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Prediction of posttraumatic stress disorder by immediate reactions to trauma: a prospective study in road traffic accident victims

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Abstract Road traffic accidents often cause serious physical and psychological sequelae. Specialists of various medical faculties are involved in the treatment of accident victims. Little is known about the factors which might predict psychiatric disorders, e.g. Posttraumatic Stress Disorder (PTSD) after accidents and how psychological problems influence physical treatment. In a prospective study 179 unselected, consecutively admitted road traffic accident victims were assessed a few days after the accident for psychiatric diagnoses, severity of injury and psychopathology. All were inpatients and had to be treated for bone fractures. At 6-months follow-up assessment 152 (85%) of the patients were interviewed again. Of the patients, 18.4% fulfilled the criteria for Posttraumatic Stress Disorder (DSM-III-R) within 6 months after the accident. Patients who developed PTSD were injured more severely and showed more symptoms of anxiety, depression and PTSD a few days after the accident than patients with no psychiatric diagnosis. Patients with PTSD stayed significantly longer in the hospital than the other patients. Multiple regression analysis revealed that the length of hospitalization was due mainly to a diversity of factors such as severity of injury, severity of accident, pre-morbid personality and psychopathology. Posttraumatic stress disorder is common after road traffic accidents. Patients with PTSD at follow-up can be identified by findings from early assessment. Untreated psychological sequelae such as PTSD cause longer hospitalization and therefore more costs than in non-PTSD patients.

Key words Posttraumatic stress disorder · Road traffic accidents · Injury · Psychopathology · Anxiety · Depression · Prospective study

Introduction

The estimated economic cost for the sequelae of 6 million motor vehicle accidents (MVAs) with nearly 2 million injured victims in the United States is \$137 billion (Taylor and Koch 1995) and is estimated to exceed those of coronary heart disease (Hartunian et al. 1980). The view that the psychological sequelae might be an economic problem is supported by the estimation (Malt 1988) that 20–30% of the accident victims suffer from long-lasting psychological problems. Because of the help-seeking behaviour of the patients and the overlap with pain, physical illness or depression, PTSD symptoms might easily be overlooked or misinterpreted. Therefore, the knowledge about psychiatric disorders, such as PTSD, as sequelae of traffic accidents might be valuable, e.g. for surgeons, internists or family practitioners.

The fact that psychological problems may occur after accidents is well known. In 1888 the term “traumatic neurosis” (Oppenheim 1888) was introduced. Since then there has been a controversial discussion about the validity of psychological sequelae of traffic accidents and the problems in differentiating between physical and psychological sequelae. Despite the long-lasting debate and the amount of injured accident victims, knowledge about the prevalence, validity and predictors of psychological sequelae after injuries is sparse.

Accidents are one of the most prevalent traumas in western culture (Taylor and Koch 1995). After accidents, responses such as depression, phobic anxiety or PTSD may occur (Malt 1988; Mayou 1992). In the general population PTSD is estimated for a lifetime prevalence of 5% for men and 10% for women (Kessler et al. 1995); therefore, PTSD is a frequent disorder. The diagnostic criteria for PTSD (American Psychiatric Association 1987) require (a) exposure to a traumatic event, e.g. a severe acci-

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dent, (b) the reliving of the experience, e.g. in nightmares or intrusive thoughts, (c) numbing or avoidance of cues associated with the trauma, (d) hyperarousal and hypersensitivity, e.g. sleep disturbances, exaggerated response to stimuli reminiscent of the trauma, (e) persistence of the symptoms for at least 1 month.

It is estimated that the lifetime prevalence of exposure to an accident is 25% for men and 13% for women (Kessler et al. 1995). Prevalence rates of PTSD vary greatly in studies on accident victims. Rates of 1% PTSD were reported in accident victims of various types (Malt 1988), 11% PTSD in road traffic accident victims (Mayou et al. 1993) and 49% PTSD 4 months after motor vehicle accidents (Blanchard et al. 1994). The wide range of prevalence rates of PTSD might be due to different methodological approaches and shortcomings, e.g. from retrospective studies (Goldberg and Gara 1990; Hickling et al. 1992), low number of subjects (Goldberg and Gara 1990; Feinstein and Dolan 1991; Green et al. 1993) or heterogeneity of type of accident (Malt 1988; Shalev et al. 1996). Little is known about the various factors which might predict PTSD in these groups.

Premorbid psychiatric disorders were found in 37% of the injured patients (Malt 1987). The strongest predictor for developing PTSD was the initial description of horrific memories of the accident (Mayou et al. 1993) itself. Posttraumatic stress disorder did not occur in those who had been unconscious and were amnesic after the accident. Comorbidity was shown with anxiety, depression and phobic travel anxiety. Poor psychological outcome at 1 year follow-up was associated with more intense symptoms of anxiety, depression or "horrific memories" during the first days after the accident.

In a recent study (Blanchard et al. 1996) it was found that extent of injury, involvement in litigation, fear of death and prior major depressive episode were the best predictors for PTSD in motor vehicle accident victims. The authors reported a positive correlation between severity of injury and diagnosis of PTSD. Although the extent of injury is a significant predictor of PTSD, it lacks specificity. Some patients suffer from PTSD after minor injuries in traffic accidents, whereas other victims with a severe level of injury do not develop PTSD. The lack of linearity between severity of injury and PTSD symptoms is one of the problems in litigation processes.

Hypotheses were derived from the findings reported in the literature: patients who will develop PTSD after a road traffic accident can be identified by the severity of the trauma, early assessment of first reactions to the accident and initial psychopathology. To test the hypothesis we conducted a prospective study on PTSD in traffic accident victims.

Patients and methods

In a prospective study design patients who had been injured in a road traffic accident were included. Their injuries were so severe that they had to be treated as inpatients in the Department of Traumatology at the University of Freiburg (Germany). The minimal severity of the injuries of these patients were bone fractures. The

patients who were included lived in the region around Freiburg and were more than 17 years of age. No patient had a loss of consciousness for more than 15 min and no lesions or edema were visible on cranial computed tomography. The Department of Traumatology treats the vast majority of the severely injured accident victims of the region around Freiburg, so there is no relevant selection of patients. Various vehicles were used among the patients who were involved in a traffic accident. Patients were injured as pedestrians, while riding a bicycle or while driving a motorcycle or a car.

Procedure

The hospitalized patients of the Department of Traumatology were asked to participate in the study as soon as possible after the accident. They were included consecutively. Patients gave written informed consent. The study was approved by the local ethics committee.

The patients were assessed a few days after the accident (mean 8.6 ± 6.7 days, range 1–30 days) and were asked to participate in a 6-month follow-up. Trained clinical research assistants conducted the assessments.

Instruments

A few days after the accident, the first reactions and sequelae of the accident were assessed with a structured interview: Anxiety Disorders Interview Schedule (ADIS-R; DiNardo and Barlow 1988), which is a structured clinical interview according to DSM-III-R (American Psychiatric Association 1987). We used the modified German version of the ADIS-R, "Diagnostisches Interview bei psychischen Störungen" (DIPS; Margraf et al. 1991), which was applied to assess a wide range of lifetime psychiatric diagnoses at first assessment after the accident and to assess the psychiatric diagnoses as sequelae of the accident at 6-month follow-up.

A history of psychosocial data and previous trauma was also obtained. Patients were asked about their psychosocial history and previous traumas from early childhood up to the present.

The self-rating instruments for current psychopathology were as follows:

1. Beck Depression Inventory (BDI; Beck et al. 1988a). A widely used standard instrument for self-report of depressive symptoms (21 items, scores range from 0 to 63).
 2. Beck Anxiety Inventory (BAI; Beck et al. 1988b). An instrument for self-reported anxiety symptoms (28 items, scores range from 0 to 84).
- According to the construct of PTSD we administered the following instruments:
3. Impact of Event Scale (IES; Horowitz et al. 1980). The standard in self-reported posttraumatic stress symptoms (15 items, scores range from 0–45).
 4. Posttraumatic Stress Scale (PSS; Foa et al. 1993). A self-report measure to assess the symptoms of PTSD according to the PTSD criteria of DSM-III-R (17 items, scores range from 0–51).

The severity of injury was assessed by the Abbreviated Injury Scale (AIS) (Greenspan et al. 1985). In the AIS seven regions of the body are rated, each for severity of injury, on a scale from 1 to 5. The total score of severity in the injury severity score (ISS) is derived from an algorithm out of the ratings from the AIS.

We also assessed premorbid personality and coping strategies, life events, cognitions during and after the accident, and psychosocial sequelae of the accident, on which we will report in subsequent papers.

Six months later, patients were contacted again by the same research assistant who had assessed them after the accident. Patients were given an appointment in the clinic, they were visited at home, in clinics or, if not otherwise possible, were interviewed by telephone.

In this personal 6-month follow-up assessment we applied (a) the Diagnostic Structured Clinical Interview (ADIS-R) for the occurrence of psychiatric diagnoses since the accident, (b) a structured follow-up interview for the sequelae of the accident concerning health, treatment, social support, litigation, feelings of guilt, etc. and (c) current psychopathology, especially for PTSD.

Statistics

Statistics were performed by means of the SPSS program, version 6.1.2. For categorical variables we applied the chi-square test. Numerical variables were tested by the procedures analysis of variance, analysis of covariance and tests between groups by the test for littlest significant difference (LSD). To predict duration of hospitalization we used a multiple regression analysis.

Results

Patients

Two hundred thirty-one patients were consecutively admitted to the hospital after a road traffic accident. Nineteen (8%) patients refused to participate and another 33 (14%) fulfilled exclusion criteria. One hundred seventy-nine patients fulfilled the inclusion criteria and signed written informed consent for participation in the study. One hundred fifty-two (85% of 179) patients were interviewed for follow-up 6 months later. At follow-up the psychiatric diagnoses as sequelae of the accident were assessed.

Ninety-three (61%) of the 152 patients were male and 59 (39%) were female (Table 1). More victims with PTSD were female and in this respect they significantly differed from the other diagnostic groups of the accident victims ($\chi^2 = 9.97$, $df = 3$, $p < 0.02$). The mean age at first interview was 36.0 years. Forty-one percent of patients were married or lived with a partner.

Table 1 Gender differences in traffic accident victims. Diagnoses by ADIS-R according to DSM-III-R. No. of patients and percentages of each gender category. Differences between male and female patients and diagnostic groups: $\chi^2 = 9.97$, $df = 3$, $p = 0.02$

Diagnostic category	Total no. of patients	Gender	
		Male	Female
No psychiatric diagnosis (at both assessments: lifetime)	51 (33.6%)	36 (38.7%)	15 (25.4%)
Posttraumatic stress disorder (at 6-month follow-up)	28 (18.4%)	10 (10.8%)	18 (30.5%)
Subsyndromal PTSD (at 6-month follow-up)	43 (28.3%)	27 (29.0%)	16 (27.1%)
Other psychiatric diagnosis (at both assessments: lifetime)	30 (19.7%)	20 (21.5%)	10 (16.9%)
	<i>n</i> = 152 (100%)	<i>n</i> = 93 (100%)	<i>n</i> = 59 (100%)

Table 2 Severity of injury in different diagnostic categories. Diagnoses by ADIS-R according to DSM-III-R. ANOVA, $F = 11.13$, $df = 3$, $p = 0.001$. LSD test B > A, C, D; C > A

Diagnostic category	Injury severity score (mean \pm SD)
A) No psychiatric diagnosis (at both assessments: lifetime)	9.47 \pm 3.6
B) PTSD (at 6-month-follow-up)	17.54 \pm 8.98
C) Subsyndromal PTSD (at 6-month follow-up)	12.30 \pm 6.36
D) Other psychiatric diagnoses (at both assessments: lifetime)	10.50 \pm 5.99
All patients	11.96 \pm 6.72

Diagnoses

According to their diagnoses (made at 6-month follow-up) the patients were arranged into four groups (Table 1). In group A 51 patients (33.6% of 152 patients) were subsumed who did not fulfill the criteria for any psychiatric diagnosis at both assessments. They serve as a control group. Group B contains those 28 patients who developed a full PTSD syndrome (18.4% of 152 patients) within 6 months after the accident. In group C the 43 patients who reported a subsyndromal form of PTSD (28.3% of 152 patients) were organized, i.e. they only fulfilled one or two of the DSM-III-R criteria B, C or D for PTSD, as sequelae of the accident. Group D is a mixed category containing the 30 patients who fulfilled the criteria for any other psychiatric diagnosis at both assessments (19.7% of 152 patients) without the diagnoses of full PTSD or subsyndromal PTSD at the follow-up assessment.

In the following we analyze the data of these four groups:

1. Use of vehicle at time of accident. Forty-three patients were car occupants. The majority, i.e. 31 of them, were the drivers. Forty-seven patients were motorcyclists (43 of them were the drivers). Forty-one patients were riding a bicycle when the accident happened, and 11 were pedestrians. A disproportionately high number, i.e. 50% of the PTSD patients, 42% of the subsyndromal PTSD patients, but only 20% of the patients without any psychiatric diagnosis, were car occupants.

2. Severity of injury. The patients with PTSD were injured more severely on the head ($F = 8.95$, $df = 3$, $p \leq 0.001$) and spine ($F = 3.2$, $df = 3$, $p \leq 0.03$), according to the ratings in the Abbreviated Injury Score (AIS).

The overall severity, as assessed in the Injury Severity score (ISS), revealed that the PTSD patients were injured more severely than the other patients ($F = 11.13$, $df = 3$, $p \leq 0.001$; Table 2). The ISS scores of the PTSD patients

Table 3. Early psychopathology in traffic accident victims. Diagnoses by ADIS-R according to DSM-III-R. ANOVA, group differences at $p \leq 0.05$ by LSD test. Total scores of self-rating scales for depression (Beck Depression Inventory *BDI*), anxiety (Beck Anxiety Inventory *BAI*), PTSD (Impact of Event Scale *IES*; Posttraumatic Stress Scale *PSS*) at first assessment, mean \pm SD

Diagnostic category	Self-rating scales			
	Depression (BDI; $n = 123$)	Anxiety (BAI; $n = 123$)	PTSD (PSS; $n = 131$) (IES; $n = 128$)	
A) No psychiatric diagnosis (at both assessments: lifetime; $n = 51$)	3.7 \pm 3.6	6.36 \pm 7.2	7.0 \pm 7.0	3.5 \pm 4.5
B) PTSD (at 6-month follow-up; $n = 28$)	14.1 \pm 10.1	18.9 \pm 14.7	17.0 \pm 6.7	13.9 \pm 7.6
C) Subsyndromal PTSD (at 6-month follow-up; $n = 43$)	7.9 \pm 6.0	11.7 \pm 9.8	14.0 \pm 7.9	8.4 \pm 6.2
D) Other psychiatric diagnoses (at both assessments: lifetime; $n = 30$)	5.4 \pm 4.6	7.8 \pm 8.6	6.9 \pm 7.7	4.2 \pm 4.3
$F = 16.0$	$F = 8.92$	$F = 14.9$	$F = 20.9$	
$df = 3$	$df = 3$	$df = 3$	$df = 3$	
$p \leq 0.0001$	$p \leq 0.0001$	$p \leq 0.0001$	$p \leq 0.0001$	
B > A, C, D	B > A, C, D	B > A, D	B > A, C, D	
C > A	C > A	C > A, D	C > A, D	

were higher (ISS score mean 17.54 ± 8.98) than those of the patients with subsyndromal PTSD (ISS score mean 12.30 ± 6.36), other psychiatric disorders (ISS score mean 10.50 ± 5.99) or those without any psychiatric diagnoses (ISS score mean 9.47 ± 3.60). All patients had a mean ISS score of 11.96 ± 6.72 .

3. Early psychopathology. A few days after the accident, the patients rated their symptoms of the previous 7 days according to the instruction of the rating scales. In several self-rating scales the results of this first assessment revealed significant differences (ANOVA; $p \leq 0.001$) between the patients who later fulfilled all of the criteria for PTSD and those who did not fulfill any or only some of the PTSD criteria at 6-month follow-up (Table 3).

A few days after the accident, the total score of the Beck Depression Inventory (BDI) in those victims with PTSD at follow-up was more than threefold higher than in those victims without any psychiatric diagnosis. The same relationship was found for the scores in the Beck Anxiety Inventory (BAI).

In the Impact of Event Scale (IES) the victims with PTSD at follow-up scored more than twice in the total scores (including items for intrusions and avoidance) than those victims without any psychiatric diagnosis at both assessments. In the Posttraumatic Stress Scale (PSS), which is derived from the PTSD criteria of the DSM-III-R, the differences between the groups were even higher. In the PSS total scores (including subscales for intrusions, avoidance and hyperarousal) the mean scores of the victims with PTSD at follow-up were approximately threefold higher than in those victims without any psychiatric diagnosis, assessed only a few days after the accident.

The victims with a subsyndromal form of PTSD scored in between those victims with PTSD and those without any psychiatric diagnosis. The patients with other psychiatric diagnoses scored mostly like or slightly higher than those patients without any psychiatric diagnosis.

4. Duration of PTSD. At 6-month follow-up assessment 28 patients fulfilled the criteria for PTSD as sequelae of

the traffic accident within the 6 months after the event. However, at the time of the 6-month follow-up assessment, 15 patients (i.e. approximately half of them) no longer fulfilled all of the DSM-III-R criteria B (intrusions), C (avoidance) or D (hyperarousal) for PTSD. Their PTSD was a transient form. Only 13 (46%) of these patients still fulfilled all of the criteria for PTSD at follow-up assessment. This subgroup (8.6% of the total sample of 152 patients) suffered from a chronic form of PTSD.

Comorbidity (post trauma)

Twelve (43%) of 28 victims with PTSD additionally fulfilled the criteria for another psychiatric diagnosis. Eleven (39%) of the PTSD patients reported a depressive syndrome, e.g. major depression. Three (11%) of these patients with major depression also fulfilled the criteria for an anxiety disorder.

From 43 patients with a subsyndromal PTSD, 8 (17%) reported another psychiatric syndrome, e.g. major depression or alcohol abuse.

Duration of hospitalization

The 28 patients with PTSD at follow-up stayed significantly longer in the hospital than the patients of the other diagnostic groups ($F = 12.05$, $df = 3$, $p \leq 0.001$; Table 4). While the patients with the diagnosis of PTSD stayed 37.36 days in the hospital, the patients with subsyndromal PTSD stayed 21.74 days and the patients with other psychiatric diagnoses, and those without any psychiatric diagnosis, were hospitalized 16 days. The severity of the injuries did not explain all of that variance. Even after controlling for the severity of injuries by the ISS score as a covariate, the patients with PTSD had a significantly longer duration of hospitalization than the patients of the other groups.

To examine the relative explanatory power of the variables on duration of hospitalization, a multiple regression analysis was carried out.

Table 4 Duration of hospitalization in patients of different diagnostic categories. Diagnoses by ADIS-R according to DSM-III-R. ANCOVA (ISS as covariate) $F = 12.05$, $df = 3$, $p \leq 0.001$. LSD test $B > A, C, D$

Diagnostic category	Days in hospital (mean \pm SD)
A) No psychiatric diagnosis (at both assessments: lifetime)	16.88 \pm 10.50
B) PTSD (at 6-month follow-up)	37.36 \pm 21.09
C) Subsyndromal PTSD (at 6-month follow-up)	21.74 \pm 15.97
D) Other psychiatric diagnoses (at both assessments: lifetime)	16.80 \pm 16.17
All patients	22.0 \pm 17.18

The overall fit of the multiple regression analysis was significant ($F = 16.39$, $df = 4, 113$, $p \leq 0.001$). The multiple R was 0.60. With few variables we accounted for 36% of the variance on duration of hospitalization: the higher the severity of injury ($\beta = 0.20$), the greater the severity of accident ($\beta = 0.26$), the higher the amount of rigidity ($\beta = 0.26$) and the higher the initial PSS score ($\beta = 0.19$), the longer the duration of hospital stay.

The severity of accident was determined by the extent of injury of other persons. The personality trait of rigidity was assessed with the Munich Personality Test (von Zerssen et al. 1988). Rigidity is a personality trait which is associated with depression.

Discussion

In our prospective study on traffic accident victims we found a prevalence rate of 18.4% of PTSD within 6 months after the accident. Another 28.3% reported symptoms of a subsyndromal PTSD. These rates for PTSD are higher than expected in the general U.S. population (Kessler et al. 1995) and are higher than those found in prospective Norwegian and British studies (Malt 1988; Mayou et al. 1993) but lower than those found in an Israeli study (Shalev et al. 1996). The differences in the findings of the studies might be due to different methodologies. The studies varied in the approaches for the assessment of diagnoses and recruitment or selection of subjects. According to the findings of other authors (Malt 1988; Mayou 1992) we found that within 6 months after the accident the rate of psychological sequelae decreases. However, nearly half of the PTSD patients still fulfilled the criteria for PTSD at 6-month follow-up. Their symptoms may persist for months or years (Taylor and Koch 1995; Shalev et al. 1996) causing a severe and disabling course including loss of job, disturbed family relationships and resulting in litigation and compensation processes. A substantial proportion (28%) of the accident victims develop a subsyndromal PTSD. Although these patients do not develop all of the symptom criteria necessary for PTSD, they show the same, although attenuated, characteristics of increased severity of injury or psychopathological impairment and longer hospitalization as the full PTSD syndrome.

In PTSD patients there were significantly more females than in the other diagnostic groups. These data are in accordance with the findings of a positive correlation between females and diagnosis of PTSD in motor vehicle accidents (Blanchard et al. 1996).

Our findings of a dose-response relationship between the diagnosis of PTSD and the severity of injury does not gain much support in the literature (Feinstein and Dolan 1991; Green et al. 1993), with the exception of one report (Blanchard et al. 1996).

To our knowledge, this is the first report that shows that injured patients with a PTSD stay significantly longer in the hospital than those patients without any lifetime diagnosis of a psychiatric disorder and longer than patients with a subsyndromal PTSD or other psychiatric diagnoses. This holds true even when statistically controlled for the severity of injury as a covariate.

Posttraumatic stress disorder patients exhibited more psychopathological symptoms of depression, anxiety and PTSD a few days after the accident than the other patients. The finding of predictors of PTSD at an early stage after the accident might be helpful in identifying high-risk patients for the development of PTSD after road traffic accidents. In the next step a form of brief intervention program, as is suggested for rape victims (Foa et al. 1995), might be applied to those identified as high-risk patients during hospitalization on surgical wards in order to shorten the hospital stay or prevent the development of a full PTSD.

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