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The Incidence of Driving Under the Influence of Drugs 1985: An Update of the State of Knowledge

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16. Abstract

This report reviews recent studies of the incidence of drug use by drivers. Only reports published since a 1980 state of knowledge report were included. The report is divided into three sections covering the incidence of drug use by: (1) fatally injured drivers, (2) injured drivers, and (3) non-accident involved drivers detained by the police.

The studies reviewed indicate which drugs are being used by drivers. The drugs (or drug classes) most frequently detected are (in order of decreasing incidence):

- Marijuana
- Diazepam (Valium(R))
- Cocaine
- Barbiturates (e.g., Secobarbital)
- Methaqualone
- PCP (phencyclidine)

The data reviewed indicate that drugs are detected in 10% to 22% of the accident involved drivers. Drugs (other than alcohol) are detected by themselves in 2% to 15% of the accident involved drivers. The majority of the drug using drivers were found to have high levels of alcohol in combination with the drugs (ranging from 53% to 77%).

The studies reviewed do not allow us to precisely estimate the extent of drug use by drivers. Most of these studies did not use unbiased representative samples and tested for only a limited number of drugs. The simple incidence data currently available is insufficient to determine which specific drugs increase accident risk. This would require data on the extent to which non-accident involved drivers use these drugs. These missing data would allow a determination of the degree to which drivers using drugs are overrepresented in accidents.

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EXECUTIVE SUMMARY

Alcohol is accepted as a major highway safety problem. This came about only after a considerable research effort was undertaken to demonstrate the causal role of alcohol in automobile accidents. Recently, increased concern has been expressed that drugs other than alcohol may also contribute to a significant number of accidents. However, only limited research has been conducted in the drugs and driving area. No empirical evidence yet exists to document the nature and magnitude of the highway safety problem that might be due to drugs.

There have been a number of laboratory studies that have shown that performance on tasks that utilize driving related skills (e.g., divided attention, tracking) is impaired by some of these drugs. Given these results, it might be argued that there is a drug related highway safety problem and that the laboratory data could be used to specify its nature and magnitude. Unfortunately, this is not possible because there is no way to directly relate performance on laboratory tasks to accident risk. In addition, even if a drug has the potential for producing severe impairment, it would not be considered a problem unless there was strong evidence that a significant number of drivers who are driving under the influence are consuming a sufficient quantity of the drug prior to driving.

In order to find out whether any drugs are significant highway safety problems, field research is required that will determine (1) their frequency of occurrence in accident involved drivers, and (2) the extent to which they contribute to the accidents.

In 1980 a drugs and highway safety "state of knowledge" report was published by the NHTSA (Joscelyn, Donelson, Jones, McNair and Ruschmann, 1980) that summarized the data available at that time from accident and police arrest drug incidence studies. The authors concluded that there were insufficient data to define the nature and magnitude of the drug/highway safety problem. Since that time there have been a number of highway-related drug incidence studies carried out by state and local medical examiners, public and private research institutions, and foreign governments. The work reported on in this report reviews these recently published studies to determine whether they contain sufficient data to allow more definitive conclusions regarding which drugs are likely to be highway safety hazards.

This review of the studies published since the 1980 state of knowledge report is divided into three sections, namely: (1) the incidence of drug use by fatally injured drivers, (2) injured drivers, and (3) nonaccident involved drivers detained by the police.

The studies reviewed in this paper tend to report the highest incidence rates for the drugs (or drug classes) listed below (in Table 1).

Table 1

Drugs Found Most Frequently in the Blood of Drivers
(Listed in Order of Decreasing Frequency)

- o Marijuana
- o Tranquilizers
  - diazepam (Valium(R))
  - chlordiazepoxide (Librium(R))
- o Sedative/Hypnotics
  - barbiturates (Seconal(R))
  - methaqualone (Quaalude(R))
- o Hallucinogens
  - phencyclidine (PCP)
- o Stimulants
  - cocaine
  - amphetamines
- o Narcotics
  - codeine
- o Antihistamines
  - diphenhydramine

The incidence rate for the use of drugs other than alcohol, reported in these studies, is summarized in Table 2 (below). Separate estimates are given depending on whether the study samples were fatally injured drivers, injured drivers, or drivers arrested by the police on suspicion of impaired driving. These numbers are not statistically valid estimates of the incidence of drugs in these populations, but represent the best guess one can make based on the available information.

Table 2

Frequency of Drug Incidence in Fatally Injured Drivers, Injured Drivers and Drivers Arrested for Impaired Driving

Driver Type	Incidence
Fatally Injured	10% - 15%
Injured	22%
Arrested Drivers*	14% - 50%

* Note - with BACs below 0.10% w/v

Unfortunately, these data are not representative of drivers in U.S., for a number of reasons. These studies looked at relatively small samples of drivers that were typically not selected in a random or unbiased fashion that would allow generalizations to be made. Also, most of the studies did not screen the drivers for many potentially impairing drugs; they looked only for a limited number of drugs.

The studies of drug use by arrested drivers are particularly difficult to interpret. They generally included only drivers who chose to take a blood (rather than a breath) alcohol test and who had BACs under 0.10% w/v (between 1% - 3% of all drivers arrested by the police). Even with this restriction the drivers were not necessarily selected in an unbiased manner.

It is not possible to say how many of the drivers using drugs were impaired by the drugs, nor whether the use of the drugs contributed to their accidents. The mere presence of drugs in drivers, at any incidence rate, does not necessarily imply that the use of the drug was causally related to the accidents. Only if the drug occurs significantly more frequently in accident involved drivers than it does in nonaccident involved drivers can it be considered a possible causal factor. The greater the overrepresentation of a drug in the accident involved sample, the more likely the drug is a significant highway safety hazard. Only one study reviewed in this report collected any exposure data from nonaccident involved drivers (a foreign study conducted in Finland which had a small sample size and poor blood sampling procedures); thus, they can not be used to establish that drugs other than alcohol are safety problems for drivers.

One important finding is that most of the accident-involved drivers in whom drugs were detected had also consumed alcohol, often in sufficient quantities to produce relatively high BACs (i.e., over 0.10% w/v). For example, the percentage of fatally injured drivers using drugs who also had used alcohol ranged from 54% to 80%, while for injured drivers using drugs approximately 42% had also consumed alcohol.

The frequency with which drivers use drugs in combination with alcohol makes it difficult to determine if the use of drugs increases accident risk. While the dosage of the drug taken may not be sufficient to produce significant driving impairment by itself, the combined effect of the drug and alcohol may increase the impairing effects of the alcohol. This increased impairment may be greater than the sum of the impairing effects of either drug alone.

The critical piece of information necessary for establishing that certain drugs pose significant safety risks, namely the extent to which nonaccident involved drivers use these drugs, is still not available. Without this information it is not possible to meaningfully interpret incidence rates by accident involved drivers.

THE INCIDENCE OF DRIVING UNDER THE INFLUENCE OF DRUGS 1985: AN UPDATE OF THE STATE OF THE KNOWLEDGE

Richard P. Compton & Theodore E. Anderson

INTRODUCTION

Alcohol is accepted as a major highway safety problem. There have been a large number of research studies over the past 30 years designed to examine this problem and determine its magnitude. At this point in time, it is known that alcohol is involved in approximately 50% of all fatal and 20% of all serious injury highway accidents, and that the critical blood alcohol concentration (BAC) associated with an increased accident risk is between 0.08% w/v and 0.10% w/v. Based on this and other information regarding the alcohol problem, programs to reduce alcohol-impaired driving have been developed and are being implemented in States and localities around the country.

Recently, concern regarding drugs other than alcohol has also been increasing. Efforts are underway to educate the public to the dangers of drug abuse. In this context, questions have been raised about whether drugs other than alcohol are a significant highway safety problem. There have been a number of laboratory studies that have shown that performance on tasks that utilize driving related skills (e.g., divided attention, tracking) is impaired by some of these drugs. Given these results, it might be argued that there is a drug related highway safety problem and that the laboratory data could be used to specify its nature and magnitude. Unfortunately, this is not possible for the following reasons:

- For a given driving related task, large differences in the degree of performance decrement are often exhibited between subjects consuming the same drug (and dosage level). Also, the average degree of drug related performance impairment may differ substantially between tasks.

- Perhaps even more important is the fact that there is no agreement as to which of the many driving-related tasks used in the laboratory contain the critical combination of skills necessary to the safe operation of an automobile. Even if this ideal set of performance tasks could be developed, the exact degree of performance impairment that would be required to increase accident risk would be very difficult to determine. Also, the fact that a specific performance impairment results under the artificial and non-life threatening situations necessary in the laboratory, does not mean that this same performance impairment will be evident in the real world. It may be increased or reduced depending on the driver's physical and mental reactions to the specific traffic situations being experienced.

- Finally, laboratory performance data do not provide any indication of how frequently drivers in the real world are consuming drugs that increase accident risk. If a drug has the potential for producing severe impairment of the driving task, but the driving public is not consuming the drug prior to driving, it can be concluded that there is no highway safety problem associated with that particular drug at the present time.

These observations do not mean that laboratory-related data have no utility in assessing the drug related highway safety problem. Drugs that impair driving-related performance in the laboratory can be considered potentially hazardous, whereas drugs that do not precipitate performance impairment can be disregarded. Based on the laboratory research to date, the following drugs (or drug classes) can be classified as potentially hazardous to the driving task:

- Marijuana
- Tranquilizers (e.g., Valium(R))
- Barbiturates (e.g., Seconal(R))
- PCP, LSD, other hallucinogens
- Opiates (e.g., heroin)
- Amphetamines
- Cocaine
- Antihistamines
- Methaqualone (Quaalude(R))

In order to find out whether any of the drugs listed above are indeed significant highway safety problems, field research is required that will determine (1) their frequency of occurrence in accident involved drivers, and (2) the extent to which they contribute to the accidents. This type of research is difficult to carry out for the following reasons:

- Blood samples are required from accident involved drivers within 1-2 hours of the accident. Many of the drugs of interest rapidly disappear from the blood and would not be detected if a longer time period was allowed.

- Blood samples are required from a nonaccident group of drivers so that the frequency of occurrence of the various drugs in this group can be compared with the corresponding frequency in the accident group. If the drug occurs more frequently in the accident drivers, it can be considered a possible causal factor. The greater the overrepresentation of a drug in the accident sample, the more likely the drug is a significant highway safety hazard. Collecting blood samples from a comparable sample of drivers (to the accident group) is a complex and expensive procedure that requires the setting up of safety checkpoints and the cooperation of drivers stopped at these checkpoints.

- The analysis of the blood samples, for a wide range of possible drugs (both an initial screen and a confirmation procedure that specifies dosage level) is very expensive, and requires technical expertise and equipment available in only a few labs around the country. Urine is easier to collect and cheaper to analyze, but it is not a reliable indicator of whether the individual recently consumed the drug, and therefore may be experiencing its effects.

There have been a number of accident investigation studies conducted with the stated purpose of assessing the nature of the drug/highway safety problem. However, most of these studies have focused on determining the incidence of certain drugs only in accident-involved drivers. The corresponding nonaccident control data, required to assess potential causation, were hardly ever collected. This makes it very difficult to interpret the results from these studies. There have also been a number of studies designed to determine the frequency of drug occurrence in drivers arrested for Driving Under the Influence of Drugs (DUID). From an accident causation point of view, these studies are even more difficult to interpret, since DUID drivers included in the study samples were typically not accident-involved drivers.

In 1980 a drugs and highway safety "state of knowledge" report was published by the NHTSA (Joscelyn, Donelson, Jones, McNair and Ruschmann, 1980) that summarized the data available at that time from accident and police arrest drug incidence studies. The authors concluded that there were insufficient data to define the nature and magnitude of the drug/highway safety problem. Since that time there have been a number of highway-related drug incidence studies carried out by state and local medical examiners, public and private research institutions, and foreign governments. The current report that follows will review these studies published since 1980 and determine whether they contain sufficient data to allow more definitive conclusions regarding which drugs are likely to be highway safety hazards.

The following review of the studies published since the 1980 state of knowledge report is divided into three sections, namely: (1) the incidence of drug use by fatally injured drivers, (2) injured drivers, and (3) nonaccident involved drivers detained by the police.

STUDIES OF FATALLY INJURED DRIVERS

None of the studies reviewed in this section collected exposure data from nonaccident involved drivers. Thus, any direct estimation of whether the use of a drug increases accident risk is not possible from these studies. Some of the studies reviewed below have attempted to estimate whether the driver could have been impaired by the drugs they were found to have used. This estimate was typically based upon the concentration of the drug found in their bodies. If the concentration of the drug exceeded the therapeutic or normal dose, or was at a level that has been shown to produce debilitating behavioral effects, the driver was classified as probably impaired. The purpose of this type of analysis is to reduce potentially misleading incidence rates when only trace amounts of a drug are detected.

Two reports have been published from a study that examined the use of alcohol, marijuana, and other drugs in fatally injured drivers killed in single vehicle crashes in North Carolina, during the period of 1978 - 1981 (Owens, McBay & Cook, 1983 and Mason & McBay, 1984). Single vehicle crashes were selected so that driver fault in causing the accident would not be at issue. The specific drugs of interest in the study were: alcohol, marijuana, barbiturates, cocaine, opiates, phencyclidine (PCP), amphetamines and methaqualone. Approximately 850 drivers were fatally injured during the study period, of which 600 (70%) met the study criteria and were included.

The following criteria were used to select cases for the study:

1. The victim was the driver of a vehicle (car or truck) involved in a single-vehicle crash.

2. A suitable specimen containing greater than 5 ml of whole blood or plasma was obtained.

3. The specimen submitted was representative of the blood of the driver at the time of the crash. Either the driver was killed in the crash, or lived for less than one hour after the crash occurred (this was to reduce the effects of either drug metabolism or elimination). The victim must not have received any vigorous medical treatments including medications, surgery or transfusions.

4. Complete documentation was available (toxicology request, medical examiner's report, pathologist's report on any autopsy performed, death certificate, and motor vehicle crash report).

The results showed the incidence of drug use was fairly low. Approximately 14% of the drivers had used any of the drugs tested for in this study. The vast majority of the drivers who had used drugs had also used alcohol (i.e., 80%). The most commonly detected drugs were: THC (8%), methaqualone (found in

6% of 260 cases tested for this drug), and barbiturates (3%). Phencyclidine (PCP), opiates, cocaine and benzoylecgonine, and other volatile substances were detected only rarely (in 2% or less of the drivers).

As might be expected, alcohol was found in 79% of the drivers, with 68% of these drinking drivers having BACs greater than or equal to 0.10% w/v. Of those drivers who had consumed both alcohol and drugs, 77% had BAC's greater than or equal to 0.10% w/v.

The drug concentrations found were usually within or below the accepted therapeutic dosage range. According to the authors, only a small number of drivers (between 2.5% and 8.5%) could have possibly been impaired by drugs and most of these drivers had high BACs. The authors suggest an even smaller number of drivers (2% or less) could have been influenced by drugs alone. Multiple drug use (excluding alcohol) was not common (less than 1%). The authors concluded that alcohol was the only drug for which they tested that appeared to be a significant highway safety problem.

It should be noted that many drugs or drug classes were not screened for in this study. For example, drugs such as some frequently used tranquilizers (like diazepam and chlordiazepoxide), antidepressants, analgesics (e.g., methadone, pentazocine), hallucinogens (such as LSD or mescaline), muscle relaxants (e.g., meprobamate) and antihistamines (e.g., diphenhydramine) were not included. Other studies of fatally injured drivers have reported high incidence rates for some of these other drugs.

Williams, Peat, Crouch, & Finkle (1985) recently reported a study conducted in southern California that documented the drug use of fatally injured young male drivers. The study population consisted of 15-34 year old fatally injured male drivers of motor vehicles who died during selected periods of 1982-1983, in four California counties. Williams et al. state that they selected this special population for study because these individuals have high drug use and high crash rates. They felt this population, above any other, would reveal a high incidence of drug use if such use was significantly related to fatal accident involvement. Of course, the critical issue actually is the extent of overrepresentation of a drug in fatally injured drivers rather than the rate of drug use (which is not necessary related to accident causation).

The study included only victims who died during the crash or within 2 hours of the crash to minimize effects of metabolism and elimination on drug concentrations. During the study period 789 male 15-34 year old drivers died. Of these, 440 (56%) met the study criteria, had sufficient quantities of blood available for analysis, and other necessary information could be obtained. These 440 drivers included 220 automobile drivers and 220 drivers of other vehicles (e.g., motorcycles, pickup trucks, vans, etc.). The blood samples were screened for the presence of 23 drugs or drug groups identified by NHTSA (Joscelyn and Donelson, 1980) as those that might impair driving ability.

Approximately 51% of the drivers were reported to have used drugs other than alcohol. Drugs, when found, were infrequently found alone (in less than 30% of the drivers using drugs), usually occurring in combination with alcohol (and with BACs equal to, or greater than 0.10%). Table 3 (below) shows the percentage of drivers who had used specific drugs who had also consumed alcohol and shows the percentage of those drivers whose BAC was greater than or equal to 0.10%.

Table 3

Percentage of Drivers Using Specific Drugs Also Consuming Alcohol And Percentage of Drivers Using Drugs and Alcohol With BACs $\geq$ 0.10%

Drug Used	(N)	% Using Drug and Alcohol	% Using Drug and Alcohol With BACs $\geq$ 0.10%
Marijuana	(162)	81% (132)	84% (111)
Cocaine	(47)	77% (36)	86% (31)
Other Drug	(113)	70% (79)	81% (64)

The use of multiple drugs was common with 43% of the drivers in the sample having two or more drugs present. Viewed slightly differently, 85% of the drivers consuming drugs used two or more drugs. Alcohol, alone or in combination with drugs was present in 70% of the drivers.

The most common drug category found was cannabinoids (constituents of marijuana) which was detected in 37% of the drivers, followed by cocaine in 11% of the drivers. Diazepam (Valium$^{(R)}$), phencyclidine (PCP), methamphetamine (stimulant), phenyl-propanolamine and ephedrine (decongestants) were found in 2-4% of the drivers. The fairly high incidence of marijuana, 37% of the drivers, should be interpreted cautiously as it includes drivers in whom only very small quantities of THC were found. At least 40% of these drivers would have been treated as false positives and would not have been counted by other authors, based on the THC levels detected (i.e., concentrations of less than 1 ng/ml in hemolyzed blood).

In a major part of this study, police reports were reviewed to determine driver responsibility for the accident. Comparisons were then made between responsible and nonresponsible drivers in terms of drug presence in order to estimate the role of drugs in accident causation. Williams et al. were trying to determine whether more responsible drivers had used drugs than had nonresponsible drivers. In this analysis, only sex and age were controlled for (all subjects were young males), though other important factors in which the groups may not have been comparable were not controlled (e.g., prior driving record, vehicle factors).

The results showed that drivers who used alcohol alone were more likely to be responsible for their accidents (92%) than were drug-free drivers (71%), and that accident responsibility increased with increasing BACs. However, only 53% of the drivers who used marijuana alone were judged responsible for their accidents (compared to the 71% for the drug-free drivers). The combined use of alcohol and marijuana did not lead to a significant increase in responsibility for accidents (95% judged responsible) over that found for drivers using alcohol alone.

The authors concluded that their analyses indicated that alcohol was significantly related to accident responsibility but that marijuana was not. This analysis was constrained by the small numbers involved (e.g., only 19 drivers had used marijuana alone), and the fact that in the population studied, accident responsibility rates for alcohol alone were greater than 90 percent so that adding marijuana could not have had much of an effect.

A simple descriptive study by Cimbura, Lucas, Bennett, Warren and Simpson (1982) was designed to look at the incidence of drug use by fatally injured drivers in the province of Ontario, Canada during a 1-year period (4/78 - 3/79). A total of 768 driver fatalities were recorded during this time period, and blood and urine samples were collected from 401 drivers who met the study criteria. Excluded were victims who died more than one hour after admission to a hospital and from whom blood and urine specimens were either not available or inadequate. Thus, data were obtained on approximately 52% of the intended study sample.

The blood and urine specimens were screened for a wide range of drugs (at least 90). Psychoactive drugs (e.g., marijuana, diazepam/Valium$^{(R)}$) were found in the blood of 9.5% of the drivers, though the authors report that in many of these cases the concentrations of drugs other than alcohol detected were just trace amounts. The psychoactive drugs detected in the blood most frequently were THC (a metabolite of marijuana) in 3.7% of the drivers and diazepam (Valium$^{(R)}$) in 3%. A number of other drugs were found in less that 2.7% of the drivers.

Psychoactive drugs were rarely found alone (3.7% of the time), typically being used in combination with alcohol. For example, of the 15 drivers who had used marijuana, 53% had BAC levels over 0.10% w/v and almost all had used alcohol (13 out of the 15 or 87%).

The authors of the study report finding drugs, other than alcohol, in 26% of the fatally injured drivers. However, this number is quite misleading for two reasons. First, this study screened for a large number of "drugs" that included such substances as salicylate (aspirin) and acetaminophen (tylenol), which probably do not impair driving ability. Secondly, many of the cases included in the 26% figure involved detection of a drug in urine but not in blood, implying that the drivers had used the drugs in the past but may not have been under the influence at the time of their accident.

In comparison to the drug findings, Cimbura et al. report that alcohol was detected in 57% of the fatally injured drivers. Also, 86% of the drinking drivers had a BAC level in excess of the Canada's statutory limit of 0.08% w/v. Thus, this study found that beyond the incidence of alcohol, only marijuana and diazepam appeared with any significant frequency in the blood of fatally injured drivers, often in combination with alcohol, and typically in fairly low concentrations.

A recent study by Donelson, Cimbura, Bennett & Lucas (1985) documented the incidence of marijuana and alcohol in fatally injured drivers in Ontario, Canada. The study sample was obtained from driver fatalities occurring over a twenty-nine month period (from 3/82 to 7/84), where the death occurred within one hour of the accident. The study sample included 1,169 cases that met the basic eligibility criteria for the study (88% of the total driver fatalities during this time period). The blood samples obtained were tested only for the presence of the two substances, alcohol and marijuana.

Marijuana alone was detected in the blood of only 2% of the drivers tested. Marijuana and alcohol were found in 9% of the drivers. Most of the drivers in whom marijuana and alcohol were detected had BACs over 0.08% w/v (i.e., 69%).

The authors note that the vast majority of the drug-positive cases were male drivers (98% of the marijuana-positive cases were male). Approximately 12% of the male drivers in the sample were marijuana-positive, while only 2% of the females were marijuana-positive. The younger males (14-24 years old) had the highest frequency of drug usage with a 22% marijuana-positive rate.

A study of limited relevance to the situation in the United States was conducted by Krantz and Wannerber (1981) in Sweden. They investigated the incidence of some commonly used tranquilizers and sedatives, including barbiturates (e.g.,Secobarbital), benzodiazepines (e.g., Diazepam), meprobamate (e.g., Miltown(R)), methaqualone (Quaalude(R)) and phenothiazines (e.g., Chlorpromazine) in drivers killed in automobile accidents in southern Sweden, during 1977 and 1978. In southern Sweden, autopsies are routinely performed on all persons killed in traffic accidents. Unfortunately, this study included drivers who survived up to ten hours after their accident, which may mean that any drugs they had used were no longer present in the blood in quantities that would be detected.

Of the 122 drivers analyzed, drugs were found in only nine drivers (7.3%). Two of these drivers (1.6%) had also been drinking of alcohol (they had BACs of approximately 0.30% w/v). Benzodiazepines were found in 3.3% of the drivers, and Methaqualone and Meprobamate were each found in ?% of the drivers. In twenty-three percent of the drivers only alcohol was detected.

Thus, the incidence of drugs found in this study was low and as a result provides very little evidence that tranquilizers/sedatives were a potential problem in the fatal accidents studied. However, this study looked at just one drug category and did not include many important drugs that are potential safety hazards (e.g., marijuana, cocaine, etc.).

Wetli (1983) conducted a study of methaqualone-related (Quaalude(R)) deaths in Dade County, Florida during an eleven year period from 1971 through 1981. The Medical Examiner's Office routinely autopsies and performs toxicological tests on deaths involving physical trauma in any form in Dade County. Wetli reports that Methaqualone was detected in 58 cases involving motor vehicle operators during this period. However, the author does not provide any information on the sampling method used, nor does he report any data about the total number of driver fatalities during this period, thus it is not possible to tell what percentage of the fatally injured drivers these 58 cases represent. This study is of little use in estimating the incidence of this drug in fatally injured drivers.

Summary

These few studies of fatally injured drivers report relatively low incidence rates for drugs other than alcohol. The incidence rates for drugs ranged from 9.5% in Ontario (Cimbura et al., 1980) to 13.8% in North Carolina (Mason & McBay, 1984). Fifty-one percent of a special population of high-risk young males in Southern California were found to have used drugs other than alcohol, though this included detections of extremely small quantities (Williams et al., 1985).

Most of the drivers who were found to have used drugs in these studies were also under the influence of alcohol (i.e., with BACs greater than or equal to 0.10% w/v). The percentage of fatally injured drivers using drugs who also had consumed any alcohol was 54% in Ontario, 80% North Carolina, and approximately 77% of young males in Southern California. The frequency with which drivers use drugs in combination with alcohol makes it difficult to determine if the use of drugs increases accident risk.

The mere presence of drugs in fatally injured drivers, at any incidence rate, does not necessarily imply that the use of the drug was causally related to the accidents. Only if the drug occurs significantly more frequently in accident involved drivers than it does in nonaccident involved drivers can it be considered a possible causal factor. The greater the overrepresentation of a drug in the accident involved sample, the more likely the drug is a significant highway safety hazard. None of the studies reviewed in this section collected any exposure data from nonaccident involved drivers, thus they can not be used to establish that drugs other than alcohol are safety problems for drivers.

These studies have looked at relatively small non-representative samples of fatally injured drivers that do not provide a basis for estimating the incidence of drug use by drivers in the U.S. However, certain drugs have been detected with some frequency in these studies and thus are more likely to be possible problems than other drugs; they are: marijuana, tranquilizers and sedatives (diazepam, barbiturates, methaqualone), cocaine, codeine, PCP, and amphetamines.

STUDIES OF INJURED DRIVERS

Joscelyn, et al. (1980), in the 1980 review of the state of knowledge on drugs and highway safety, noted that incidence rate data for injured drivers in the U.S. were virtually non-existant. Only one study of accident involved injured drivers in the U.S. has been conducted since that time. That study, by Terhune and Fell (1982), provides the only available data on American drivers and is reviewed below. A number of studies have recently been conducted in other countries (in Europe, Scandinavia, and New Zealand) that can not be assumed to be representative of American drivers, but may be of interest to the extent that foreign drug use rates reflect American patterns. These foreign studies will also be briefly reviewed in this section.

Only one of the studies reviewed below, that was conducted in Finland, collected exposure data from nonaccident involved drivers that would allow some estimate of increased crash risk as a result of drug use. The Terhune and Fell study of American drivers did include a crash responsibility analysis to determine if drivers who used drugs were more likely to be estimated as responsible for their accidents than were drug free drivers. This type of analysis tries to control for other factors that might be related to accident involvement in order to establish a possible link between drug use and accident risk.

The Terhune and Fell study examined the role of alcohol, marijuana and other drugs in the accidents of 497 injured drivers who were treated at a hospital in Rochester, N.Y., during parts of 1979 and 1980. The authors of this study were unable to obtain a representative sample of injured drivers in this jurisdiction (only one hospital agreed to participate in the study), so the results should be interpreted with caution. Of 1,062 drivers identified as eligible for inclusion in the study, 47% (497) were eventually included. Eligible drivers were lost primarily through not being detected or refusing to participate. Blood samples were screened for the presence of 23 drugs or drug groups identified by NHTSA as potential highway safety hazards (Jones and Donelson, 1980).

The results indicated that approximately 22% of the drivers had used drugs other than alcohol. The drivers were found to have used the following drugs:

Drug	Percent of Drivers
Marijuana	9.5%
Tranquilizers	7.5%
Sedative/hypnotics	2.8%
Cocaine	2.0%
Anti-convulsants	2.0%
Other	Less than 2%

Multiple drug use occurred in about 10.5% of the drivers. Many of the drug users had also consumed alcohol (42% of all the drivers using drugs also had consumed alcohol). For example, over half of the drivers who had used marijuana had also consumed alcohol, 32% of the tranquilizer users and 80% of the cocaine users had also used alcohol. Of all the drivers who had used alcohol, 78% had BACs above 0.10% w/v (no separate breakdown was provided for using drugs).

The THC concentrations detected were mostly quite low, though they did vary widely (from barely detectable traces to fairly high levels of .011 ug/ml). The alcohol and THC concentrations found were not necessarily very representative of the concentrations at the time of the accidents, since up to four hours may have elapsed by the time the blood was drawn.

The responsibility analysis was based on data obtained from police accident reports and driver interviews. Each driver was judged as either responsible or not responsible for his/her accident by two independent coders. Responsibility rates for users of different drugs were then compared to the responsibility rate for drug free drivers. Terhune and Fell assume that the finding of a higher accident responsibility rate for drivers using drugs would imply that the drug use contributed to the accident occurrence. This type of analysis is dependent upon the assumption that the groups being compared do not differ in any other respect than drug use (that might account for the difference in responsibility rates), a very difficult fact to establish.

The accident responsibility analysis resulted in the following estimated responsibility rates for drivers using different drugs:

Drug Group	Responsibility Rate
BAC (over 0.10%) alone	74%
BAC (below 0.10%) alone	54%
Marijuana alone	53%
Drug Free	34%
Tranquilizers alone	22%

These data are consistent with the previous finding that alcohol increases accident risk. The difference between the marijuana or tranquilizer groups and the drug free drivers was not statistically significant. The responsibility rates for alcohol in combination with THC or tranquilizers did not differ significantly from the alcohol-alone group. Thus, this analysis supported the established fact that alcohol remains a serious problem in highway safety. The sample sizes for the other drugs (e.g., marijuana) were too small to allow definitive conclusions to be drawn.

The remainder of this section briefly describes some foreign studies of drug incidence in accident involved drivers. While these studies can not provide direct evidence regarding drug usage rates by American drivers, there is a definite well documented similarity in drug usage patterns (both legal and illegal) throughout the western world.

A preliminary incidence study of alcohol and drug use by accident involved drivers in southern Italy was reported by Ferrara, Castagna and Tedeschi (1980). Details of the methodology used for collecting the sample were not provided in this preliminary report so it is not possible to determine whether the sample used was randomly selected. The study reports on the presence of drugs in the blood and urine of 1,000 injured drivers treated at hospitals in the region of Venezia. All specimens were collected within one hour following the accident.

The blood and urine specimens were screened for a variety of drugs including sedatives and hypnotics, tranquilizers, narcotics, stimulants, and analgesics. Any level of drug detection was considered positive. The results show that approximately 14.7% of the drivers had used drugs (not counting analgesics like aspirin and tylenol(R)).

The most common drug category detected in the blood of these drivers was tranquilizers with 12.[illegible]f the drivers having used this drug. Sedatives and hypnotics were used by [illegible]2% and stimulants and narcotics were used by less than 1%. These percentages reflect multiple drug use by approximately 3.2% of the drivers. No blood tests were run for marijuana though it was found in the urine of 14% of the drivers (out of only 100 tested for THC). The presence of marijuana in the urine of drivers does not necessarily imply they were under the influence of the drug at the time they were driving (metabolites can remain in the urine for several weeks after use). Of the drivers who used drugs other than alcohol, approximately 64% had also used alcohol.

Honkanen, Ertama, Linnoila, Alah, Lukkari, Karlson, Kiviluto and Puro (1980) conducted a small scale incidence study in Helsinki, Finland in 1977. The study sample was comprised of all injured car drivers who arrived for treatment at any of five hospital emergency rooms for injuries received in automobile accidents within six hours of their accident during April to October of 1977. The authors estimate they obtained approximately 90% of the eligible sample. Serum blood samples and breath alcohol samples were collected from 201 drivers.

Due to this sampling approach, which allowed for the blood and breath samples to be collected up to six hours after the accident occurred, it is possible that many drugs present in the driver's blood at the time of the accident had been metabolized and were no longer detectable at the time the sample was collected. Also, the fact that they were able to obtain breath samples implies that most of these drivers had received very mild injuries.

A control group of 325 nonaccident involved drivers, selected randomly at gas stations (matched to the accident involved drivers by day of week, time of day, and roadway), were also screened for alcohol and drugs. The purpose of including these nonaccident involved drivers in the study was to determine whether the use of drugs was overrepresented in the accident involved group. A finding that certain drugs were overrepresented in the accident involved group would suggest the possibility that the drugs contributed to their accidents.

The blood specimens were screened for about 50 different prescription drugs which included tranquilizers (like diazepam), barbiturates (e.g., secobarbital), amphetamines and narcotic analgesics (e.g., codeine). However, many non-prescription drugs of abuse like marijuana, cocaine and other narcotics were not included in the analytic screen used in this study. The results showed that more injured drivers (5%) had used these drugs than had control drivers (2.5%). Due to the small sample size, however, this difference was not statistically significant. Diazepam was found in 16 of the 18 subjects (89%) in whom drugs were found. Alcohol was found in 15% of the injured drivers and only 1% of the controls. No information on the combined use of drugs and alcohol was reported.

This study is one of the few conducted to date that has at least provided some direct evidence that injured drivers are more likely to have used drugs than are non-injured control drivers. This finding occurred in spite of the long delay in obtaining blood samples from the injured drivers, which undoubtedly resulted in underestimating the percentage of injured drivers using drugs. The extent to which the use of drugs contributed to these drivers' accidents is difficult to determine, especially when one considers that no information was provided regarding the possible role of alcohol (which may have been the prime contributor to the accident occurrence).

A study conducted in Norway by Setekleiv, Wickstrom, Enoksen, Hasvold and Sakshaug (1980) reported on drug use by accident involved drivers treated at a single hospital in the city of Stavanger over a twelve month period in 1978 and 1979. The report states that blood samples were obtained from the drivers as soon after their admission to the hospital "as possible." A total of 41 accident involved drivers were included in this study. The blood specimens were screened for alcohol, benzodiazepines (e.g., diazepam/Valium(R)), acidic and neutral drugs (e.g., barbiturates, methaqualone), and antidepressants and decongestants (e.g., diphenhydramine). Other psychotropic drugs (e.g., marijuana,) narcotic analgesics (e.g., codeine) and stimulants (e.g., PCP, amphetamines) were not included.

Approximately 10% of the injured drivers were found to have used drugs other than alcohol. All of the drivers using drugs had used diazepam (though the levels detected were very low). Almost all of the drivers in whom drugs were detected had also used alcohol (used by 10% of the injured drivers). This study contained such a small sample of injured drivers that no strong conclusions can be drawn from it.

Summary

The one useful study of injured American drivers reported that 22% of the drivers had used drugs other than alcohol (Terhune & Fell, 1982). The comparable alcohol use rate was 25% of the drivers. The most commonly used drugs were marijuana (9.5% of the drivers), tranquilizers (7.5%), sedative/hypnotics (2.8%) and cocaine (2%).

A large percentage of the injured drivers in this study, found to have used drugs, had also consumed alcohol (42%). The combined usage rate of alcohol and drugs found in this study is somewhat lower than that found for fatally injured drivers (which ranged from 50% to 80%).

A responsibility analysis showed that the drivers who had BACs above 0.10% w/v were significantly more likely to be responsible for their accident than were drug free drivers. Small sample sizes precluded conclusions regarding the impairing effects of the other drugs detected fairly frequently (e.g., marijuana).

The foreign studies reviewed above reported drug incidence rates among injured drivers ranging from 5.0% in Finland (Honkanen et al., 1980), 10% in Norway (Setekleiv et al., 1980) to 14.7% in Italy (Ferrara et al., 1980). The most commonly used drugs by the injured drivers were diazepam (Valium(R)), other sedative/hypnotics and tranquilizers.

The Honkanen et al. study represents one of the few investigations that have attempted to compare drug use rates between injured drivers and control drivers. It found that almost twice as many injured drivers had used drugs than had control drivers (suggesting that the use of drugs may have increased the risk of being involved in an accident). However, this study did not look at the combined effects of alcohol and drugs (which may have accounted for some of the increased crash risk) and did not screen for a number of potentially hazardous drugs (e.g., marijuana, cocaine).

STUDIES OF DRIVERS DETAINED BY THE POLICE

This section reviews studies designed to determine the incidence of drugs in drivers believed to be impaired by drugs who were typically not involved in accidents (drivers arrested under "Driving Under the Influence of Drugs (DUI)" laws). Three new studies were conducted in the U.S. since the 1980 drugs and highway safety report was published and will be covered in this section. One additional published article on a large scale project conducted in California (which was reviewed in preliminary form in the previous 1980 drugs and highway safety report) will also be covered. Finally, a number of studies that were conducted overseas will be reviewed briefly.

The typical approach used in these studies is to make use of blood samples drawn at police request from drivers arrested for suspicion of driving under the influence and to screen all or a sample of these specimens for selected drugs. Usually the specimens selected for study are those that have a BAC level below 0.10% w/v. In other words, the drivers selected have a profile that would strongly suggest drug involvement. None of the studies in this section looked for a wide variety of drugs, thus they may not provide an indication of the overall drug use rates for the drivers in their sample.

Valentour, McGee, Edwards and Goza (1980) reported a study by the State of Virginia in which a selection of blood samples taken from drivers charged with DUI were screened for a variety of drugs. The blood samples used in this study were collected over a sixteen month period in 1978 and 1979. The authors report that approximately 7200 blood tests are given in Virginia each year (out of approximately 44,000 arrests). The vast majority of arrested drivers take a breath test rather than blood test. Of those drivers who take a blood test, about 90% have a BAC level of greater than 0.10% w/v. The samples used in this study came from the drivers who had a blood alcohol content below 0.10% w/v (approximately 2% of all arrested drivers). During the study period, 788 samples meeting the criteria were collected and analyzed. No clear statement of which drugs were included in the screening is provided, though the authors do note that some popular drugs were not detectable by the procedures used, including marijuana, LSD, heroin, antidepressants, and antihistamines. The authors do not describe the assay methods used.

The results showed that 16% of the samples analyzed contained one or more drugs. The most frequently found drugs were reported to be the tranquilizers (diazepam and/or nordiazepam, chloriazepoxide), methaqualone, phenobarbital, and phencyclidine (PCP). The authors do not provide any indication of the number or percentage of drivers using the individual drugs. Eighty-four percent of the drug positive samples also contained alcohol in concentrations ranging from 0.01 to 0.09% w/v. The authors report that the probability of a drug being present was inversely related to BAC.

A relatively ambitious study of the use of sedative/hypnotics by drivers arrested for impaired driving in Orange County, California, was reported by White, Clardy, Graves, Kuo, McDonald, Wiersema and Fitzpatrick (1981). This study reports on the drug use rates found in blood samples taken from 8,116 drivers (out of approximately 72,000 drivers arrested for impaired driving, or 11%) during a 6-year period from 1973 to 1978. The authors report that in 1978 approximately 60% of the drivers arrested took a blood test, while the remaining 40% took either breath or urine tests. All the cases included in the study came from drivers who had taken a blood test and who had blood alcohol levels of less than 0.10% w/v (one of the criteria for screening for drugs). Thus, the study sample was not complete and is not representative of arrested drivers nor arrested drivers with BACs below 0.10% w/v. The blood samples were screened for barbiturates (e.g., secobarbital, amobarbital), benzodiazepines (e.g., Valium(R), Librium(R)), methaqualone (Quaalude(R), meprobamate, ethchlorvynol (e.g., Placidyl(R)), and PCP (which was tested for in 1977 only).

The results showed that these tranquilizers and sedative/hypnotic drugs were found annually in 30-50% of the sample tested. The incidence of these drugs was considerably higher in the alcohol negative drivers (approximately 60-70%) than in the drivers with BACs from 0.01 to 0.09% w/v (approximately 20-30%). The usage rate for sedative/hypnotic drugs appeared to show a substantial drop in 1977 and 1978. The authors felt this reflected a shift in drug usage patterns away from drugs detectable by their analytic screen (e.g., toward increased use of drugs like PCP, marijuana, and cocaine that were not detectable).

The most common drugs found in the drivers tested were barbiturates, diazepam and methaqualone. The barbiturates and diazepam were much more likely to be seen in combination with another drug than was methaqualone. Overall, approximately 18% of the drivers were found to have used two or more drugs. Many of the drug positive drivers had also used alcohol (i.e., approximately 40%).

A study conducted in Georgia by McCurdy, Solomons and Holbrook (1981), was designed to assess the range of methaqualone concentration found in the blood of drivers arrested for DUI in order to relate the methaqualone level to deterioration in driving ability. The study sample included only drivers arrested on suspicion of DUI who tested positive for methaqualone (974 cases). The authors did not indicate what percentage of arrested drivers these methaqualone users represented. The study found that the majority (55%) of these drivers had not consumed alcohol or other drugs. Approximately 39% of the methaqualone users had consumed alcohol, while 14% had also taken diazepam, with a smaller percentage (7%) having used a variety of other drugs. The authors reviewed the arresting officer's reports and developed a list of behaviors they felt were indicative of methaqualone impairment (as determined by the methaqualone concentration found in the blood samples).

A report on a study of marijuana use by impaired drivers in California was published recently by Zimmermann, Yeager, Soares, Hollister and Reeve (1983). Preliminary results from this study were reviewed in the Joscelyn et al. report (1980) and only brief comments will be made here. Readers interested in a more thorough review should consult the 1980 report.

Zimmermann et al. indicate that one out of every three drivers stopped by the California Highway Patrol for driving under the influence submit to blood alcohol determination. This results in about 20,000 blood specimens being collected per year, of which greater than 90% have blood alcohol levels above 0.10% w/v. Zimmermann et al. selected a sample of 1792 of these cases, collected from December 1977 to June 1978, for screening for THC.

In their 1983 report they state that these cases were selected at random with an equal number chosen with BAC's above and below 0.10% w/v. However, a previous report on this study indicated that there were 1027 cases selected from the drivers whose BAC level was 0.10% or less and 765 cases whose BAC level was greater than 0.10% w/v. This more detailed report also indicated the month of the incident leading to the specimen collection. The number of specimens per month is not consistent with a random sampling approach. Further, 542 of the cases apparently were accident involved fatally and non-fatally injured drivers. They are not separated out in the analyzes presented in this report (the accident involved and nonaccident involved drivers should have been looked at separately). Thus, these drivers are not representative of impaired drivers or drivers stopped for DUI, and possibly not even those detained drivers who choose to give a blood sample rather than a breath sample.

The results of the analyses performed by Zimmermann et al. indicate that 14.4% of all the specimens analyzed were positive for THC. The drivers who had a BAC of below 0.10% (10% of the sample), had a 23% marijuana positive rate. The percentage of drivers using marijuana increased with driver age (up to age 61), ranging from 13.3% for the drivers 21 years old and under, up to 19% for the drivers 40-61 years old. This finding is at variance with the patterns of usage reported from other sources and raises questions concerning the possibility that this sample was highly unusual. Of the 1,792 samples tested, 252 were positive for THC (14%), while 1507 tested positive for alcohol (84%). Of the drivers who tested positive for THC, approximately 85% had also used alcohol (90% of the total sample had used alcohol).

The interpretation of these findings is complicated by the factors enumerated above (sampling primarily alcohol impaired drivers, non-random selection of cases, unexpected and unexplained usage rates by age of driver, inclusion of fatally and non-fatally injured drivers, etc.). The study does show that some impaired drivers use marijuana, although the magnitude of the marijuana and driving problem can not be estimated from these data. How many of these drivers were impaired by marijuana is unknown. Most of these drivers had used alcohol, and many may have used other drugs (the authors only looked for marijuana).

A study of 254 drivers in New Zealand, who were detained by the police and were suspected to have used drugs, during 1975 - 1979, was reported by Missen, Cleary, Eng, McDonald and Watts (1982). The authors do not indicate how this sample was selected or how the blood samples were obtained. The blood samples taken from the 254 drivers were screened for a large variety of drugs (though some classes of drugs were not included, e.g., marijuana, amphetamines, LSD).

The results showed that 37% of the drivers tested positive for drugs other than alcohol while 63% tested positive for alcohol. The most common drug category detected was the tranquilizers (31%), with diazepam being found in 23% of the drivers. Sedative/hypnotics (10%) were the next most frequently detected drug, followed by anticonvulsants (3%), illicit drugs (3%) and antidepressants (2%). Approximately 50% of the drivers who had used drugs also had used alcohol (with BACs greater than 0.08% w/v).

A study by Peel, Perrigo and Mikhael (1984) reported on the drug use by a small sample of impaired drivers in Ottawa, Canada. The drivers comprising the sample had been detained for driving while impaired and after completing a breath alcohol test were requested to provide a saliva sample for "research purposes." The authors report obtaining 56 samples from 445 drivers suspected of impaired driving during the study period (not specified). This low cooperation rate strongly suggests that this was a biased sample. The saliva samples were tested for the presence of marijuana, benzodiazepines (e.g., Valium(R)), and other base/neutral/acid compounds (e.g., cocaine, amphetamines, LSD).

Drugs other than alcohol were detected in 10 of the 56 cases analyzed (18%). The most common drugs detected were cannabinoids (marijuana) with 11% of the drivers testing positive and diazepam (Valium(R)) with 7%. All of the 56 drivers were shown to have consumed alcohol and the 10 drivers who tested positive for drugs had BACs above 0.14% w/v. These findings should be interpreted cautiously since the finding of drug traces in the saliva of drivers may not be indicative of blood concentration of the drug.

Wilson (1980) reported some data on drug use by drivers suspected of driving while impaired in Queensland, Australia during the period from 1974 to 1979. These drivers had all been tested for breath alcohol and the BAC results did not account for the driver's behavior (typically BACs below 0.08% w/v) so that blood tests for drugs were requested. Thus, these drivers may have had no alcohol or may have had BACs between 0.08% and 0.10%. Certain drugs (e.g., marijuana, LSD) were not included in the screening techniques used.

The sample was comprised of 173 drivers out of which 115 drug positive specimens were detected (66%). The most frequently detected drugs were the benzodiazepines (e.g., Valium(R)) with 38% of the drivers having used these drugs. The next most frequently used drugs were the barbiturates (20% of the drivers), followed by methaqualone (6%). No other drug was found in more than 2% of the drivers. No information about drug concentrations was included in the report, thus it is not possible to estimate how many of these drivers might have been impaired. Also, no data were provided about the frequency with which drugs and alcohol were both found, nor regarding the incidence with which multiple drugs were detected.

SUMMARY

These studies of drug use by impaired drivers detained by the police are particularly difficult to interpret. The drivers dealt with in these studies are a special subsample of the general driving population. Because the study samples are not drawn in a random or unbiased fashion, they are not representative of the general driving public, nor necessarily of drivers who use drugs, or drivers who the police detain for suspicion of drug use. Most drivers detained by the police for suspicion of impaired driving elect to take a breath test rather than a blood test. Of the small number of drivers who do take a blood test, all of these studies found that 90% or more of the drivers had BACs over 0.10% w/v, and thus no tests for other drugs were performed. These study samples came from the remaining 10% or less of the drivers who had low BACs. Such a sample is not representative of any population other than the one from which the data were collected.

While the drivers in these studies came to the attention of the police as a result of committing some illegal driving behavior, one can not assume that the drugs they consumed were necessarily responsible for their deviant driving. Most of the drivers found to have consumed drugs had also consumed alcohol (the percentage of drivers in whom drugs were detected who had also used alcohol ranged from 40% to 100%). Thus, one does not know whether their driving was impaired (drivers not under the influence of alcohol or drugs also commit driving violations), and if it was impaired, whether it was due to the drug or the alcohol they had consumed, or due to the drug enhancing the effects of the alcohol.

One can conclude from these studies that a significant percentage of the drivers the police stop for suspicion of impaired driving, who agree to take a blood test, and whose BAC tests out below 0.10% w/v, have consumed drugs. These studies suggest this percentage ranges from 14% to 50%.

These data are useful in indicating which drugs are likely to be used by drivers suspected of impaired driving by the police. The studies reviewed above appear to indicate that the following drugs or drug categories are the most commonly detected:

- Marijuana
- Tranquilizers (e.g., diazepam/Valium(R))
- Methaqualone (Quaalude(R))
- Barbiturates (e.g., secobarbital)
- Narcotics (e.g., codeine)
- Hallucinogens (e.g., phencyclidine (PCP)

Only a couple of these studies reported data on multiple drug use. These studies indicate that between 18% and 21% of the drivers who had used drugs had taken two or more drugs.

CONCLUSIONS

In the introduction it was stated that in order to determine whether any specific drug was a significant highway safety problem, information was needed to document the extent to which accident involved drivers used the drug and the extent to which the use of the drug contributes to accident risk. The studies reviewed in this report provide information regarding which drugs are being used by drivers and give us some rough idea of the extent of drug use by the drivers. However, since these studies do not report drug incidence for nonaccident involved drivers, they can not be used to determine whether specific drugs, by themselves, or in combination with alcohol, increase accident risk.

The data reviewed indicate that drugs are detected in 10% to 22% of the accident-involved drivers. This range does not probably reflect the true potential drug and highway safety problem. The actual range could be significantly reduced if one considers the finding that drugs, by themselves, occur in only 2% to 15% of the accident-involved drivers. The majority of the drug using drivers (53% to 77%) were found to have high levels of alcohol in combination with the drugs. In these cases, the alcohol may have been primarily responsible for the driver impairment leading to the accident. For the studies reviewed it was not possible to factor out the alcohol effects from the drug effects, or to determine whether there were any combined alcohol and drug effects. When alcohol is not considered, multiple drug use is relatively infrequent in drivers in whom drugs were detected.

The studies reviewed in this paper tend to report the highest drug use incidence rates for the same potentially hazardous drugs. However, since many of these studies only tested for a few drugs (e.g., marijuana) or drug classes (e.g., sedatives and tranquilizers), the repeated reporting of the same drugs may be as much a function of what drugs were looked for, as what the drivers were using. Those drugs (or drug classes) most frequently detected are (in order of decreasing incidence):

- Marijuana
- Diazepam (Valium(R))
- Cocaine
- Barbiturates (e.g., Secobarbital)
- Methaqualone
- PCP (phencyclidine)

In conclusion, it is apparent that the nature and magnitude of the drug and highway safety problem has not been resolved by the recent studies of drug incidence reviewed above. It is important that research be conducted to determine the incidence of drug use in accident and nonaccident involved drivers so that some estimate of the extent to which drugs contribute to the occurrence of accidents can be determined.

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