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R. F. Turk,[1] *Ph.D.*, *A. J. McBay*,[1] *Ph.D.*, *and Page Hudson*,[1] *M.D.*

Drug Involvement in Automobile Driver and Pedestrian Fatalities

It has been recognized that traffic crashes are one of the leading causes of death in the United States. In many of these traffic deaths drugs are directly or indirectly involved. The drug most commonly encountered is alcohol, but the extent of involvement of other drugs is unknown.

The incidence of alcohol in traffic crashes has been established and reviewed [*1–6*]. Several investigators have observed that a drug alone or in combination with alcohol can impair driving ability. This has been established mainly by studies employing driving simulators after drug administration; however, drugs have also been administered to operators confined to a prescribed driving course. These studies have been reviewed by several authors [*5*, *7–10*].

The presence of drugs in living operators suspected of driving under the influence of a drug (or drugs), has been investigated recently by Finkle et al [*11*, *12*]. Through the questioning of some operators and the testing of others, they have found that drugs other than alchohol are being used. Other studies [*13*,*14*] which involved the analysis of various tissues (mainly blood) have found that drugs other than alcohol are found in from 4 to 13 percent of the operators in fatal crashes. All the above mentioned authors point out that although the other drugs are detected, alcohol has been the drug encountered most frequently.

This study deals with the incidence of drugs occurring in single and multiple automobile crashes in which the operator or a pedestrian was fatally injured.

Method

Specimens

For this study the operator or pedestrian must have been 15 years or older, and must have died at the scene of the crash or have been dead on arrival at a hospital. A blood and liver specimen were also required to be submitted, and urine was to be submitted when available.

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[1] Assistant chief toxicologist, chief toxicologist, and chief medical examiner, respectively, Office of the Chief Medical Examiner, North Carolina Department of Human Resources, Chapel Hill, N.C. 27514.

Urine—Urine was extracted for organic bases and the solvent extract was then analyzed by gas-liquid chromatography according to the method described by Finkle et al [*15*]. Following gas chromatography analysis, the remainder of the extract was placed on thin-layer chromatography according to the method of Davidow et al [*16*]. Urine was analyzed for morphine according to the spectrofluorometric screening method of Mule and Hushin [*17*].

Blood—Blood was extracted and analyzed by gas-liquid chromatography for acids, neutrals, and bases according to the method of Finkle et al [*15*]. Ethanol and other volatiles were determined by gas-liquid chromatography using the method described by Parker et al [*18*].

The method described by Freireich and Landau [*19*] for the co-oximeter was used to determine carbon monoxide saturation.

Liver—Liver was extracted for organic bases according to the following method:

A basic ether extraction of liver was made, and the organic phase was re-extracted into acid. The acid layer was analyzed by ultraviolet spectrophotometry for organic bases, the acid solution was made basic, and the ultraviolet spectrum redetermined.

The basic solution was made acidic and hydrolyzed in a boiling water bath. After cooling, the acid solution was analyzed by ultraviolet spectrophotometry. The acid solution was then irradiated with ultraviolet light and again analyzed by ultraviolet spectrophotometry for propoxyphene. If propoxyphene were detected by this method, then propoxyphene was quantitated by the method of McBay et al [*20*].

A microscopic examination of liver sections was performed to determine the presence and extent of changes likely due to alcohol abuse. The extent of these changes was defined as follows (Fig. 1):

Negative—No fatty vacuolization present.

Trace—Rare isolated vacuole of questionable significance. These were treated as "negatives," although the suspicion should remain that these were really a milder example of alcohol abuse effect than the other cases.

Positive, one to plus four: Increasing scale ranging from scattered, but easily perceptible, vacuoles of varying sizes up to almost complete replacement of the cytoplasm of most hepatic cells by vacuoles.

Laennec's cirrhosis—Classic, textbook microscopic characteristics were used. (Examples of other types of cirrhosis were occasionally encountered, but were not considered alcohol-related.)

The microscopic sections of liver had previously been coded by one author and submitted for examination by a forensic pathologist who did not know the history of the cases or of the blood alcohols.

Results

Tissue specimens from 67 vehicle operators and 33 pedestrians were examined for the presence of drugs and carbon monoxide. Liver sections were examined microscopically.

Single Automobile Crashes

In this group 39 operators were involved in fatal single automobile crashes. Alcohol involvement occurred in 61 percent of these cases, while alcohol plus another drug occurred in 5 percent of the cases (Table 1). Drugs alone were not detected in this group. Blood alcohol and drug concentrations found in this group are given in Tables 2, 3, and 4.

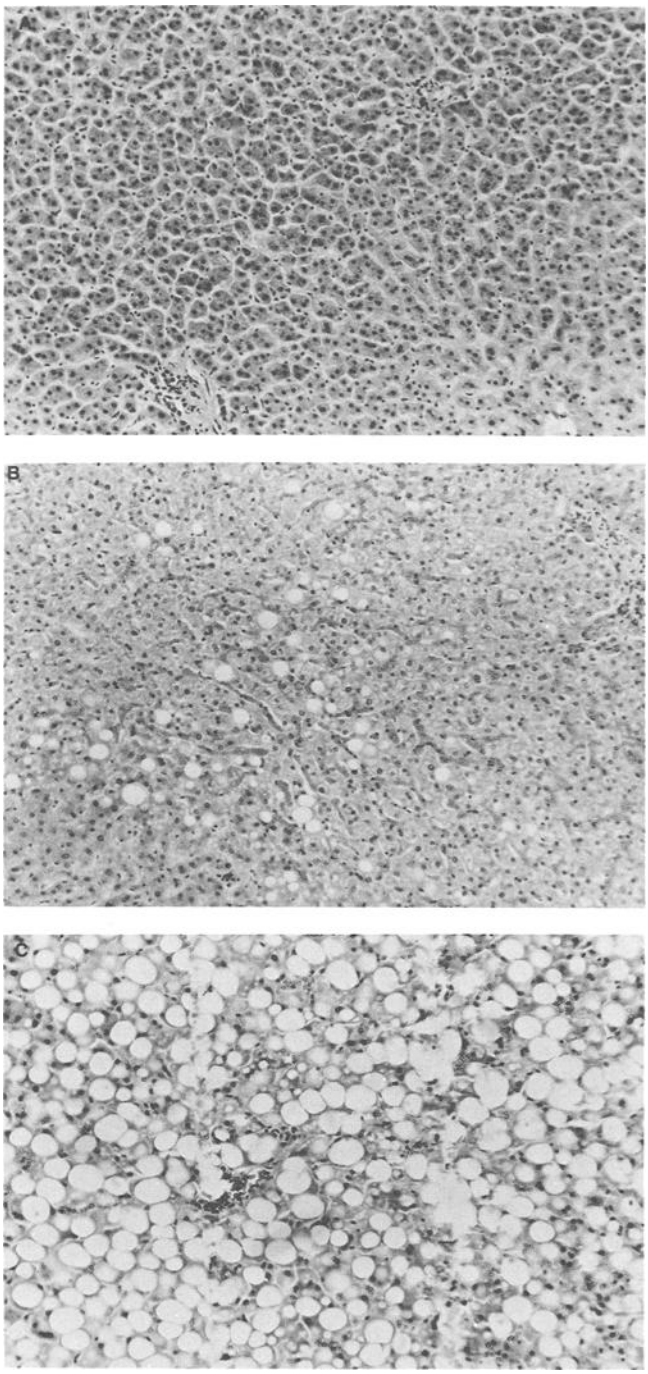

FIG. 1—*Hemotoxylin and eosin stain. Original magnification ×150.* (A) *Normal liver.* (B) "*2+ fatty liver,*" *scattered hepatocytes containing intracytoplasmic lipid vacuoles of varying size.* (C) "*4+ fatty liver,*" *replacement of most of cytoplasm by lipid vacuoles.*

TABLE 1—*Summary of case findings.*

Type of Case	Total Cases	No Drugs Detected	Alcohol Alone Detected	Drug Alone Detected	Drug Plus Alcohol Detected
All Operators	67	34 (50.8%)	31 (46.3%)	0	2 (2.9%)
Single-Car Crash Operators	39	13 (33.4%)	24 (61.5%)	0	2 (5.1%)
Multiple-Car Crash Operators	28	21 (75%)	7 (25%)	0	0
Pedestrians	33	8 (24.2%)	18 (54.5%)	5 (15.2%)	2 (6.1%)

TABLE 2—*Blood and urine drug levels of automobile operators fatally injured in single and multiple crashes, respectively.*

Blood Drug Levels—Single Crashes			
Case	Drug Detected	Blood Level, mg%	Blood Alcohol Level, mg%
1	Phenobarbital	0.4	30
2	Propoxyphene	0.07	220

Urine Drug Levels—Multiple Crashes			
Case	Drug Detected	Urine Drug Level, mg%	Blood Alcohol Level, mg%
1	Salicylate	1.4	Negative
2	Chlorpromazine	0.1	Negative

TABLE 3—*Positive drug cases.*

Type of Case	Total Drugs Detected	Alcohol Alone Detected, %	Drugs Alone Detected, %	Drug Plus Alcohol Detected, %
All Drivers	33	94	0	6
Single-Car Crash Operators	26	92.5	0	7.5
Multiple-Car Crash Operators	7	100	0	0
Pedestrians	25	72	20	8

TABLE 4—*Blood alcohol levels of automobile operators fatally injured in single-car crashes (mean blood alcohol level = 180 mg%).*

Blood Alcohol Level, mg %	Number of Operators	Alcohol Involvement, %
Negative	13	33.4
30–49	1	2.7
50–99	4	10.0
100–199	10	25.7
200–299	9	23.1
300–400	2	5.1

Microscopic examinations of the livers of 24 of these crash victims were performed. The bloods of four of the 24 driver victims of single-car crashes contained no alcohol. The livers of three of these four had distinct fatty changes indicative of chronic alcohol abuse. There was no other explanation for the fatty change. Thus, the livers of 14 of the single-car driver group of 24 showed changes highly indicative of chronic alcohol abuse. Two more had equivocal liver findings and both of these had blood alcohol concentrations between 200–300 mg/100 ml.

Multiple Automobile Crashes

The total number of drivers fatally injured in multiple crashes in this study was 28, and the incidence of alcohol involvement in this group was 7 (25 percent). No other drug was detected in the blood. However, a drug was detected in the urine of two of the victims (Table 2). The concentrations of blood alcohol observed in this group are given in Table 5.

TABLE 5—*Blood alcohol levels of automobile operators fatally injured in multiple-car crashes (mean blood alcohol level = 180 mg %).*

Blood Alcohol Levels, mg %	Number of Operators	Alcohol Involvement, %
Negative	21	75
30–49	...	...
50–99	2	7.1
100–199	...	...
200–299	5	17.9
300–400	...	...

Microscopic liver examination of 20 of these operators was performed. Of these 20 driver victims in multicar crashes, the bloods of six were negative for alcohol but had fatty changes of the liver. Seven who had fatty changes of the liver had no alcohol in their blood at the time of death; three more with equivocal fatty change were negative for alcohol. Ten of the 20 had distinct liver changes indicative of chronic alcohol abuse, and three more had equivocal changes.

Pedestrians

Specimens from a total of 33 pedestrian fatalities were submitted. Alcohol alone was found to be involved in 18 (54 percent) of these cases, drugs alone were detected in five (15 percent) of the cases, and the combination of alcohol plus another drug was found in two (six percent) of the cases (Table 1). Blood alcohol concentrations and drug concentrations are given in Tables 6 and 7.

The livers of 25 victims were examined for changes indicative of alcohol abuse. Eight of the 25 adult pedestrian victims had no alcohol in their blood. Five of these eight had fatty livers, one of which was extremely severe. Of the 25, eight did not have hepatic fatty change, one had equivocal changes, and 16 had hepatic changes highly indicative of chronic alcohol abuse.

Discussion

This study is a three-year study and the results reported in this paper represent only the first year. Thus far, the study has revealed that the major drug detected in operators

TABLE 6—*Pedestrian blood alcohol levels (mean blood alcohol level = 240 mg %).*

Blood Alcohol Levels, mg %	Number of Pedestrians	Alcohol Involvement, %
Negative	13	39.4
30–49	1	3.0
50–99	1	3.0
100–199	2	6.0
200–299	11	33.4
300–399	4	12.2
400 +	1	3.0

TABLE 7—*Incidents of drugs detected in pedestrians.*

Case	Drug Detected	Blood Level, mg %	Blood Alcohol Level, mg %
1	Slow-Acting Barbiturate	2.0	Negative
2	Amobartital	1.0	
	Secobarbital	1.0	Negative
3	Meprobamate	0.5	Negative
4	Meprobamate	0.9	Negative
5	Phenobarbital	0.2	Negative
6	Phenobarbital	0.3	320
7	Salicylate	9.5	220

fatally injured in single and multiple crashes is alcohol. If one considers only the positive drug cases, then in the single crashes alcohol involvement was found in 92 percent of these cases and other drugs in combination with alcohol in seven percent of these cases (Table 3).

Alcohol was the only drug detected in multiple crash fatalities. The difficulty in assessing drug involvement in these multiple accidents is that the operator of the other vehicle is not analyzed for drugs unless he is also injured fatally.

In the two single-car crashes in which a drug was involved, alcohol was also involved. In one of the cases the blood alcohol concentration was 220 mg/100 ml with a blood propoxyphene level of .07 mg/100 ml. The alcohol concentration alone in this case was sufficient to cause impairment of driving skills. In the other single-vehicle case, the victim had 0.4 mg phenobarbital per 100 ml of blood and a blood alcohol concentration of 30 mg/100 ml. These drugs individually, at the levels detected, probably would not have impaired the driver's ability to safely operate his vehicle. However, in combination these drugs possibly could have impaired the driver's operating ability.

Alcohol involvement in pedestrians represented 72 percent of the total positive drug cases. Drugs other than alcohol were found in 20 percent of these cases, and drugs plus alcohol in 8 percent of the cases. Drugs other than alcohol were more of a factor in pedestrian fatalities than either the single or multiple vehicle operator fatalities.

In four of the pedestrians, drugs could be considered a factor in the accident. One case is questionable and in two cases alcohol, rather than another drug, would be considered a major factor in causing the fatality (Table 7).

It should be mentioned that drugs were found in the urine of two multiple-vehicle operator victims (Table 2). Detectable concentrations of these drugs in blood and liver were not found.

Drugs found in the blood were also found in the liver. Thus far, no drug has been found in the liver that was not detected in the blood.

The microscopic liver examination indicated at least half of the operators and pedestrians showed evidence of having been chronic alcoholics. Although the presence of fatty vacuoles in the liver is the base of this conclusion, it is not a completely specific indicator of alcoholic abuse unless other conditions which could produce this change have been eliminated. These conditions would include poisoning with hydrocarbons or phosphorus, Reye's syndrome (a rare affliction of children), uncontrolled diabetes mellitus, high carbohydrate intake combined with low protein intake (a phenomenon existing in many chronic alcoholics), and occasionally gross obesity. In the absence of these and related conditions the presence of fatty vacuoles in the liver parenchymal cells almost invariably reflects severe alcohol abuse of at least several days, or moderately severe abuse of several weeks or more.

The data in this report indicate a gross overrepresentation of alcoholics among the operator crash victim and the pedestrian crash victim populations. This has also been observed by Waller [*2*].

At this time the study is accumulating driving records of all the operators in this study. The correlation of these records to the other parameters discussed in this paper is in process.

Summary

The cases presented were those of drivers and pedestrians fatally injured in auto crashes who did not receive emergency medical treatment in a hospital. Blood was analyzed for alcohol and other volatiles; urine and blood were analyzed for acids, neutrals, and organic bases; and the liver was analyzed for organic bases. The liver was also examined microscopically for fatty changes and cirrhosis. In this study 61 percent of the single-vehicle operator victims had significant amounts of alcohol in their blood, and 5 percent had combinations of alcohol and a drug. In the multiple vehicle crashes 25 percent of the operator victims showed significant blood alcohol concentration and no other drugs were detected. Of the pedestrian victims 54 percent had significant amounts of alcohol in their blood, 15 percent had detectable amounts of drugs other than alcohol, and 6 percent had both alcohol and another drug present. The microscopic examination of the livers indicated that over half of the drivers and pedestrians displayed changes indicative of a severe alcohol problem.

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Office of the Chief Medical Examiner
North Carolina Department of Human Resources
P.O. Box 2488
Chapel Hill, N.C. 27514