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Alcohol, Drugs and Traffic Safety

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Summary

This paper reviews existing empirical evidence on the possible influence of a wide range of psychotropic substances on driving ability. Substances which are considered include alcohol; antidepressants; sedatives and hypnotics; stimulants; opiates; cannabis; anaesthetics. Data are much richer in some of these areas than others. Different research approaches are outlined. Legislative, medico-legal and prevention aspects are briefly noted.

Traffic accidents are a major cause of morbidity and responsible for a wide variety of social problems all over the world. Generally they are multifactorial, but fortunately most of the factors involved can be studied by methods that have been applied to other social and health problems.

It is rather common to say in public health that road trauma belongs now to a new group of epidemics, together with cardiovascular diseases, hypertension, neoplastic diseases. After a rising curve in the occurrence of road accidents in the industrialized countries until 1973, there has since been a definite improvement in the level of road safety and road accident fatalities have declined by about 15%. Nevertheless, at the present moment there are still about 300,000 who are killed and 10 million who are injured throughout the world each year.

Three related factors contribute to road accidents: the *condition of the road*, the *vehicle*, and the *road user*. A relationship is known to exist between the occurrence of a road accident, the condition of the road, and the climate. Experience shows that well designed roads with different lanes can reduce the frequency of road accidents. Consequently a lot of research has been done on the design, lighting, and surfacing of roads for different types of user, including special tracks and paths for cyclists and pedestrians.[1]

The percentage of accidents due to mechanical defects in vehicles is not known accurately, although it is believed that defective brakes, poor lights, worn tyres, and faulty steering are often responsible for accidents.

The behaviour of road-users—more especially drivers and pedestrians, but also passengers to a certain extent—constitutes an important risk factor. Training, experience, age, sex, marital status, way of life, emotional status, visual efficiency, fatigue, reaction time, vigilance, and driving speed, in addition to actual traffic conditions, all play a major part in road accidents.

Finally, there are certain diseases, both acute and chronic especially those which produce sudden loss of consciousness, impaired concentration, defective eye-hand co-ordination, and delayed reaction that can increase the risk of accidents. These include epilepsy, cardiovascular diseases, diabetes mellitus, etc. But the role of such diseases is relatively unimportant apart, perhaps, from those responsible for detective vision.

If a new factor is introduced, e.g. intake of alcohol or another drug, a new system of interaction is added.[2,3]

Table 1(i). *Antidepressants and Driving Impairment*

Antidepressants	Year	Tests*	Impairment	Author
Amitriptyline	1978	SRT	Yes	Crome & Newman[8]
	1979	SRT	Yes	Peck *et al.*[9]
	1982	BRT	Yes	Hindmarch[10]
	1983	CPT/CMT	Yes	Linnoila *et al.*[11]
	1983	DSST/CRT/FFT	Yes	Hindmarch *et al.*[12]
	1983	FFT	Yes	Seppala *et al.*[13]
Amitriptyline-chlordiazepoxide	1980	FFT/CRT	Yes	Hindmarch *et al.*[14]
Desipramine	1983	CPT/CMT	Yes	Linnoila *et al.*[11]
Imipramine	1976	DSST	Yes	Wittenborn *et al.*[1]
	1977	FFT	Yes	Hindmarch *et al.*[16]
	1977	DSST	Yes	Wittenborn[17]
Mianserin	1977	CRT	Yes	Seppala[18]
	1978	FFT/SRT	Yes	Crome & Newman[8]
	1983	FFT	Yes	Seppala *et al.*[13]
Nomifensine	1977	CDS	Yes	Hindmarch[19]
	1980	CDT/FFT/CRT	No	Hindmarch *et al.*[14]
Nortriptyline	1978	DSST/AT/SRT	Yes	Bye *et al.*[20]
Viloxazine	1978	CDT	Yes	Bente *et al.*[21]
Zimelidine	1981	FFT	Yes	Holmberg[22]
	1982	FFT	No	Herberg[23]
	1982	BRT	No	Hindmarch[10]
	1983	FFT	No	Seppala *et al.*[13]
	1983	CPT/CMT	No	Linnoila *et al.*[11]
Mianserin-alcohol	1977	CRT	Yes	Seppala[18]
Zimelidine-alcohol	1982	SEM	Antagonism	Schaffler *et al.*[24]
	1983	CPT/CMT	No	Linnoila *et al.*[11]
	1983	FFT	No	Seppala *et al.*[13]

* See footnote to Table 1(ii).

Advances in pharmaco-toxicological studies and the development of specific laboratory tests have shown that, in addition to alcohol, other drugs, especially psychotropic drugs, can impair mental and physical functions and thus contribute to road accidents.

1. Alcohol

Even if the risk can be defined relative to levels of alcohol, the extent of the problem and the population at risk vary so much that it is important for each country to undertake epidemiological investigation in order to determine the local situation.

As long ago as 1930 there were studies in Europe and North America on the presence of varying concentrations of alcohol in drivers and pedestrians involved and not involved in crashes.

It is now accepted that the increase in accident risk is small at blood levels below 50 mg%, except for teenagers and sick persons. The risk increases 3-, 10-, and 40-fold if the BAC (blood alcohol concentration) exceeds 80, 100, and 150 mg%, respectively. At BAC of 100 mg% or higher, the probability that a person is responsible for the accident in which he is involved is about 90%.

These experimental findings have led to the establishment of 80 mg% as a reasonable BAC limit, and it has been legally accepted in a number of countries.

Behavioural studies have demonstrated a relationship between physiological and psychological factors and certain geographical factors. Theoretically, therefore, it is possible to identify drivers or pedestrians at high risk. High-risk drinking drivers tend to have the following features in common:

- indulgenic in at least occasional driving with high BAC levels;
- frequent consumption of beer or large quantites of liquor in a single session;
- preceding court sentences for driving under the influence of alcohol and/or for other reasons;

- *age less than* 40 years; low socio-economic status and cultural level; tendency towards night and week-end driving; liable to skid off the road, colliding with a non-moving obstacle or other vehicle.

The consequences of these findings have a bearing of the whole approach to drunken driving, from types of sanction to be applied, suspension of driving licence, rehabilitation attempts, and rates of relapse, as well as differential preventive and curative measures.[4-6]

2. Psychotropic Drugs

The larger number of drugs available, the great variation in doses taken, and their metabolic fate, the variability between individuals with regard to rates of uptake and of elimination, the highly differential effects on the Central Nervous System, and for many drugs a lack correspondence between CNS impairment and the blood level of the parent drugs, make it necessary to carry out a large number of alcohol studies by the number of drugs and medicaments.

The latest move in this field is the development of new, exact and promising methods of drug analysis, allowing ascertainment of very low concentrations of different types of drugs as well as of their main metabolites. A growing problem is the combined intake of alcohol and other drugs.

Pharmaco-toxicological Studies on Man-machine Interactions

'Man-machine interaction' is a term that applies not only to the action and skills involved in driving a car, but to the operation of complex machines in general, as in industry.

For the relevant studies, the following approaches are proposed:[7]

(a) Driving in supervised conditions. One possibility is closed-circuit driving on a stretch where, for example, the effects of alcohol on braking time may be analysed. An airport runway is another place where relevant test parameters (following the car at various speeds, lane changing, braking, etc.) can be applied. Supervised driving is a good approach on the whole but special cars are needed preferably with computer-assisted recording devices, and the analysis of the multifactorial results is complex.

(b) Simulated driving consist of the simultaneous testing of different skills with the test subject using normal car equipment, while the driving situation is projected on a screen. The handling of the accelerator, brake, indicator, etc. in various situations are observed and all the data are recorded on magnetic tape and analysed by computer. The approach is expensive, but, since the driving continues for 20–40 minutes, the 'pulling oneself together' phenomenon is minimized.

(c) Laboratory tests are very suitable for predictive studies, provided that

- combinations of tests, rather than a single test, are used;
- the test combinations chosen cover several psychomotor factors;
- in the cross-over studies, the sequence effect is taken into consideration;
- both subjective and objective tests are used;
- conclusions are drawn with care.

On the basis of current knowledge, the psychotropic drugs capable of producing impairment of driving are: antidepressants, sedatives, hypnotics, stimulants, anaesthetics (Table 1), antihistamines, narcotics, hallucinogens, cannabis, volatile liquids, cardiovascular drugs.

Major Epidemiological Issues and Techniques of Assessment

The major epidemiological issues relating to alcohol, other drugs, and road safety are:

(a) the nature and extent of the role, if any, played by these substances in road accidents involving users;

(b) how crashes involving alcohol and other drugs differ qualitatively from other crashes;

(c) causes of increased risk in identified populations;

(d) implications of data for prevention programmes.

Four different approaches have been employed in ascertaining the role of alcohol in road accidents. These are relevant also for other drugs.

Table 1(ii). *Sedative Hypnotics and Driving Impairment*

Sedative-hypnotics	Year	Tests*	Impairment	Author
Bromazepam	1976	CRT/FFT/AT/CT	Yes	Seppala *et al.*[25]
	1981	AT	No	Hobi *et al.*[26]
	1981	FFT/SRT	No	Hobi *et al.*[27]
Clobazam	1979	CRT	No	Hindmarch[28]
	1979	DSST	No	Salkind[29]
	1980	FFT	No	Hindmarch & Parrot[30]
	1980	CDT-LCT	No	Hindmarch & Gudgeon[31]
	1980	SRT	Yes	Kawazu *et al.*[32]
	1981	FFT/DSST/LTC	No	Robinson *et al.*[33]
Clorazepate	1978	FFT/T	No	Dureman *et al.*[34]
	1979	SRT	No	Hindmarch & Parrot[35]
	1980	SRT/LTC	No	Lader *et al.*[36]
Diazepam	1978	DSST	Yes	Shira[37]
	1978	FFT	Yes	Grundstrom *et al.*[38]
	1979	FFT	Yes	Hindmarch & Parrot[35]
	1981	SRT	Yes	Harms *et al.*[39]
	1982	CDS	Yes	Moskowitz & Smiley[40]
	1982	FFT	Yes	Palva *et al.*[41]
	1982	DSST/SRT	Yes	Lader[42]
	1982	DSST/TT	No	Hamilton *et al.*
	1984	CDT	Yes	De Gier[44]
	1984	CDS/SRT	Yes	Willumeit *et al.*[45]
	1985	CDS	Yes	Smiley *et al.*[46]
Flurazepam	1979	DSST/CRT	Yes	Church & Johnson[47]
	1980	DSST	Yes	Roth *et al.*[48]
	1983	CDS	Yes	Willumeit *et al.*[49]
Lorazepam	1979	FFT	Yes	Farhoumand *et al.*[50]
	1979	DSST	Yes	File & Bond[51]
	1980	CDT-LCT	Yes	Hindmarch & Gudgeon[31]
	1982	FFT/T	Yes	Mattila *et al.*[52]
Lormetazepam	1983	CDS	No	Willumeit *et al.*[49]
	1984	GSM/TT	No	Morgan[53]
	1984	CDS/SRT	Yes	Willumeit *et al.*[45]
Midazolam	1983	FFT/CDT	Yes	Hindmarch & Subhan[54]
Nitrazepam	1977	SRT	Yes	Peck *et al.*[55]
	1977	FFT	Yes	Grundstrom *et al.*[38]
	1979	CRT	Yes	Hindmarch[28]
	1979	CRT	Yes	Liljequist & Mattilla[56]
	1980	FFT/CRT	Yes	Hindmarch & Clyde[57]
	1983	SRT/LTC	Yes	Cook *et al.*[58]
	1984	GSM/TT	Yes	Morgan[53]
Temazepam	1980	SRT	Yes	Pishkin *et al.*[59]
	1982	CDT	Yes	Betts & Birtle[60]
	1983	SRT	Yes	Cook *et al.*[58]
Bromazepam-alcohol	1976	AT/CT/CRT/FFT	Yes	Seppala *et al.*[25]
Diazepam-alcohol	1982	FFT	Yes	Palva *et al.*[41]
	1984	CDS/SRT	Yes	Willumeit *et al.*[45]
	1985	CDS	Yes	Smiley *et al.*[46]
Flurazepam-alcohol	1982	CRT/DSST/ FFT/CDT	No	Hindmarch & Gudgeon[61]
Loprazolam-alcohol	1982	CRT/DSST/ FFT/CDT	No	Hindmarch & Gudgeon[61]
Lorazepam-alcohol	1982	FFT/T	Yes	Mattila *et al.*[52]
Lormetazepam-alcohol	1984	CDS/SRT	Yes	Willumeit *et al.*[45]
Midazolam-alcohol	1983	FFT/CDT	Yes	Hindmarch & Subhanz[54]
Amylobarbitone	1974	DSST/T/SRT	No	Tansella *et al.*[62]
	1979	DSST/T/SRT	No	Hindmarch[63]
	1983	SEM	Yes	Tedeschi *et al.*[64]
Amylobarb.-secobarb.	1980	DSST/SRT	No	Linnoila *et al.*[65]
Secobarbital	1985	CDS	Yes	Smiley *et al.*[46]

Table 1(iii). *Stimulants and Driving Impairment*

Stimulants	Year	Tests*	Impairment	Author
Amphetamine	1975	FFT	No	Parrot & Hindmarch[66]
	1976	FFT/SRT	No	Taeuber *et al.*[67]
	1983	SEM	No	Tedeschi[68]
Methyphenidate	1975	FFT	No	Parrot & Hindmarch[66]
Pemoline	1975	FFT	No	Parrot & Hindmarch[66]

Table 1(iv). *Anaesthetics and Driving Impairment*

Anaesthetics	Year	Tests*	Impairment	Author
Alphadione	1972	OI (M.W.)	Yes	Hannington-Kiff[69]
	1975	CDS	Yes	Korttila *et al.*[70]
Methohexitone	1972	OI (M.W.)	Yes	Hannington-Kiff[69]
	1975	CDS	Yes	Korttila *et al.*[70]
Propanidid	1967	EEG	No	Doenicke *et al.*[71]
	1975	CDS	No	Korttila *et al.*[70]
Thiopentone	1975	CDS	Yes	Korttila *et al.*[70]

* Abbreviations used for description of tests in Table 1.

AT =Attention task
BRT =Brake reaction time
CDS =Complete driving simulator
CDT =Car driving test
CMT =Cognitive memory test
CPT =Continuous performance task
CRT =Choise reaction time
CT =Co-ordination tests
DSST =Digit symbol substitution test
EEG =Electroencephalogram
FFT =Flicker fusion test
GSM =Gibson spiral maze
LCT =Letter concellation task
OI (M.W.) ='Ocular imbalance' (Maddox-Wing)
SEM =Saccadic eye movements
SRT =Simple reaction time
T =Tracking task
T.T. =Tapping task.

The first is the anecdotal approach. Individual case histories can suggest relationships and mechanisms in specific instances, but they can provide no information as to the frequency of such relationships.

The second approach involves the systematic analysis of blood or other biological specimens obtained from the persons involved in crashes, but the presence of certain drugs in some accidents does not yield any clue to the frequency with which these drugs contribute to accidents.

The third approach is to compare crash-rates of drivers who use drugs frequently and in large quantities with those of drivers who do not use drugs. The limitation of this method is that any difference observed is attributable to factors other than drug use, unless it can be shown that an excess crash rate on the part of drug-users is solely due to accidents occurring while a driver is under the influence of the drug or drugs in question.

The fourth approach involves epidemiological studies based on the comparative analysis of various drug concentrations in persons who gave and who have not been involved in crashes while on the road under similar circumstances of time and place.

Specific epidemiological studies may be conducted by investigating the cases of those who died and those who survived.

Table 2(i). *Epidemiological Studies on Drivers and on Surviving Injured Drivers and Pedestrians*

Author†	Year	Country	Drugs detected	Sample size	Control group
Crancer & Quiring[72]	1968	U.S.A.	Multiple	302	Yes
Finkle *et al.*[73]	1968	U.S.A.	Alcohol	3409	No
Finkle[74]	1969	U.S.A.	Alcohol/multiple	2500	No
Babst *et al.*[75]	1970	U.S.A.	Opiates	1245	Yes
Babst *et al.*[76]	1973	U.S.A.	Methadone	630	Yes
Blomberg & Preusser[77]	1974	U.S.A.	Opiates/methadone	1562	Yes
Smart*[78]	1974	Canada	Alcohol/mariuana	296	No
Bo *et al.**[79]	1975	Canada	Alcohol	74	Yes
Maddux *et al.**[80]	1975	U.S.A.	Methadone/heroin	174	No
Christensen & Hen*[81]	1976	Denmark	Alcohol/barbiturat. Carbon/monoxide	320	No
Garriot & Latman*[82]	1976	U.S.A.	Alcohol/multiple	135	No
Smart & Fejer*[83]	1976	Canada	Alcohol/multiple	710	No
Lundberg *et al.**[84]	1978	U.S.A.	Alcohol/multiple	836	Yes
Mari *et al.**[85]	1978	Italy	Alcohol/multiple	140	No
Missen *et al.*[86]	1978	New Zealand	Alcohol/multiple	1000	No
Skegg *et al.**[87]	1979	U.K.	Alcohol/multiple	57	Yes
Ferrara *et al.**[88]	1980	Italy	Alcohol/multiple	1000	Yes
Honkanen *et al.**[80]	1980	Finland	Alcohol/multiple	201	Yes
Solarz[90]	1980	Sweden	Alcohol/multiple	6725	Yes
Weher, Dieter & Maier*[91]	1980	Germany	Alcohol/multiple	145	No

* Injured drivers and pedestrians.
† See **References** for full bibliographical details.

Post-mortem Studies

The possible difficulties and limitations of post-mortem studies are as follows.

(1) Age. In many countries (e.g. Canada) it is not usual procedure to perform post-mortem examinations on subjects under 14 or 15 years of age.

(2) Time of death. Persons dead or dying on arrival at hospital must be examined immediately, since it is difficult to establish if a specific substance was taken by the victim before the accident or if it was administered in the hospital in an attempt to save him.

(3) Availability of urine and blood samples. The probability of detecting specific substances is reduced considerably in the absence of blood or urine samples. But while the former are easily obtained, the latter are often in quantities that are insufficient for the determination of drugs or alcohol.

(4) The lengthy period required for collecting a significant case series.

(5) Limitations of the results. This type of research is based largely on the examination of cadavers arriving at the hospital. Thus the false conclusion may be reached that a specific substance played an important role in provoking alterations of driving behaviour, as it is found in a high percentage of this small group of test subjects, whereas the much greater number of persons involved in accidents, but not injured, are ignored.

Studies of Injured Persons

Epidemiological research on survivors of road accidents presents undeniable advantages, over post-mortem studies. These advantages include: the possibility of obtaining a very high and statistically valid number of cases in a relatively short period of time; and the greater readability of the results, stemming from the heterogeneity and great number of the subjects in the test group and from the possibility of collecting precious data through a questionnaire to be answered by those concerned. This type of investigation, however, also raises numerous problems:

(a) the difficulty of choosing and specifying the place of examination of the subjects, considering that data and possibly samples may be collected at the accident site or at the hospital centre receiving them;

(b) the problems, both theoretical and practical, of whether to study all or a selection of the cases dealt with by one or all of the health care facilities in

Table 2(ii). *Epidemiological Studies on Drivers and on Surviving Injured Drivers and Pedestrians*

Author†	Year	Country	Drug detected	Sample size	Control group
Australian Government Publishing Service*[92]	1980	Australia	Alcohol	91,600	No
Keskinen *et al.*[93]	1981	Finland	Alcohol	1631	No
Rockerbie *et al.*[94]	1981	Canada	Alcohol	776	No
Bonnischsen *et al.*[95]	1981	Sweden	Alcohol/multiple	6725	No
Terhune*[96]	1981	U.S.A.	Alcohol/multiple	497	No
Toffel-Nadolny[97]	1981	Germany	Alcohol	15,959	No
White *et al.*[98]	1981	U.S.A.	Sedat./hypnot.	72,000	No
Balint*[99]	1981	Hungary	Alcohol	58,650	No
McGuire[100]	1981	U.S.A.	Alcohol	934	No
Baedeker[101]	1982	Germany	Alcohol/benz.	56,000	No
Jordan* & Young[102]	1982	Australia	Alcohol		No
Warren *et al.*[*103]	1982	Canada	Alcohol	1148	No
Missen *et al.*[104]	1982	New Zealand	Sedat./hypnot.	254	No
Jacobson *et al.*[*105]	1983	Sweden	Alcohol/multiple	244	No
McDermott & Hughes*[106]	1983	Australia	Alcohol		No
Ulrich *et al.*[107]	1984	Switzerland	Alcohol/multiple	144	No
Soderstrom *et al.*[*108]	1984	Sweden	Alcohol	111	No
Neuteboom & Zweipfenning[109]	1984	Netherlands	Alcohol/multiple	40,000	No
Holmgren *et al.*[110]	1985	Sweden	Alcohol/multiple	1603	No
Ferrara *et al.*[111]	1985	Italy	Alcohol/multiple	2000	Yes

* Injured drivers and pedestrians.
† See **References** for full bibliographical details.

a specific locality, and the related problem of the statistical adequacy or inadequacy of the number of cases collected by a single accident service or all accident services combined;

(c) whether or not the constant presence of personnel in the case-collecting office is necessary.

In addition to exploring the local situation, the epidemiological studies must also evaluate the efficacy of the countermeasures adopted, the success of the morbidity/mortality prevention programme, and the degree of development of the national public health system.

The available post-mortem and survivor studies (Tables 2 and 3) report the percentage of psychotropic drugs present in biological fluids, and essentially confirm the figures inferred from an annual survey initiated in 1978 and presently in completion at University of Padua.[88–111]

The percentiles for the association or probable association of drugs with road accidents vary so markedly that it is not possible at present to assign any reliable general or specific value to them.

For *sedative/hypnotics*, the available data show that their use may more than double the risk factor; but for tranquillizers, whose users, emotional and social problems alone increase the risk, the few data available are not conclusive.

The problem of impairment of driving ability by *anaesthetics* is important only in the case of persons receiving outpatient anaesthesia, but even for this group epidemiological data are rare, relating mainly to local anaesthetics. Epidemiological studies in this field are of little use, owing to the impossibility of examining adequate numbers control subjects. Laboratory studies, however, are indispensable since these have already demonstrated the existence of risk in the 24 hours following the use of most forms of anaesthetics and sedative/hypnotics cited above.

From the available data it would appear that *opiate* users are not at special risk of road accidents, but the incomplete reliability of both control groups and laboratory studies calls for caution in arriving at any general conclusions. It is desirable to identify the various phases in the complex clinical conditions of the opiate-user, who may or may not be in therapy.

The absence of exhaustive and systematic epidemiological studies does not permit any evaluation of the *hallucinogens*, whose negative effects on driving have been demonstrated in laboratory tests.

Studies in North America and in Europe seem to demonstrate a significant proportion of *cannabis* users among the victims or survivors of traffic accidents. Besides other difficulties and the associa-

Table 3(ii). *Epidemiological Studies on Fatally Injured Drivers and Pedestrians*

Author	Year	Country	Drug detected	Sample size	Control group
California Highway Patrol[112]	1967	U.S.A.	Alcohol/multiple	772	No
Brownstein *et al.*[113]	1968	U.S.A.	Alcohol/multiple	188	No
Turk *et al.*[114]	1974	U.S.A.	Alcohol/multiple	100	No
Glauz & Blackburn[115]	1975	U.S.A.	Alcohol/multiple	710	Yes
Kaye[116]	1975	Puerto Rico	Alcohol/multiple	508	No
Sterling-Smith[117]	1975	U.S.A.	Alcohol/multiple	267	No
Woodhouse[118]	1975	U.S.A.	Alcohol/multiple	710	No
Sterling-Smith & Graham[119]	1976	U.S.A.	Alcohol/marijuana	1068	Yes
Blackburn & Woodhouse[120]	1977	U.S.A.	Alcohol/multiple	500	Yes
Cimbura *et al.*[121]	1980	Canada	Alcohol/multiple	484	No
McBay[122]	1981	U.S.A.	Alcohol/multiple	343	No
Krantz & Wannerberg[123]	1981	Sweden	Alcohol/multiple	112	No
Sheeman & Bowen[124]	1981	Great Britain	Alcohol	500	No
Crompton[125]	1982	Great Britain	Alcohol	208	No
Ansford & Lecky[126]	1982	Australia	Alcohol/multiple	229	No
Goldsmith & Kearns[127]	1982	Australia	Alcohol	701	No
Irwin *et al.*[128]	1983	Ireland	Alcohol	50	Yes
Barois & Got[129]	1983	France	Alcohol	402	No
Schneider[130]	1983	Denmark	Alcohol	124	No
Vine & Watson[131]	1983	Australia	Alcohol/multiple	425	No
Owens *et al.*[132]	1983	U.S.A.	Alcohol/multiple	169	No
Mason & McBay[133]	1984	U.S.A.	Alcohol/multiple	600	No
Muller[134]	1984	Germany	Alcohol	502	No
Wechsler *et al.*[135]	1984	U.S.A.	Alcohol/marijuana	623	No

tion of the drug with other drugs, there remains the problem of the reliability of the control groups, which are particularly difficult to establish in the case of users of illegal substances. However, several laboratory studies have furnished evidence that cannabis reduces driver performance. Equally sound epidemiological investigations have been performed on *stimulants* and *antidepressants*, whose effects on driving performance are known at therapeutic doses. Of the other psychotropics drugs, *antihistamines*, deserve particular attention, not so much because of any widespread use (no more than 2–3% of road users are involved according to the available data), but rather for their ascertained sedative effect and for their potentiating effect when associated with other drugs.

Only isolated data exist on *hormones* and *cardiovascular drugs*, which theoretically influence driver behaviour. In any case, no involvement over 3–5% is reported.

Finally, *solvents* and *carbon monoxide* are worthy of attention, not because of the possibility of acute poisoning, but because of the voluntary sniffing of benzene, ethyl acetate, and the like. Mention must also be made of the low carbon monoxide levels produced through tobacco smoking. Even in the absence of exhaustive studies, it is reasonable to assume that the contribution of these substances to the general phenomenon of road accidents is negligible.

3. Legislative Aspects

The legal and medical principles applied are more or less the same in a number of countries and aim at reducing the number of persons driving under the influence of alcohol or drugs.

There are three ways of defining illegal behaviour as regards the use of drugs by those involved in traffic accidents. The first is based on observation of the subject's clinical state, his or her behaviour, and other circumstantial facts. The second is based on the identification and assay of alcohol and drugs in the biological fluids of the person or persons involved in the accident. The third is the sum of the preceding two.

By compromising between political, practical, and public safety necessities, several countries have introduced a legal BAC limit (Table 4) with various penal sanctions and fines based on the gravity of the offence.

In addiction, several countries prohibit driving under the effect of drugs, without specifying their concentration in biological fluids, since the quantitative relationship between this concentration and driver performance is not clear. Hence, the impossibility of recording clinical and circumstantial findings, and the consequent difficulty of applying penal sanctions or fines.

4. Medico-legal Aspects

The efficacy of the measures adopted depends upon the rapidity of their application; procedures must therefore be highly simplified. They should comprise the following phases: breathanalyser test in case of behaviour suspected to be conditioned by alcohol; medical examination and taking of blood and urine samples when it is suspected that the use of alcohol and/or drugs is involved in an offence; analysis of biological fluids by a qualified, authorized laboratory; and police investigation. Since impairment of driving ability may be demonstrated by clinical examination, several countries have developed selected psychomotor and perceptional tests for the examination of drivers suspected of using drugs or alcohol. In addition, medical personnel must determine if the suspected is suffering from any disease and decide whether he or she has been drinking, is an acute alcoholic, or is under the influence of drugs. With the introduction of fixed BAC limits, there has been a tendency in most industrialized countries to limit the use of clinical tests. Nevertheless, it is important to perform tests on suspected persons who having consumed alcohol, and on those suspected of being under the influence of legal or illegal psychodrugs. A discrepancy between individual behaviour and the result of breathalyser tests suggests that those should be a clinical test and an examination of blood and urine for the presence of drugs.

When BAC is used to judge the level of impairment in driving performance, it must be known whether the blood sample refers to the ascending or descending part of the Widmark curve. If it is suspected that consumption took place shortly before the examination, it is best to wait 30 minutes; otherwise, it is more useful to take two samples at an interval of an hour, so that the direction of the curve is more clearly detectable. The degree of alcohol concentration in the blood, as well as the identification of its points on the curve, should establish the basis for an evaluation of the legal consequences. Furthermore, BAC should be determined by law in all road traffic victims admitted to hospital, and in all victims of fatal accidents, in which case the blood test may be replaced by one of occular fluid. In the case of alcohol, the use of the breathalyser is a useful screening procedure in countries where a fixed concentration limit is laid down. Suspects are then subjected to analysis of a blood sample.

The problems relating to alcohol are much simpler than those involved in estimating and evaluating the role of other drugs in traffic cases. The difficulties are due to the remarkable number of drugs, the possibility of combining two or more drugs, and especially possibility of combining drugs with alcohol. As well as applying suitable technical procedures the laboratory staff must interpret the significance and value of the analytical findings in blood, urine, and tissue samples (fatal cases). For this purpose, an accurate and specific knowledge of a variety of pharmaco-toxicological factors is needed.

In some developed countries, the following procedure has been adopted. When no drugs are found in the blood sample or those found are known to be non-hazardous for driving at normal doses, the conclusion is of a negative or excluding kind. If hazardous drugs are detected, but their concentration in blood is below therapeutic level, it is concluded that it is fairly unlikely to have produced an effect on driving ability. When hazardous drugs are found in blood at therapeutic level, it is declared that the possibility that ingested drugs contributed cannot be excluded; if the concentration of the drug is very high a short indication of the toxic concentrations is furnished. In any case a critical interpretation is indispensable.

In medico-legal cases the various investigations must meet the requirements of strict necessity and ethical respect for the person involved. In view of the lack of success of punitive sanctions legislative bodies are beginning to consider programmes based on education, treatment, voluntary commitment, and other alternative approaches.

5. Prevention

It is meaningless to set up programmes of punishment, treatment, or education if nothing serious is done about the fundamental aspect of prevention. The following sub-programme should therefore be undertaken.

General publicity on the risk of driving under the influence of alcohol, drugs, and/or narcotics and the relevant penal, civil, and insurance sanctions.

Information and education of health personnel, and in particular physicians and pharmacists, on the risks arising from the use of drugs.

Abolition of their legal sale of alcohol in high-risk areas, such as service areas on motorways. The issue or renewal of driving licences to be subject to careful and obligatory medical check-ups and police records.

Periodic random checks on drivers not involved in road accidents with the aim of maintaining awareness of the possibility of sanctions, controlling relevant trends, and evaluating the efficacy of the countermeasures adopted.

Pharmaceutical companies should be required to print on the containers of all drugs put on sale detailed information on the ascertained or possible risks of driving impairment through use of the drug in question.

The phenomenon of road accidents produced or aggravated by the use of psychotropic substances has grown to a disturbing extent in developed countries and is in danger of becoming an important public health problem in developing countries too. In the latter, morbidity and mortality due to traffic accidents are increasing as specific consequences of unsatisfactory mechanical facilities, environmental conditions, and licensing procedures. These countries can reduce the spread of this phenomenon by learning from experience acquired elsewhere, and setting up long-term programmes of prevention and enforcement.

As regards the part played by psychotropic drugs, the fundamental premise for the establishment of such programmes consists of acquiring reliable information on the current local situation by means of epidemiological investigations.

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