance.
- Self-report follow-up only.
- Response rate at follow-up was 75% of participants at 3 months and 67% at 1 year.

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