Role of drugs in traffic accidents

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Summary and conclusions

Serum samples from 201 drivers who presented at emergency departments within six hours after being injured in a road accident and 325 control drivers selected randomly at petrol stations were screened for drugs by combined thin-layer and gas chromatography. Blood alcohol concentrations were also measured, and a questionnaire on the subjects' state of health and use of drugs administered. At interview 30 patients (15%) and 44 controls (13%) said that they had taken drugs in the previous 24 hours. Four patients (2%) and six controls (2%) said that they had taken psychotropic drugs, but serum analysis detected psychotropic drugs in 10 patients (5%) and eight controls (2·5%). Diazepam was found in 16 of the 18 subjects in whom psychotropic drugs were detected. Alcohol was detected in 30 patients (15%) and three controls (1%).

Drug use appeared to be somewhat lower in Finland than in other Western countries, and illness to be a more important traffic hazard than drugs in general. Interview was not a reliable method of establishing whether drivers had taken psychotropic drugs. Taking diazepam may increase the risk of being involved in a traffic accident, but alcohol was the most powerful risk factor.

Introduction

Traffic accidents cause great human and economic suffering in modern society, and their prevention has long been a priority issue. Alcohol intoxication is regarded as one of the most important causes of traffic accidents and has been extensively investigated both experimentally and in epidemiological roadside studies. In laboratory experiments therapeutic doses of several drugs have been shown to impair psychomotor skills related to driving.[1] In addition, certain drugs may potentiate the deleterious effects of others or alcohol.[2] Drug consumption in Western countries has increased considerably over the past 20 years,[3] minor tranquillisers in particular having become widely prescribed. It may thus be assumed that harmful drug effects may increasingly endanger road traffic. Epidemiological field studies of the role of drugs in traffic accidents, however, are few. According to two reviews the incidence of use of psychotropic drugs among drivers was about 2-4%, and among fatally injured drivers about 11-18%.[4,5] In a Norwegian study, however, diazepam alone or in combination with alcohol was found in 20% of injured drivers and in 2% of control drivers attending for a medical check-up.[6] Difficulties in forming a comparable reference group have been common to these studies. Skegg *et al*[7] solved this by using a prospective cohort study. They found that use of minor tranquillisers increased the risk of sustaining an accident. Their method of recording drug use, however, was rather inaccurate.

Our study was aimed at elucidating the incidence of drug use associated with driving in Finland and the role of drugs as a risk factor in accidents.

Methods

To obtain groups of patients and controls we used a method similar to that used in the controlled studies of traffic accidents of Borkenstein *et al*[8] and Honkanen *et al*.[9]

Patients eligible for study comprised all injured car drivers who arrived at any of the five public emergency departments in Helsinki within six hours of their accidents during 16 weeks in April, May, September, and October 1977. The number of patients studied was 203. When an eligible patient arrived the nurse called for the interviewer on duty (one of us), who arrived within half an hour. On the basis of a subsample taken from the largest hospital we estimated that we missed 10% of the eligible cases, usually because the nurse forgot to call the interviewer. Information on the patient's driving experience, previous accidents, state of health, use of drugs, consumption of alcohol, and smoking, and the age of the car, cause of the accident, and responsibility for the accident was obtained at interview. A 20-30 ml blood sample was obtained from all patients except two.

Controls—The control group, of a predetermined size, was formed by randomly selecting 352 car drivers at 10 petrol stations in Helsinki on 14 different days during the two periods in which the patients were studied. These days (two of each weekday) were randomly selected. The controls were matched according to weekday, hour of day, and location of the traffic accidents for the periods April-May and September-October of the previous year. They were interviewed in a minibus parked at the petrol station. After the interview they were asked to blow into an Alcolmeter breathalyser, and a blood sample was drawn from 325 of them.

Serum drug analyses—Blood alcohol concentration was measured by the Widmark alcohol dehydrogenase method. The results are expressed as grams of ethanol per litre of whole blood (g/l). Drug analyses were performed by methods developed by Alha *et al*.[10] Thin-layer chromatography, which was used for screening, detects a great variety of drugs in fairly high concentrations. Gas-liquid chromatography was used to detect and measure about 50 drugs in therapeutic concentrations, including psychotropics (for example, benzodiazepines, tricyclic antidepressants, neuroleptics, stimulants, barbiturates, and some newer antidepressants) and analgesics (for example, codeine

TABLE I—*Distribution of patients and controls by number of years for which they had held driving licence*

	<2 years	2-10 years	>10 years	Total
Patients	40 (20)	65 (33)	94 (47)	199 (100)
Controls	31 (9)	113 (33)	199 (58)	343 (100)

$\chi^2 = 17{\cdot}25$, df = 5, $p < 0{\cdot}01$.

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TABLE II—*Reported drug use among 196 patients and 344 controls*

	No (%) using drugs within: 6 hours	24 hours	7 days
	Psychotropic agents		
Patients	1 (0·5)	4 (2·0)	8 (4·1)
Controls	3 (0·9)	6 (1·7)	8 (2·3)
	Analgesics		
Patients	1 (0·5)	8 (4·1)	32 (16·3)
Controls	5 (1·4)	19 (5·4)	60 (17·4)
	Spasmolytics		
Patients	1 (0·5)	5 (2·6)*	7 (3·6)
Controls		1 (0·3)	4 (1·1)
	Respiratory agents		
Patients	1 (0·5)	3 (1·6)	5 (2·5)
Controls	2 (0·6)	4 (1·1)	13 (3·8)
	Cardiovascular drugs		
Patients	5 (2·6)	9 (4·4)	10 (5·1)
Controls	7 (2·0)	11 (3·2)	12 (3·5)
	Hormones		
Patients	1 (0·5)	5 (2·6)	6 (3·1)
Controls	3 (0·9)	6 (1·7)	6 (1·7)
	Chemotherapeutic agents		
Patients	1 (0·5)	5 (2·6)	6 (3·1)
Controls	3 (0·9)	6 (1·7)	6 (1·7)
	Other drugs		
Patients			6 (3·1)
Controls	4 (1·1)	8 (2·3)	22 (6·4)
	All drugs		
Patients	8 (4·1)	30 (15·3)	62 (31·6)
Controls	19 (5·5)	44 (12·8)	89 (25·9)

* Significance of difference between patients and controls: p = 0·026.

Remedia Fennica,[14] a reference book for doctors containing all drugs available in Finland. Psychotropic drugs included antihistamines, anorectic agents, rauwolfia alkaloids, and antimigraine drugs. Cardiovascular drugs also included rauwolfia alkaloids and antimigraine drugs.

Health disorders—Patients and controls were asked whether they had any of the following health disorders: sight or hearing defect, cardiovascular disease, diabetes, epilepsy, other neurological disease, kidney disease, limb defects, mental health problems, and other acute or chronic illnesses. Visual acuity was measured by a screening test. In addition, the interviewers (doctors) used observation and, in selected patients, certain simple methods of physical examination. The actual and potential influence of health disorders on driving ability was assessed.

Statistical methods—Differences in the distributions of the variables were tested by the χ^2 test, and differences in mean ages by the *t*-test. Differences in the detection of drugs were tested with Fisher's exact test. Agreement between the results of serum analysis and statements given at interview concerning drug use was tested with the unweighted κ coefficient.[15]

Results

Characteristics of accidents—Of the 203 accidents, 55 involved a single vehicle and 143 several vehicles. Five collisions were between a single vehicle and an animal. The two most common types of accident were collisions at crossroads with the cars approaching on different roads (54) and collisions in which the driver drove into the back of the car in front (45). According to Finnish traffic regulations, the injured driver was responsible in 99 (49%) of the accidents and not responsible in 75 (37%); the responsibility remained controversial in the remaining 28. Injuries sustained were mostly slight, and 173 (85%) of the injured patients were treated as outpatients. The most common first diagnoses were neck distension (46 patients; 23%), head wound (26; 13%), head contusion (26; 13%), concussion (20; 10%), and contusion of the legs (16; 8%). Bone fractures comprised 26 (13%) of the first diagnoses.

Sociodemographic factors—The proportion of women was higher among the patients (18%) than the controls (11%) (p = 0·03). Young drivers (15-24 years) were proportionately more common among the patients (27% *v* 19%). The mean age of the patients (34·2 years) did not differ significantly, however, from that of the controls (35·5 years).

TABLE III—*Details of patients and controls in whom combined thin-layer and gas chromatographic analysis of serum detected drugs*

Case No	Sex and age	Driving experience*	Responsible for accident	Serum drug concentrations (mg/l)	Reported drug use within one week	Health disorders
				Patients		
1	M36	Good	No	Diazepam (2030)	None	None
2	M23	Poor	Yes	Diazepam (110)	None	None
3	M23	Good	Yes	Diazepam (100)	Isopropamide bromide and diazepam 9 h previously	None
4	M37	Good	Yes	Diazepam (100)	Glycopyrronium bromide and diazepam 9 h previously	None
5	F48	Good	No	Diazepam (60)	Propylene glycol and diazepam 20 h previously	Valvular heart disease, migraine (inactive)
6	M47	Good	No	Diazepam (40)	Aspirin, phenazone, and codeine 36 h previously	None
7	M18	Poor	Yes	Diazepam (30)	None	None
8†	M39	Good	Yes	Diazepam (trace)	Diazepam 7 h previously	None
9	M19	Poor	Yes	Diazepam (trace)	None	None
10	M25	Good	Yes	Diazepam ? (trace)	None	Juvenile thoracic kyphosis
				Controls		
11	M69	Good		Diazepam (180) oxazepam (1300)	None	None
12	M54	Good		Oxazepam (1120)	Phenylbutazone and chloroquine 20 h previously	Rheumatoid arthritis
13	M51	Good		Diazepam (390)	Noscapine hydrochloride 2 h, analgesics about 20 h previously	Acute respiratory infection
14	F57	Good		Diazepam (220)	Contraceptive 20 h, diazepam 3-4 days previously	Diabetes (treated by diet)
15	F45	Good		Diazepam (200)	None	None
16	M26	Good		Diazepam (40)	None	None
17	M25	Good		Diazepam (trace)	None	None
18	M34	Good		Phenytoin (7100)	Phenytoin 2 h previously	Epilepsy
19	M31	Good		Bromhexine (350)	Bromhexine 3 h previously	None
20	M51	Good		Sulphonamide (trace)	Sulphonamide 3 h, and aspirin, phenazone and codeine 12 h previously	Abdominal ureterolithotomy 10 days previously

* Driving experience: poor = driving licence held for less than two years; moderate = driving licence held for two to five years with up to 10 000 km/year; good = driving licence held for over five years, or for two to five years with more than 10 000 km/year.
† Blood alcohol concentration = 2·2 g/l; alcohol was not detected in the remaining patients and controls.

and indomethacin). In addition, some specific methods were used for other drugs: salicylates were determined by Trinder's method[11] in all patients and controls; propranolol was determined by Shand's method[12] in the six patients and four controls who indicated at interview that they had taken the drug but in whom screening did not detect it; phenazone was determined by gas-liquid chromatography with methylene chloride extraction in seven patients; and paracetamol by an estimation kit[13] in five patients and four controls who reported use of analgesics.

Drug classification—The use of the following minor drugs was not considered (see table III): vitamins, iron preparations, expectorants, mucolytes, antacids, laxatives, and topical preparations. The remaining drugs were grouped according to their indications as presented in

One hundred and fifteen (57%) of the patients and 227 (66%) of the controls were married. Twenty-seven (13%) of the patients and 78 (23%) of the controls had professional occupations.

Driving experience—A higher proportion of patients than controls had had a driving licence for less than two years (table I) ($p < 0.01$). Six patients (3%) and one control (0·3%) did not have a driving licence. Forty-nine (25%) of the patients and 62 (18%) of the controls reported having driven less than 10 000 km in the year before interview.

TABLE IV—*Agreement between statements made at interview concerning drug use and results of serum analysis in 201 patients and 325 controls*

Use of drug	Results of serum analysis: Positive	Results of serum analysis: Negative	Coefficient of agreement (x) with 95% confidence limits
	Benzodiazepines		
Confirmed	5	0	
Denied	12	509	0·446 (0·189-0·704)
	Other drugs		
Confirmed	8	2	
Denied	1	515	0·839 (0·660-1·018)
	All drugs		
Confirmed	13	2	
Denied	13	498	0·620 (0·444-0·796)

in three patients and two controls and aspirin in one control. The 10 patients in whom psychotropic drugs were detected were younger than the eight controls, the mean ages being 31·5 and 45·1 years respectively ($p = 0.04$). Nine of these patients were men, of whom one was intoxicated. None of them had health disorders that affect driving.

TABLE VI—*Distribution of patients and controls by blood alcohol concentration*

	Blood alcohol (g/l): 0-0·1	0·2-0·5	0·6-1·5	1·6-	Total
No (%) of patients	170 (85)		4 (2)	26 (13)	200 (100)
No (%) of controls	336 (99)	3 (1)			339 (100)

$\chi^2 = 53.05$, df = 6, $p < 0.001$.

Agreement between results of interview and serum drug analysis—Under half of the patients in whom benzodiazepines were detected by serum analysis reported having taken these drugs (table IV). Reporting of use of other drugs was more accurate. Agreement in patients (0·616) did not differ significantly from that in controls (0·624).

Health disorders—Though health disorders were recorded in 106 (54%) of the patients and 145 (42%) of the controls ($p = 0.008$), most of them, like myopia, were too slight to affect driving. Drug use within the previous 24 hours was reported by six (7%) of the 92

TABLE V—*Details of patients and controls with chronic (permanent) health disorders affecting driving*

Case No	Sex and age	Driving experience*	Responsible for accident	Health disorder	Reported drug use within one week
				Patients	
21†	M31	Good	Yes	Traumatic arm amputation	Sleeping pill 2 days previously
22	F38	Good	?	Short limb anomaly	Salicylamide and phenazone 6 days previously
23	M44	Good	Yes	Traumatic limb defect	Dextropropoxyphene 2 days previously
24	M56	Good	No	Rheumatoid arthritis of hands	None
25	M51	Good	Yes	Disease of lower back and legs	None
26	M65	Good	Yes	Blindness in right eye; poor vision (0·2) in left eye	None
27	M57	Good	No	Blindness in one eye	None
28	M35	Good	Yes	Blindness in one eye	None
29	M27	Good	Yes	Poor vision (0·2) in one eye	None
30	M26	Good	Yes	Colour vision defect	None
31	M45	Good	Yes	Epilepsy	None
32	M63	Poor	Yes	Congestive heart failure, myocardial infarction	Digoxin, frusemide, warfarin, and glyceryl trinitrate within 24 h
33	M45	Good	Yes	Angina pectoris	Cardiovascular drug 2 h previously
34	M27	Good	?	Diabetes	Insulin Novo Lente 12 h previously
35	M34	Good	Yes	Mental disease	Chlorpromazine, other psychotropic drugs, and biperiden 10 h previously
				Controls	
36	M26	Good		Limb defect due to polio	None
37	F33	Good		Rheumatoid arthritis of hands	Aspirin 7 h previously
38	M43	Good		Myopia -15/-15, visual acuity 0·4	None
39	M33	Poor		Myopia -8/-9, visual acuity 0·3	None
40	M21	Moderate		Myopia -9·0/-7·25, visual acuity 0·7	Aspirin and noscapine hydrochloride about 3 days previously
41	M22	Moderate		Deafness	Aspirin 4 days previously
42	M34‡	Good		Epilepsy	Phenytoin 2 h previously
43	M52	Good		Angina pectoris, diabetes	Digoxin and glyceryl trinitrate 1 h, carbutamide 21 h previously
44	M69	Good		Angina pectoris	Digoxin 8 h previously

* For definitions of driving experience see footnote to table III.
† Blood alcohol concentration 3·5 g/l; alcohol was not detected in the remaining patients and controls.
‡ Serum analysis detected phenytoin in this control; no other drug was detected in the patients and controls with chronic health disorders.

Drug interview—Only the use of spasmolytic drugs was significantly ($p = 0.026$) more common among patients than controls (table II). When the minor drugs (see methods) excluded from table II were also taken into account the incidences of all drug use within 24 hours increased from 15 to 18% in the patients and from 13% to 15% in the controls. Only one patient indicated that drug use may have played a causative role in his accident: the accident occurred after a dental operation in which local anaesthesia was used.

Serum analyses for drugs—Psychotropic drugs (table III) were found more commonly in patients than controls ($p = 0.06$). The difference was greater and almost significant ($p = 0.03$) for diazepam. Other than psychotropic drugs the only drugs detected in the serum samples by combined thin-layer and gas chromatography were a sulphonamide and a bromhexine. In addition, specific methods detected propranolol

patients and eight (4%) of the 199 controls without any health disorder, while the figures were 24 (23%) and 36 (25%) respectively in those with health disorders. A chronic (permanent) health disorder that affected driving was found in 15 patients and nine controls (table V) ($p = 0.007$) and was the likely cause of four accidents (anginal pain in cases 32 and 33, epilepsy in case 31, and poor vision in case 26). Chronic health disorders may also have played some causative role in other accidents. The mean ages of the patients and controls with chronic health disorders were 42·9 and 37·0 years respectively. Serum drug analysis did not detect use of psychotropic drugs. The patients with chronic health disorders were older ($p = 0.04$) than those in whom serum analysis detected psychotropic drugs. Six patients and 14 controls reported acute health disorders, most being infections and injuries. Causal relations could not be verified. Use of antibiotics and

analgesics was often reported by these drivers. The only drug found on analysis, however, was sulphonamide, in one control.

Blood alcohol concentrations were appreciably different between the patients and controls (table VI). The mean age of the 30 intoxicated patients was 31·3 years; all except two were men. These patients were judged responsible for their accident in 27 cases, while responsibility in the remaining three accidents remained controversial.

Discussion

Although stopping cars at the sites of the accidents would have been an ideal method of selecting control drivers, randomly selecting them at a nearby petrol station was thought to be an acceptable alternative as police help was not available and blood samples were required. Some drunken drivers may have avoided petrol stations, but users of permitted drugs would not have done since they were not aware of new regulations. It was unavoidable that the interviews were carried out differently at the petrol stations and the emergency departments. The high co-operation rates in both series prevented any serious bias due to non-response.

One difficulty in interpreting the results of serum drug analyses is that the concentrations of many drugs decrease rapidly below therapeutic and measurable levels. Trace concentrations of diazepam, for example, do not exclude the possibility that harmful central nervous system effects may have been operating at the time of the accident. This is true particularly if the drug has been taken irregularly. The low agreement between the data obtained at interview and the results of serum analyses indicated that the interview was least accurate in establishing the use of minor tranquillisers. Better results would have been obtained by combining a careful interview and psychological test with blood and urine drug analyses. This, however, would have been extremely laborious and beyond the means of the present project.

Use of drugs by drivers was less common than expected. Serum analyses showed psychotropic drugs to be present in 5% of the patients and 2·5% of the controls; this incidence is slightly lower than that found in American studies and much lower than that found in a Norwegian study.[4-6] The patients apparently underestimated the causative role of drugs in their accidents. People often drive unaware of the skill-impairing effects of drugs.[16] Nevertheless, the causative role of drugs in traffic accidents in Finland appears to be minor. The only drug overrepresented among injured drivers according to serum analysis was diazepam; this may have been a contributory factor in 1-5% of the accidents. Larger study samples would have been required for more exact assessment of its role. The role of propranolol in traffic accidents also needs further clarification.

Drug use was naturally associated strongly with the presence of a health disorder. Interestingly, however, use of alcohol and chronic health disorders affecting driving did not confound the effects of use of psychotropic drugs as they usually occurred independently. The indications for taking psychotropic drugs usually remained obscure, though psychosomatic disorders seemed to be the reason in some instances. The design of the present study did not allow slight mental health disorders or personality to be controlled for. Together with apparent somatic health disorders these may form a more important traffic hazard than the use of most permitted drugs in Finland. Alcohol had been taken by many more patients than controls, and our results suggest that it is a powerful risk factor.

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ONE HUNDRED YEARS AGO A rather remarkable case, that of Healey *v* Jeffries, was tried lately before Mr Justice Fry and a common jury. This was an action for false imprisonment, brought by a lady's maid against the master of the Abergavenny Workhouse. The plaintiff, who stated that she had previously been in the service of Lady Garth and other notable persons, alleged that, having been ordered to quit by her mistress, Mrs Crawshay Bailey, with one month's wages in lieu of notice, she retired to her room, feeling unwell. Here she was shortly afterwards shocked by the advent of a constable, who burst open the door. He told her she was to go with him to the Union Hotel. Thither she thought she was going, and there she thought she was, until she observed a "notice to visitors" on the wall. Then first she awoke to the consciousness that she was in the workhouse, and not in the hotel. She could not leave that day, which was a Friday, but next day was forwarded (fare paid) to London, whence she wrote the following morning a letter acknowledging the kindness with which she had been treated. Subsequently she commenced these proceedings. According to the evidence of the police, the plaintiff was raving and shrieking in a semi-nude state behind her bedroom door. The doctor who examined her gave it as his opinion that she was suffering from delirium tremens, and not from hysteria. The nurse of the workhouse and the master considered that she was incapable of taking care of herself. The judge, in a rapid but clear charge to the jury, laid down the common law right of every person to liberty, unless lunatic; and, furthermore, unless dangerous either to himself or the public; neither would any *bona fide* belief in another's lunacy justify his detention, unless he were so in fact. Here Dr Irving was of opinion that the plaintiff was in hysterics. Why was his opinion not made known to the workhouse surgeon, Mr Blanch? As to her being dangerous, she made no attempt on herself or on any one else, nor did she threaten any one. Delirium tremens was a serious charge to bring against a young woman earning her livelihood, especially when no evidence had been produced against her in this trial of any taste for drink. Ultimately the jury returned a verdict for the plaintiff—damages, £80. (*British Medical Journal*, 1880.)