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J. C. Garriott,[1] Ph.D.; V. J. M. DiMaio,[2] M.D.; R. E. Zumwalt,[3] M.D.; and C. S. Petty,[4] M.D.

Incidence of Drugs and Alcohol in Fatally Injured Motor Vehicle Drivers

Previous studies have implicated drugs as a significant factor in intoxicated motor vehicle drivers [*1,2*]. Little has yet been published on the incidence and role of drugs in motor vehicle crash fatalities, however. A comprehensive study by the Midwest Research Institute on specimens from victims of motor vehicle crashes procured from a number of geographic locations has indicated an incidence of positive drug findings of 13.09% in the urine of fatally injured drivers [*3*]. In only about 4% were drugs detected in the blood of victims, however.

The present study used comprehensive toxicologic screening on blood samples to determine the incidence of drugs and alcohol in a series of victims in motor vehicle crashes in Dallas County.

Method

All motor vehicle-associated fatalities occurring in Dallas County within a 1½-year period (June 1974 through December 1975) were included in the study. These included drivers, passengers and pedestrians. Excluded were those who survived 24 h or longer after the accident and in which no blood specimens taken on arrival at the hospital were available for toxicologic analysis, and children under the age of 15 years. The autopsy specimens saved for analysis always included blood and in some cases urine.

Four analytical procedures were carried out on blood samples from each case:

1. Carboxyhemoglobin saturation was determined by analysis of 0.5 ml of blood by using the technique of Freireich with the Co-Oximeter (Model IL182, Instrumentation Laboratory, Inc.) [*4*].

2. Screening for acidic and neutral drugs was performed by an ultraviolet spectrophotometric procedure previously described [*1*]. Included were barbiturates, salicylates, carbamates, glutethimide, and others.

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[1]Chief toxicologist, Southwestern Institute of Forensic Sciences, and assistant professor, Departments of Pathology and Pharmacology, University of Texas Southwestern Medical School at Dallas, P.O. Box 35728, Dallas, Tex. 75235.

[2]Medical examiner, Southwestern Institute of Forensic Sciences, and assistant professor, Department of Pathology, University of Texas Southwestern Medical School at Dallas, Dallas, Tex.

[3]Assistant medical examiner, Southwestern Institute of Forensic Sciences, and instructor, Department of Pathology, University of Texas Southwestern Medical School at Dallas, Dallas, Tex.

[4]Chief medical examiner, Southwestern Institute of Forensic Sciences, and professor, Department of Pathology, University of Texas Southwestern Medical School at Dallas, Dallas, Tex.

3. Basic drugs, including synthetic narcotics, tranquilizers, antihistamines, amphetamines, and others, were detected and quantitated by gas chromatography as previously described [1,5]. When drugs were present in trace quantities, or for confirmation in some cases, further identification was accomplished with gas chromatography-mass spectrometry (Finnigan Model 3100D).

4. Alcohols were determined by the gas chromatographic method of Jain [6].

In about half (47%) of the cases, urine was available for screening. In these cases, three additional tests were performed to detect certain drugs more readily detected in urine than in blood: (1) the ferric chloride, perchloric acid, nitric acid (FPN) reagent color test for phenothiazines [7]; (2) the Trinder's reagent test for salicylates [8]; and (3) the diphenylamine test for ethchlorvynol [9].

Results

A total of 207 cases met the criteria for inclusion in this study. Table 1 shows the total number of individuals in each category (drivers, passengers, and pedestrians) as well as the number in each category positive for alcohol, drugs, or alcohol and drugs. In the total sample, one or more drugs were detected in 15% of all individuals and ethyl alcohol in 62%. Of the drivers, drugs were detected in 18% and ethyl alcohol in 61%. In only 30% of the drivers were neither drugs nor alcohol detected. Although a smaller sample, of 22 pedestrians killed by motor vehicles, 18 had drugs or alcohol detected. This left only 4 individuals (18%) free of drugs or alcohol.

TABLE 1—*Results of toxicologic study of fatalities in motor vehicle accidents from 9 June 1974 through 31 Dec. 1975.*[a]

	Negative	Alcohol Positive[b]	Drugs Positive	Alcohol and Drugs Positive[b]	Total Cases
Drivers	38 (30)	66 (52)	11 (9)	12 (9)	127
Passengers	20 (35)	32 (55)	4 (7)	2 (3)	58
Pedestrians	4 (18)	15 (68)	2 (9)	1 (5)	22
Total	62 (30)	133 (55)	17 (8)	15 (7)	207

[a] Percent of total in parentheses.
[b] Mean alcohol concentration of all drivers with positive alcohol was 204 mg/dl.

Table 2 lists the psychoactive drugs detected in the drivers. With three exceptions involving detection of phenmetrazine, Butazolidin®, and amitriptyline, all the drugs were in the category of central nervous system depressants. Only one drug was present with any great frequency and this was the tranquilizer diazepam. Thirteen (56.5%) of the 23 drivers in which drugs were found had detectable concentrations of this drug or the major metabolite, nordiazepam. Barbiturates were the next most frequent group of drugs found, appearing in four (17.4%) of the cases. Table 3 lists the drugs detected in nondrivers (passengers and pedestrians). Again, diazepam was the most common drug detected.

Analysis of police accident reports and reports by investigators of the medical examiner's office revealed that 105 of the 127 drivers were at fault in their respective accidents. Table 4 shows these drivers in relationship to the presence or absence of alcohol or drugs, or both. Three of the drivers found to be positive for drugs were not at fault in their respective accidents. These were Cases 4, 6, and 10 in Table 5. Of the 22 drivers

TABLE 2—*Incidence of drugs detected in drivers.*

Drug	Cases in Which Drug Was Detected, *n*	Drug-Positive Cases in Which Drug was Detected, %
Diazepam (or metabolite)	13	56.5
Barbiturates	4	17.4
Antihistamine	3	13
Methaqualone	2	8.7
Propoxyphene	2	8.7
Pentazocine	2	8.7
Alphaprodine	1	4.4
Amitriptyline	1	4.4
Morphine	1	4.4
Phenmetrazine	1	4.4
Butazolidin	1	4.4

TABLE 3—*Incidence of drugs detected in nondrivers.*

Drug	Drug Detected, *n*
Diazepam	4
Barbiturate	2
Propoxyphene	2
Phenmetrazine	2
Codeine	1
Salicylate	1
Gantrisin®	1

TABLE 4—*Number and percentage of drivers at fault and not at fault in relationship to presence and absence of drugs.*[a]

	Negative	Alcohol	Drugs	Drugs and Alcohol	Total
Total drivers	38 (30)	66 (52)	11 (9)	12 (9)	127
Drivers at fault	25 (24)	60 (57)	8 (8)	12 (11)	105
Drivers not at fault	13 (59)	6 (27)	3 (14)	0 (0)	22
Drivers at fault, % within each category	66	91	73	100	82

[a] Percent of total in parentheses.

determined to be without fault in the fatal accident in which they were killed, 9 or 41% had either alcohol or drugs in their systems. Of the 105 drivers presumed to be at fault, 80 or 76% had detectable drugs or alcohol, or both, in their systems at the time of the accident.

The drugs detected in the drivers, with the concentrations found in blood, are given in Table 5. Two of the cases require additional explanation. In Case 2, three drugs were detected in the blood, all of which were in concentrations usually considered to be lethal or near-lethal. Investigation revealed the individual to have been a long-term drug taker and drug abuser with a history of psychiatric problems who had regularly procured drugs

TABLE 5—*Fatally injured drivers in whom drugs were found.*

Case	Age/Race/Sex	Drugs and Concentrations in Blood, mg/dl	Intoxication Rating, Drugs[a]
1	53/w/m	diazepam, 0.03	+ +
		demethyldiazepam, 0.06	
2	36/w/m	propoxyphene, 0.28	+ + +
		pentazocine, 0.23	
		amitriptyline, 0.12	
3	40/w/m	diazepam, 0.08	+ +
		demethyldiazepam, 0.01	
		methaqualone, 0.04	
4[b]	22/w/m	phenmetrazine, 0.01	0
5	21/w/f	secobarbital, 0.53	+ +
		diazepam, 0.10	
		demethyldiazepam, 0.21	
6[b]	55/b/f	diazepam, 0.01	0
		demethyldiazepam, 0.01	
7	45/w/f	diazepam, 0.12	+ +
		demethyldiazepam, 0.04	
8	18/w/m	morphine:	+ + +
		blood, 0.031	
		urine, 1.40	
9	57/w/m[c]	diphenhydramine, 0.01	0
		chlorpheniramine, 0.01	
10[b]	60/w/m	phenobarbital, 0.56	+
		propoxyphene, 0.02	
		norpropoxyphene, 0.06	
11	78/w/f	pentazocine, 0.04	+ +
		diazepam, 0.01	
		demethyldiazepam, 0.01	

[a] The intoxication rating is based only on the drug concentrations and excludes the role of ethyl alcohol, when present; 0 = therapeutic drug concentration; + = greater than the therapeutic concentration of at least one drug; + + = high concentration indicative of drug abuse; + + + = concentration of at least one drug in lethal range.
[b] Cases in which driver was not at fault.
[c] Motorcycle driver.

with forged prescriptions. Apparently his acquired drug tolerance permitted him to withstand large doses of these drugs. Case 8 involved a driver who apparently injected himself intravenously with heroin just prior to running his car off the road and hitting a fixed object. The death in this case could have been the result of a heroin overdose.

The mean blood alcohol concentration for all drivers having alcohol detected in their blood was 207 mg/dl. Alcohol was regarded as present if concentrations of greater than 10 mg/dl were detected. In only eleven of the 78 positive cases was the blood alcohol concentration less than 50 mg/dl. The range of alcohol values was from 30 to 468 mg/dl. Carboxyhemoglobin was measured in all but two of the drivers (125 cases). The range of values was from 0 to 14% saturation, with a mean of 6.54%. Excluded were three drivers killed in vehicles that caught on fire. These latter cases had 65, 41, and 29% carboxyhemoglobin saturation.

No salicylates, ethchlorvynol, or phenothiazines were found in those cases where the urine was subjected to analysis.

Discussion

It has long been suspected that drugs are a significant contributing factor in the causation of motor vehicle accidents. Studies in which urine is used to detect the presence of drugs in drivers involved in fatal crashes suffer from the inherent defect that detection of a drug in urine indicates only that the individual had taken the drug and not that he was actually under the influence of it. The slow excretion rate of some drugs may permit their detection days after ingestion, when circulating blood concentrations are below those required to have any pharmacological action.

Only recently has it become technologically feasible to perform an accurate screen of the blood of drivers for drugs. The detection of certain widely used prescription drugs, such as Valium® and Darvon®, has been difficult because of very low therapeutic blood concentrations of these drugs. The newer techniques and instrumentation now make such determinations practical, and studies involving drug detection in blood are more reliable.

In our study, the blood of the driver was subjected to toxicologic screens for alcohols; acidic, basic, and neutral drugs; and carboxyhemoglobin. Of the 127 drivers studied, ethyl alcohol alone was detected in 52%, other drugs in 9%, and both drugs and alcohol in another 9%. Thus drugs were present in 18% of all drivers and ethyl alcohol in 61%.

Table 4 shows that 76% of the drivers presumed to be at fault had drugs or alcohol in their blood, while 41% of the not-at-fault drivers had drugs or alcohol detected. All the drivers in which both drugs and alcohol were detected were at fault in the accident, compared to 91% of the drivers with alcohol alone, 73% with drugs alone, and 66% of the drivers with negative toxicological results. These statistics strongly suggest that the presence of drugs or alcohol contributes to causation of accidents.

Table 5 lists all fatally injured drivers in whom drugs were detected with their respective drug concentration. Eight of the eleven drivers were responsible for the accidents. Two of the three not responsible for their respective accident (Cases 4 and 6) had low, presumably therapeutic, concentrations of the drugs in the blood. The other driver not at fault (Case 10) had concentrations of propoxyphene and norpropoxyphene consistent with a large therapeutic dose. Maximum therapeutic blood concentrations for propoxyphene and diazepam were taken as 0.02 mg/dl [*10,11*].

Of the eight individuals responsible for the accidents in Table 5, two (Cases 2 and 8) had drug concentrations in the lethal range, five had concentrations indicative of drug abuse, and one had therapeutic drug concentrations.

Table 6 lists the twelve drivers in whom both alcohol and drugs were detected at the time of death. Two of these individuals had blood drug concentrations indicative of drug abuse (Cases 2 and 4); one (Case 9) had a concentration of methaqualone higher than therapeutic, approaching concentrations seen in abuse but still consistent with a large therapeutic dose; and nine had therapeutic concentrations of drugs.

Comparison of the drug concentrations between the at-fault drivers in Tables 5 and 6 reveals that in those drivers with only drugs in the blood, seven of eight had drug concentrations above therapeutic, while of the individuals in the drug-alcohol group, three of twelve drivers had blood concentrations above therapeutic. Thus, in the second group the combination of drugs with alcohol, rather than drugs alone, appears to have induced a state of intoxication contributing to the accidents. It can, of course, be argued that in a number of these cases the concentrations of alcohol alone were adequate to have incapacitated the driver sufficiently to explain the accident and that the finding of drugs is incidental. In Case 5 (Table 5) where only Butazolidin (a nonnarcotic analgesic) was detected, this is a probability. It is an accepted fact, however, that most drugs having central nervous system depressant activity act synergistically with alcohol, leading to a much enhanced degree of intoxication [*12,13*]. In the other cases (Table 6), seven of the eleven individuals had diazepam detected in the blood. Linnoila and Mattila [*14-16*] have shown in their research that whenever diazepam and alcohol are given together, any combination of the doses impairs the reaction time, coordination, and attention of drivers. These authors also noted that the drivers with impaired abilities (because of

TABLE 6—*Fatally injured drivers in whom drugs and alcohol were found.*

Case	Age/Race/Sex	Alcohol and Drug Concentrations in Blood, mg/dl	Intoxication Rating, Drugs[a]
1	58/b/m	EtOH, 210 phenobarbital, 0.20	0
2	25/w/f	EtOH, 190 diazepam, 0.11 demethyldiazepam, 0.03	+ +
3	54/w/m	EtOH, 420 demethyldiazepam, 0.03	0
4	60/w/m	EtOH, 470 diazepam, 0.08 demethyldiazepam, 0.05 Gantrisin, positive	+ +
5	28/b/m	EtOH, 290 Butazolidin, positive	0
6	54/w/m	EtOH, 75 demethyldiazepam, 0.03	0
7	35/w/m	EtOH, 270 phenobarbital, 0.72	0
8	24/b/m	EtOH, 250 diazepam, 0.01 demethyldiazepam, 0.01	0
9	19/w/m	EtOH, 80 methaqualone, 0.07	+
10	60/w/m	EtOH, 150 diazepam, 0.01 demethyldiazepam, 0.01	0
11	50/b/f	EtOH, 30 alphaprodine metabolite, positive pheniramine, positive	0
12	27/w/m	EtOH, 210 diazepam, 0.01 demethyldiazepam, 0.02	0

[a] The intoxication rating is based only on the drug concentrations and excludes the role of ethyl alcohol, when present; 0 = therapeutic drug concentration; + = greater than therapeutic concentration of at least one drug; + + = high concentration indicative of drug abuse; + + + = concentration of at least one drug in lethal range.

diazepam and alcohol) did not have any loss in subjective appraisal of capacity of performance, thus making the combination of these drugs even more dangerous.

The results of our study seem to indicate that psychoactive drugs are a significant contributory factor to motor vehicle accidents. These drugs may be present alone or associated with alcohol. In the former instance, most such individuals have drug concentrations indicative of drug abuse, while in the latter instance, the majority of drivers had therapeutic concentrations of drugs in the presence of alcohol.

Summary

All motor vehicle accident fatalities occurring in Dallas County during a 1½-year period were studied to determine drug usage at the time of death. Blood samples ob-

tained at autopsy or at the time of hospital admission were analyzed for the presence of drugs and alcohol. Of the drivers, 70% were positive for alcohol or drugs. Ethyl alcohol alone was detected in 52%, drugs in 9%, and both drugs and alcohol in another 9%. Seventy-six percent of the drivers determined to be at fault in their respective accidents had alcohol or drugs detected compared to 41% for not-at-fault drivers.

The minor tranquilizer diazepam accounted for over half of all positive drug findings, while barbiturates, antihistamines, methaqualone, propoxyphene, and pentazocine were each detected in more than one instance.

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Southwestern Institute of Forensic Sciences
P.O. Box 35728
Dallas, Tex. 75235