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DRUGS AND HIGHWAY SAFETY

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ABSTRACT

Available data indicate that marijuana and other drugs (other than alcohol alone) constitute a traffic safety problem, and that this drug and driving problem may be serious. Society has responded by taking formal action to control the risk posed by drugs and driving. So far, research and countermeasure activity in this area has followed the alcohol model. Epidemiological research to determine the prevalence of drugs in the driving population and experimental research to determine the impairing effects of drugs on driving has been conducted. Countermeasures to drug-impaired driving, primarily legal strategies to restrict drug availability and find and punish drug-impaired drivers, have been implemented.

Not enough is known yet about the drug and driving problem to define its magnitude precisely and support countermeasure development. Research required to define the drug and driving problem more precisely and develop more effective countermeasures has been hampered by the complexity and variety of available drugs, and by the lack of analytic capability, funding, and coordination of effort. Nonetheless, a series of near-term strategies can be carried out by units of state and local government. Deficient state laws should be amended. Vigorous prosecution of impaired drivers using behavioral and other available evidence should continue, and nontherapeutic drug users who choose to drive while impaired should receive license sanctions. The health/legal approach should be used to find and treat offenders with underlying drug abuse problems. Public information and education efforts should focus on health care professionals and both therapeutic and recreational drug users. Short-term, poorly controlled, poorly coordinated research should be avoided; future research should focus on rigidly controlled, large-scale epidemiologic studies of crashed and noncrashed drivers, and of human performance while under drug influence.

This paper is a guide for action by policymakers at the state and local level. It provides a series of strategies directed at controlling the drug-

crash risk—strategies that can be implemented by state and local units of government in the near-term future.

DRUGS AND HIGHWAY SAFETY

INTRODUCTION

Drug use and drug abuse are widespread in our society. Consumption of illicit drugs, especially marijuana, has become commonplace, particularly among young people. Alcohol is also frequently used in combination with marijuana or other drugs. Licit prescription drugs, such as tranquilizers and antidepressants, and such over-the-counter drugs as cold remedies, are also widely used, and are often consumed in combination with one another or with alcohol.

It is known that millions of people in the United States use drugs other than alcohol, that many commonly used substances have at least the potential to impair the ability to drive safely, and that many persons drive after consuming potentially impairing drugs. This suggests that drugs, both licit and illicit, present the potential for causing traffic crashes, and that society should take action to control the drug-crash problem.

What is not yet known is the precise extent to which drug use contributes to the occurrence of traffic crashes. In spite of an ever-expanding body of literature on drugs and driving (e.g., Joscelyn and Donelson 1979; Joscelyn and Maickel 1977b), studies conducted to determine the prevalence of drugs among drivers, and experiments to discover the potential of drugs to impair driving skills, there are still no definitive studies linking drug use and traffic crashes. The available evidence does suggest that drugs other than alcohol **can** impair driving skills and **may** increase the likelihood of traffic crashes. Research and police investigations have documented drug involvement in specific traffic crashes and have led to the conclusion that drug-impaired driving causes traffic crashes. Drivers are regularly, though infrequently, arrested and prosecuted for drug-impaired driving. While the available evidence lends credence to the belief that a "drug and driving" problem exists, its

magnitude is still unknown. Until the problem can be better quantified it cannot be labeled a priority highway safety concern.

Figure 1 presents a structural representation of society's efforts to solve the problem of drugs and highway safety. The most general description of the relationship between drugs other than alcohol and traffic crashes is that it is highly complex and at best indirect. Equally complex research is required to define the relationship between drugs and crashes to permit development of specific strategies to manage the drug-crash risk.

To date, society's approach to drugs and driving parallels the alcohol-crash experience. Public concern about drugs and driving is part of a more general concern about the widespread use--and abuse--of drugs. Countermeasures directed at the drug-crash problem correspond to those directed at the alcohol-crash problem: restricting availability; punishing those who drive while under the influence; and educating the public about the danger of drugs and about society's efforts to curb drug-impaired driving.

Unlike alcohol, a quantitative relationship between drug concentrations in the body and impairment of driving ability has not yet been established and, in some cases, never will be. This means that alternative means of enforcing laws against drug-impaired driving and prosecuting suspected offenders should be considered. Strategies that do not rely solely on law enforcement should also be applied to the drug and driving problem.

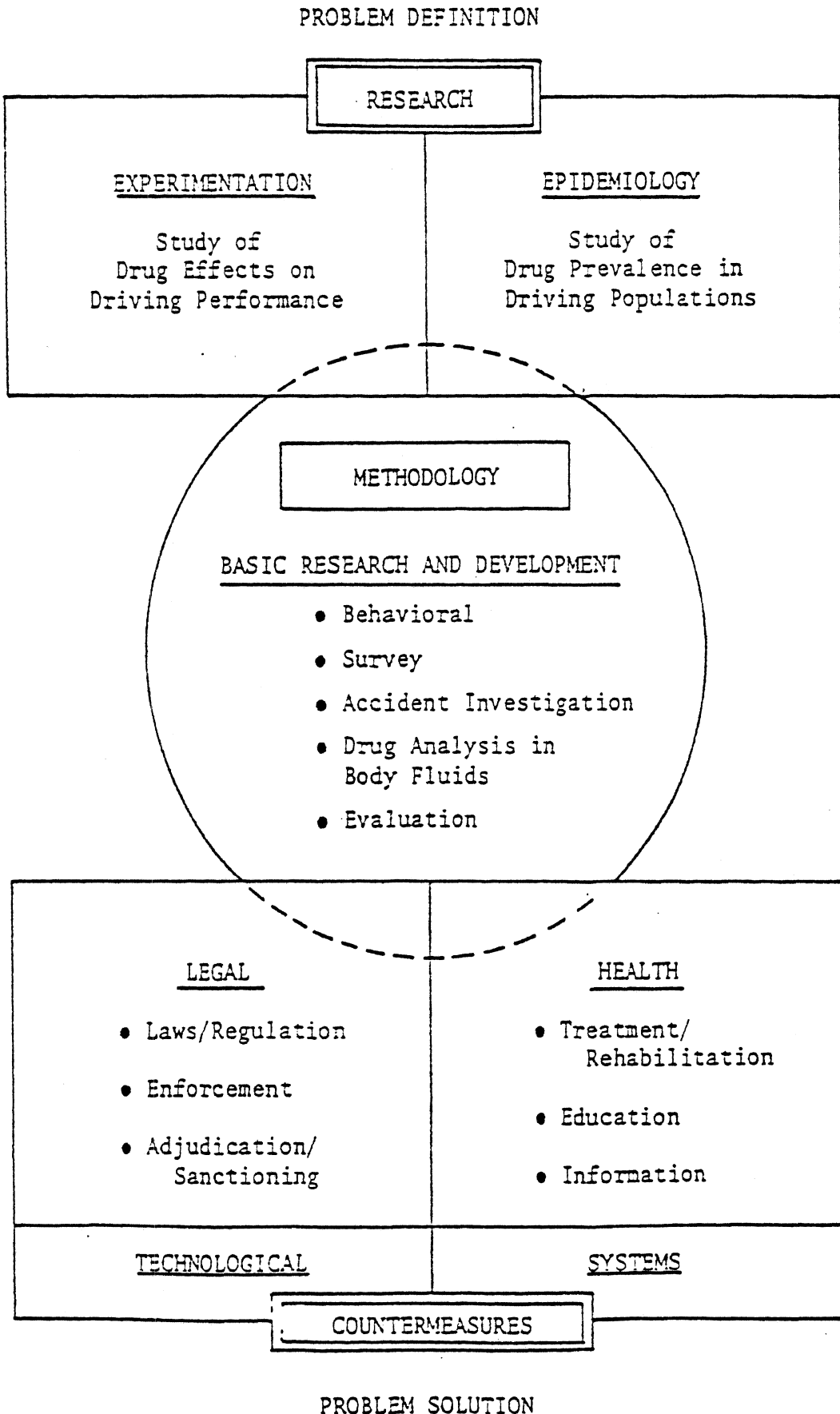
A series of approaches can and should be used by policymakers at the state and local level in the near-term future to deal with drug-impaired driving. This paper describes several of those strategies. It also sketches in broad terms the dimensions of the drug and driving problem; the current state of knowledge about drugs and driving; major areas in which knowledge is lacking and research is needed; and what is being--and can be--done about drugs and driving, based on current knowledge.

DEFINING THE DRUG AND DRIVING PROBLEM

Drugs and traffic safety remains a rather data-poor field. Reliable figures about the number of drug-related traffic crashes and the magnitude

FIGURE 1

DRUGS AND HIGHWAY SAFETY:
A STRUCTURAL REPRESENTATION



of these crash-related losses are not available. Statistical studies, most of them possessing methodological and operational problems, indicate that about 14 to 26 percent of drivers killed in traffic crashes had one or more drugs other than alcohol in their body. Analyses of fatal crashes, conducted by the Midwest Research Institute (Blackburn and Woodhouse 1977; Glauz and Blackburn 1975) showed that 14 to 24 percent of the specimens taken from fatally injured drivers contained one or more drugs, chiefly the cannabinoids. Teale and associates (1977) found that nine percent of all fatally injured drivers tested positive for marijuana. Sterling-Smith and Graham (1976) found that 16 percent of the at-fault drivers involved in fatal crashes tested positive for that substance; however, that study has been severely criticized for methodological imperfection. Cimbura and associates (1980) at the Traffic Injury Research Foundation of Ontario reported that among fatally injured drivers in Ontario, 12 percent had drugs alone in their body, and another 14 percent had alcohol and other drugs. Of the drugs found in drivers' blood and urine, cannabinoids (marijuana) were the most common, followed by salicylate (aspirin), diazepam (an antidepressant), and codeine. Sixty-nine percent of those tested positive for cannabinoids also had alcohol in their body. The Canadian data should be read cautiously, however, since drugs were identified from urine specimens that contained drug traces after their impairing effects had dissipated. Blood specimens gathered in that study indicated that only one in four marijuana-positive cases established recent use—and even this evidence does not necessarily establish impairment. The Ontario study also classified as "drugs" substances, such as salicylate, that are not impairing unless taken in grossly excessive amounts.

Treat and associates, reporting the results of their clinical study of traffic crashes in Monroe County, Indiana, estimated that impairment by drugs other than alcohol was at least a possible cause of four percent of all crashes—an estimate that is believed by the principal investigator to be conservative for crashes in general and especially with respect to fatal and serious crashes (Treat 1980). Even so, a four percent involvement rate translates, in round figures, to an annual total of 2,000 fatalities, 80,000

serious injuries, nearly three-quarters of a million traffic crashes, and a total cost to the public approaching one and one-half billion dollars. These estimates are based on figures compiled by the National Safety Council (1980).

THE ALCOHOL AND HIGHWAY SAFETY EXPERIENCE: HOW RELEVANT TO DRUGS AND DRIVING?

The Alcohol-Highway Safety Experience

Alcohol was widely used long before the invention of the automobile. Alcohol-impaired driving was quickly identified as a potential cause of traffic crashes. By the 1930s, concern over the alcohol-crash risk rose to the point where scientific study of the problem was advocated. Two approaches to defining the alcohol-crash problem emerged: **epidemiology**, dealing with the prevalence, distribution, and control of alcohol-related traffic crashes; and **experimentation**, controlled studies that measured the effects of alcohol on human performance, especially on skills believed related to safe driving. Epidemiologic and experimental research was supported by a third approach, **detection and quantitation** of alcohol in body fluids. A proven and useful variable, blood alcohol concentration (BAC), was developed. BAC could be obtained with little difficulty by drawing a small specimen of one of the driver's body fluids and analyzing it, using any of a variety of chemical analysis techniques. Using BAC levels, researchers proceeded to establish that higher BACs were more frequently involved among crashed drivers (epidemiological approach) and that driving performance tends to deteriorate as BAC increases (experimental approach).

Today the nature and magnitude of the alcohol-crash problem has been estimated but not fully defined. About one-half of all fatally injured drivers, ten percent of drivers involved in personal-injury crashes, and five percent of those involved in property-damage crashes have BACs in excess of the generally accepted legal limit of .10% w/v (Jones and Joscelyn 1978). As evidence linking alcohol and traffic crashes mounted, society

developed and implemented **countermeasures** to reduce the incidence of alcohol-impaired driving. The primary countermeasure approaches were legal: laws were passed prohibiting driving while under the influence (DUI) and specifying the legal effect of chemical test evidence. Implied-consent laws were enacted to facilitate the chemical testing process and make it safer, more reliable, and acceptable to the public. Laws provided for criminal and administrative (driver-licensing) penalties for those convicted of DUI and, more recently, courts have established treatment programs for DUI offenders with drinking problems. At the same time laws were passed to deal with alcohol-impaired driving, public information and education efforts were undertaken. The goal of these programs was to establish a public knowledge base about alcohol and highway safety that would discourage impaired persons from driving and create public support for action against impaired drivers.

Response to the Drug and Driving Problem

For more than half a century, state laws have prohibited driving while under the influence of narcotic drugs. However, prior to 1960, there was little public interest in possible highway safety problems due to drugs other than alcohol. Since then several factors—the continued development and widespread use of new psychoactive drugs; increased nonmedical use of drugs (including misuse of therapeutic substances and illicit use of nontherapeutic substances); and the combined use of alcohol and other drugs (sometimes termed "polydrug use")—have increased the level of public concern over drugs and highway safety (Joscelyn et al. 1980).

The primary means of addressing the drug and driving problem, as in the case of alcohol, is the legal approach. Drug-impaired driving is prohibited by law, and the availability of many drugs is severely restricted. Extensive public information "campaigns" have stressed the dangers of drug use in general. However, with respect to defining and better addressing the problem of drugs and highway safety, the state of knowledge about drugs and driving is still, as one researcher described it, in a prolonged state of infancy. The field contains few full-time practitioners, funding is

scarce, research is fragmentary and widely scattered, and epidemiological studies are lacking. This stands in sharp contrast to the alcohol-crash field, where research is well-established and coordinated.

Still, the alcohol experience is the pattern followed by drug and driving research. It provides perspective but, for a number of reasons, it is not fully applicable. Alcohol has different properties than other drugs. It is a single chemical entity with a simple molecular structure; other drugs number into the thousands, vary in structure, and are usually complex chemicals. Alcohol is a general depressant, while other drugs provide stimulation, hallucination, analgesia, depression, and other effects. Alcohol is rapidly absorbed and metabolized by the human body, while other drugs vary greatly in the rate of absorption, metabolism, and excretion. Other drugs are rarely secreted in the breath in significant amounts, and traces of drugs can remain in the body long after their effects have ceased. Alcohol is a "recreational" drug, while other drugs are used therapeutically as well as recreationally, and much recreational drug use is illicit. Alcohol is widely available and its moderate use is tolerated; most therapeutic substances are tightly controlled and distributed through the health-care system, and the use of most nontherapeutic substances is prohibited. Most important, though, is that alcohol can be detected and quantitated in the body, while most other drugs cannot. There are at present no objective measures of impairment by substances other than alcohol, and none are likely to be developed in the near future.

Without objective impairment standards for drugs other than alcohol, progress in meeting many of the data needs in regard to dealing with the drug and driving problem is likely to be slow. Major data needs include:

- Valid and reliable behavioral methods to measure the effects of drugs on skills related to driving, and to detect drug-impaired drivers;
- Sensitive analytic methods to determine the presence of and measure the amount of drugs in body fluids; and
- Methods to support specific countermeasures aimed at the drug and driving problem (Joscelyn et al. 1980).

THE STATE OF DRUG AND DRIVING RESEARCH

Today society is aware that drugs other than alcohol are potential contributing factors in traffic crashes, just as it became aware of the existence of the potential alcohol-crash problem early in this century. The drug and driving problem remains ill-defined, though, and this in turn constrains the development of countermeasures in this area.

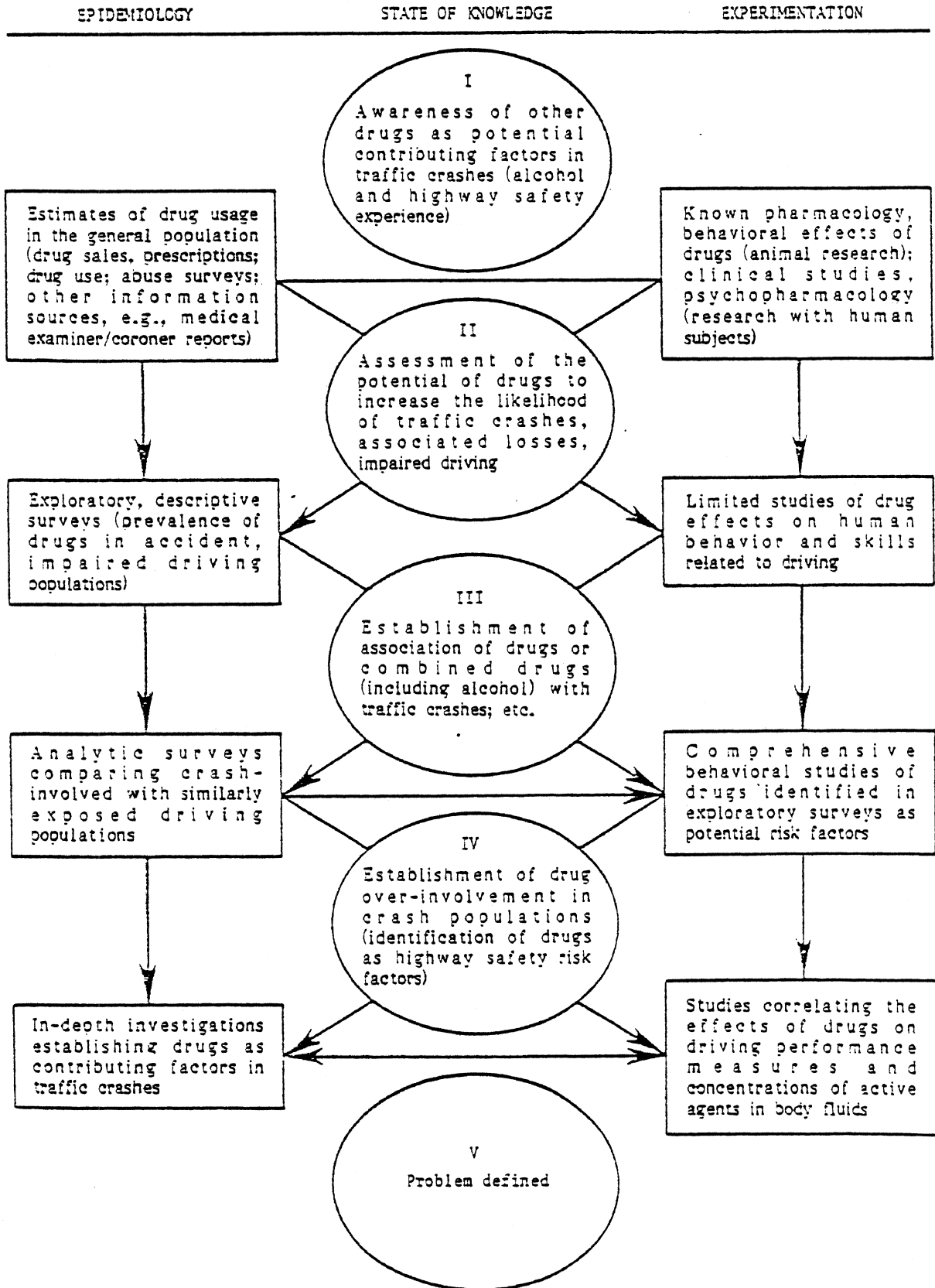
It has been said that the present state of knowledge regarding drugs and highway safety parallels that which existed about alcohol half a century ago. In the alcohol model, which drug and driving research has substantially followed, research has been both epidemiological and experimental, and has been supported by detection and quantitation procedures relating mainly to blood alcohol concentrations. Figure 2 depicts drug and driving research as a process that advances the state of knowledge toward problem definition. Each step of the process requires progressively more rigorous study, using epidemiological and experimental methods in concert. Initial exploratory studies narrow the focus for later efforts, for example, by narrowing the range of drugs of interest from the thousands of available substances to a more limited set. While the overinvolvement of specific drugs in traffic crashes is measured, the properties of specific drugs associated with traffic crashes will be identified. As the drug and driving problem becomes more clearly defined, countermeasure approaches--which currently parallel those directed at alcohol--will become better developed.

Epidemiological Research

Epidemiologic research is aimed at determining, first, whether the use of drugs other than alcohol alone increases the likelihood of traffic crashes; and second, what behavioral errors by drivers are associated with their use of drugs. The overall aim of epidemiological research is to identify specific targets, namely drugs and classes of users, for countermeasure programs.

FIGURE 2

PROBLEM DEFINITION IN DRUGS AND HIGHWAY SAFETY AS A PROCESS



Findings. Epidemiologic studies of drug use among driving populations have used three basic approaches to gathering data: questioning drivers about their use of drugs and their drug-impaired driving; examining the driving records of known drug users; and analyzing drivers' body fluids for drug presence and concentrations.

The general findings of the epidemiological studies to date indicate the magnitude of a drug and driving problem in the United States, but the available data do not reliably define the problem.

Other than alcohol, the substance of most interest as a potential cause of traffic crashes is **marijuana**. The use of marijuana among the driving population, and marijuana presence in the body fluids of crashed and impaired (arrested) drivers, have been studied in various localities. No nationwide study of marijuana and driving—or any other drug other than alcohol—has been conducted. Findings of limited epidemiological studies of a marijuana presence have been limited until recently by the lack of technology for detecting marijuana in body fluid specimens. Available data suggest that both the fatally injured and impaired driving populations contain marijuana users, and that marijuana is frequently consumed in combination with alcohol or other drugs (see, e.g., Cimbura et al. 1980; Reeve 1979). One weakness of the findings regarding marijuana is that the presence of cannabinoids in a driver's urine indicates only prior use, and not necessarily impairment by the substance. Even finding marijuana constituents in the blood does not indicate impairment at the time the substance was withdrawn. To date, the data are not conclusive or complete, and they neither support nor refute arguments that marijuana is or should be a significant highway safety concern.

Measurement of the concentrations of **benzodiazepines** (antianxiety agents) is now possible with more sensitive analytical techniques now available. Studies of suspected drug-impaired drivers in California (Lundberg, White, and Hoffman 1979) and in Texas (Garriott et al. 1977) indicated that antianxiety agents were present in roughly 20 to 30 percent of the drivers arrested for drug-impaired driving, and that polydrug use involving these substances was common. Bo and associates (1975),

comparing limited samples of crashed and noncrashed drivers, found diazepam (Valium[®]) overrepresented in the crashed group. **Other sedative-hypnotics** have been detected in the body fluids of suspected impaired drivers, but there are no studies comparing the prevalence of these drugs in crashed and noncrashed drivers. Little data are yet available regarding **other controlled substances**, because most of these drugs are present in the blood at extremely small quantities and because past analyses have used urine specimens, which contain traces of drugs that remain in the body long after their impairing effects have ceased.

Methodological Problems. Each of the primary epidemiological study methods has weaknesses that limits the value of data collected using that method. Questionnaire studies are limited in general by the unknown reliability of self-reported data. Subjects are likely to understate their drug use and impairment out of fear of legal reprisals, and their responses are not subject to verification by chemical tests. In addition, many questionnaire studies are based on samples of convenience and therefore cannot be used to support inferences about the driving population in general. Examination of driving records is even more indirect and even less reliable than using questionnaires. Many traffic record systems are not of good quality. Even when well maintained, driving records cannot specify which crashes or traffic violations occurred while the subject was under the influence of drugs. Moreover, the same factor may be responsible for the traffic incidents that appear on the subject's record and for the subject's use of drugs in the first place. The most direct approach, obtaining body fluid specimens and analyzing them for drugs, is expensive and time-consuming, and many analytic instruments now in use are not sufficiently sensitive to find all the drugs of interest. Many police departments, medical examiners, and coroners, as well as private and university-based researchers, have analyzed specimens drawn from deceased drivers, and some epidemiological data have been obtained in that manner. With respect to injured, cited, and other living drivers, research on drug prevalence becomes more problematical. Difficulties include the

unwillingness of hospitals to cooperate in and support epidemiological studies, drivers' refusal to give their informed consent to their participation, and constraints on federal agencies that prevent them from conducting or sponsoring roadside studies of drug use by drivers.

A number of other problems are present in epidemiological research. First, since most drugs are used far less frequently than alcohol, and since traffic crashes are comparatively rare events, traditional epidemiologic research may require extremely large sample sizes and entail prohibitive costs. Second, interpreting the findings of drug analyses is much more difficult and much less straightforward than is the case with alcohol. For example, in "polydrug" cases the combined use of drugs may be inferred as a cause of traffic crashes; however, no single substance may be present in a concentration indicative of impairment. Another illustration is the possibility of drug "underdoses." A driver who has taken a therapeutic drug in smaller amounts than necessary to relieve a medical condition may be too impaired to drive, but the impairment is caused by a deficiency of, and not an excess of, the therapeutic drug found in the driver's body. Finally, existing analytic techniques are not sensitive enough, in many cases, to rule out the role of certain drugs, either because they were not looked for, or because existing technology cannot detect such small but impairing quantities.

Experimental Research

Experimental research is aimed at determining, first, whether drugs other than alcohol impair driving performance; second, whether combined drug or combined alcohol and other drug effects impair driving performance; and third, how measures of drug use (such as quantity consumed, frequency of use, or body drug concentration) relate to measures of driving performance.

Findings. Research to date has been voluminous but has not fully answered the basic questions about the effect of drugs other than alcohol on driving performance. Evidence from laboratory tests indicates that **marijuana** at certain dosages, used alone or in combination with alcohol or

other drugs, impairs skills and behaviors related to safe driving. Less numerous studies involving actual vehicle handling generally support the implication that marijuana--especially when taken in large doses--can increase the likelihood of a traffic crash. Studies of **benzodiazepines** (antianxiety agents) have differed widely in experimental design and procedures, which has produced diverse findings about the effects of these substances on psychomotor skills. There are indications, though, that benzodiazepines can further reduce performance already impaired by alcohol, and that their chronic or repeated use may produce cumulative and residual ("hangover") effects. **Other sedative and hypnotic agents** are similar to alcohol in their potential to depress the central nervous system; large doses or combined use with alcohol can impair driving skills. The effects of other **central nervous system stimulants** (including the amphetamines and cocaine) on driving are not clearly established, although these substances may have an indirect effect, namely withdrawal. Sudden loss of consciousness may occur once the stimulant effects of these drugs subside; this phenomenon is relatively well known among truck drivers who use "pep pills." Few studies have been conducted for **other controlled substances**, although one substance, phencyclidine (PCP or "angel dust"), is known to produce severe impairment of nervous and cardiovascular skills and has been implicated in a number of accidental deaths, including fatal traffic crashes.

Methodological Problems. Our review of the research to date identified three general methodological weaknesses in most experimental studies. First, many routinely conducted experiments have limited validity or cannot be related to everyday driving; moreover, experiments purporting to measure like behaviors often cannot be compared to one another, because their procedures differ so greatly. Second, many experiments contain weaknesses in design (such as selection of unrepresentative subjects) that call their results into question; these weaknesses are aggravated by inadequate reporting of the researchers' methods for measuring behavior and analyzing data, and the lack of such critical

information as concentrations of active agents that the subjects received. Third, drugs are often administered to subjects in quantities and at intervals that do not reflect common drug use patterns among the user population; moreover, as already stated, research subjects often do not reflect the user population (Joscelyn et al. 1980).

Reasons for the disarray of the experimental research include the sheer number and diversity of drugs and their effects; the wide range of methods used by researchers to measure behavior; and the numerous variables pertaining to drug, subject, and experimental design. While no experiment in drugs and driving can control for all of the relevant variables, there is a disturbing pattern of discontinuity and lack of coordination across the drug and driving field. Results are equivocal about the potential traffic crash risks posed by drugs other than alcohol.

Nevertheless, in spite of the weaknesses of experimental research, existing findings indicate that the use of such frequently studied drugs as marijuana and diazepam (Valium[®]), especially in combination with alcohol, may increase the likelihood of traffic crashes and, more generally, that drugs other than alcohol have the potential to increase the risk of a traffic crash.

Detection and Quantitation of Drugs

Development of an equivalent to blood alcohol concentration for at least the most widely used drugs other than alcohol would support epidemiological and experimental research that will better define the drug and driving problem. So far no such equivalent has been developed for any substance. This does not mean that drugs present in the human body cannot be detected, nor does it mean that drug concentrations cannot be determined. However, unlike chemical testing for alcohol, which is relatively simple and straightforward, analysis of other drugs is hampered by the variety and complexity of available substances. The testing of blood--the only substance from which meaningful analytic results can be obtained (Joscelyn et al. 1979)--is complex, and most drugs can affect human performance when present in the blood in minute quantities. As a

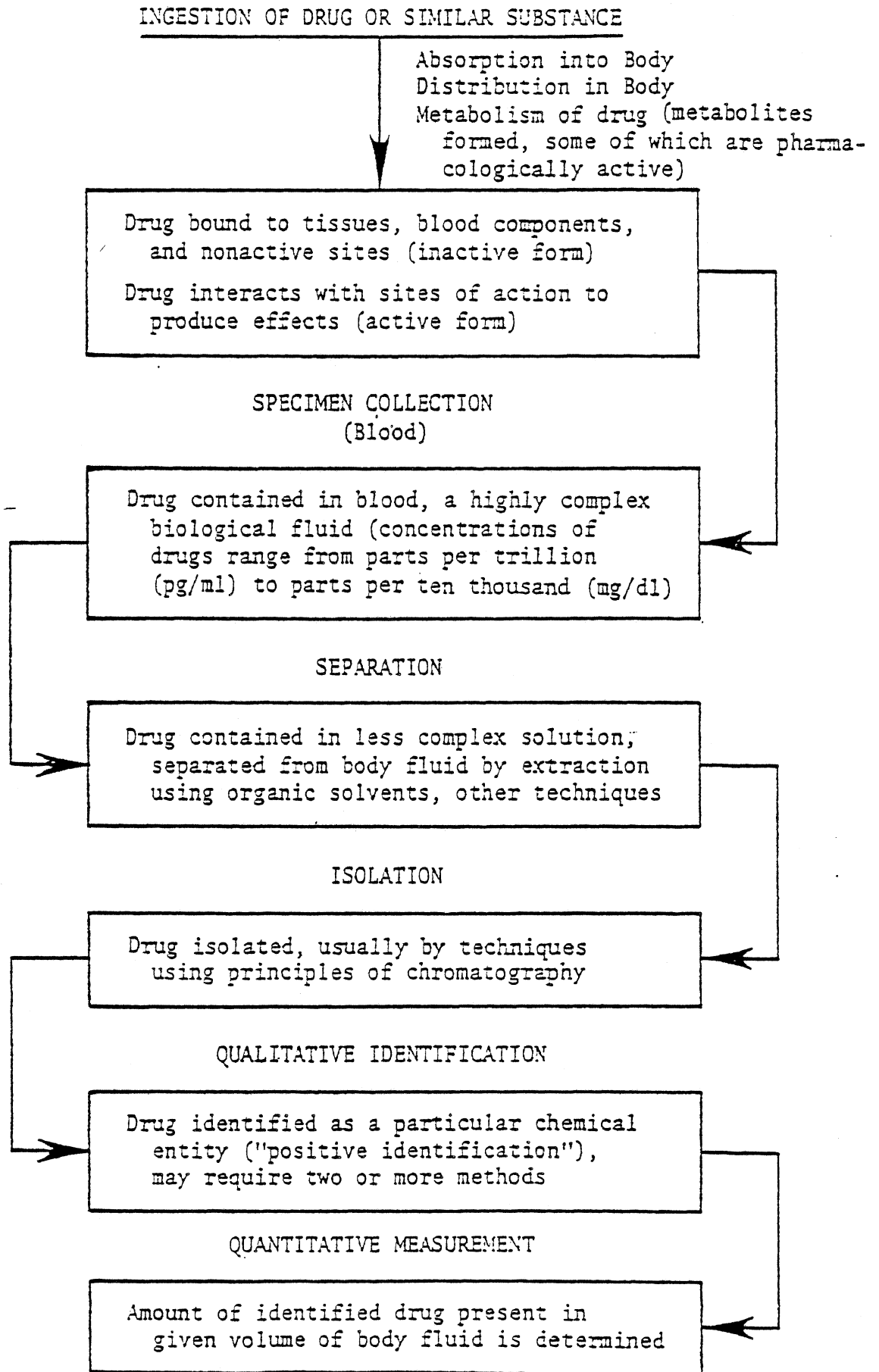
consequence, more sophisticated and costlier analytic techniques are needed to analyze for drug presence and concentration.

Most methods of analyzing body fluid specimens for drugs other than alcohol involve four steps (see Figure 3). The first step is **separation** of the drug from the blood to isolate it as much as possible. Usually the drug to be analyzed is still bound to other chemicals at this point, so **isolation** of the drug is necessary to gather the drug of interest by itself for identification. Once the drug is isolated, chemical or electronic detection methods are used to make a **qualitative identification** of what drug is present. The task of separating, isolating, and identifying the drug is complicated in most cases because the analyst does not know in advance what drugs are present or expected in a particular specimen. (This problem does not exist when analyzing for alcohol.) Unlike alcohol, other drugs number into the thousands, which means that the analyst is forced to concentrate on a limited set of "drugs of interest"--substances whose presence reasonably can be expected. Drugs not expected to appear in the specimen will go unnoticed. Moreover, limitations on cost, time, and size of specimens limit the range of substances for which analyses can be performed. Once a drug or drugs has been identified, a **quantitative measurement** of drug concentration is performed. From the size of the specimen, and the proportion of the specimen that actually underwent quantitative measurement (known quantities of chemicals, called "internal standards" are added for this reason), the drug concentration in the body can be determined.

The state of the art in analytical methods for drug detection and quantitation has advanced greatly since about 1975 (e.g., Joscelyn et al. 1979; Joscelyn and Maickel 1977a; Sunshine 1975). Recent developments include gas chromatography-mass spectroscopy, which separates drugs and records the "fingerprint" or identifying characteristics of each; and immunoassay, a sensitive, selective, and rapid procedure using radioactive substances, that can process large numbers of specimens.

FIGURE 3

THE ANALYSIS FOR DRUGS IN BLOOD



Methodological Problems. Despite recent advances, the major problems in drug detection and quantitation remain the high cost and labor intensity of state-of-the-art analytic techniques and the continued need to develop more sensitive analytical capability. Moreover, no matter how advanced detection and quantitation procedures may become, it is necessary in the first place to obtain specimens from drivers. Deceased drivers are currently the best source of specimens, because police officers or death investigators in some jurisdictions routinely draw them for postmortem analysis, and because informed-consent and other human-subjects issues do not arise. Still, laws inhibit postmortem examinations in some jurisdictions; police departments, even when allowed by law, are reluctant to draw specimens; many police officers are unaware of the value of specimens; and time and funds are not always available for governmental agencies to gather and analyze specimens (Donelson et al. 1980). Even when analysis occurs, not all drugs of interest are studied, and many common analytic procedures fail to find drugs that are present at less than toxic but nonetheless impairing levels. Because a variety of laboratories conduct drug analyses, and because procedures and standards are not uniform, comparison among studies is generally not feasible.

Ongoing and Planned Activity

Recently we directly contacted a sample of public and private organizations involved in drug-related research to determine what activity was either underway or planned. In the realm of epidemiologic research, two approaches—obtaining self-reported data on drug use and drug-impaired driving, and collecting drivers' body fluids and analyzing them for drugs—are emphasized. General objectives of research include developing methods of studying drug use patterns among drivers, determining the extent of drug use among drivers, and obtaining data kept by police departments and other agencies that indicate the prevalence of drugs among drivers. Local and state efforts to detect and measure drugs in drivers' body fluids are underway in various locations, but differences among studies, as well as biases in selecting drivers, may limit the value of these studies' findings.

Currently no nationwide epidemiological study of drugs other than alcohol is underway or even planned. More importantly, neither ongoing nor planned activity includes studies that compare drug prevalence among crashed and noncrashed drivers. Until such studies are funded and carried out, the state of knowledge about drugs and driving will not advance.

Current and planned experimental research is systematically attempting to correlate drug concentrations in the body with the impairment of driving-related skills. Although this study will not soon lead to the establishment of BAC-equivalents for drugs other than alcohol, it will identify methodological problems involved in developing them, and will give some indication of the variability among research subjects. Experiments underway at two universities are aimed at examining the effects of marijuana use on vehicle handling. Other research on drug effects and into human performance in general, while not directly related to drugs and highway safety, may produce findings that will further define the impairing effects of drugs on driving-related skills. In general, current experimentation has the potential to remedy the chief weaknesses of existing experimental data, especially the questionable validity of many laboratory and other tests.

The state of the art in detection and quantitation methods has advanced greatly in recent years, but many analytic procedures are so costly and labor-intensive that their widespread adoption has lagged. Today police agencies, death investigators, and researchers are increasingly analyzing body fluid specimens for drugs other than alcohol, and are handling a widening range of substances. Current and planned research includes developing methods of analyzing saliva or even breath specimens for drugs, developing a reliable and widely available technique for marijuana analysis, and developing portable instruments that will permit roadside testing in connection with law enforcement. Also underway are programs to improve laboratories' capabilities to analyze for drugs, and to improve quality control within laboratories.

Presently the major obstacle to drug and driving research in relation to alcohol and driving research is the lack of data that can support the

establishment of BAC-equivalents for drugs other than alcohol. Without such equivalents, it is difficult to determine with precision whether a driver—crashed, arrested, or at risk—is incapable of driving safely by reason of drug consumption. It is unlikely that BAC-equivalents will be developed in the near future, and it is possible that they may never exist for some drugs. In any event, some reliable procedure for measuring other drug impairment must be developed and put into use.

COUNTERMEASURES TO THE DRUGS AND DRIVING PROBLEM

In dealing with the drug and traffic safety risk, society has at its disposal a number of countermeasure approaches for controlling that risk. These include the legal approach, the health approach, the technological approach, and the public information and education (PI&E) approach. Often, two or more approaches are applied in concert, such as the "health/legal" approach to alcohol and traffic safety. When systematic and combined use is made of several approaches, a "systems approach" is said to be used.

Legal Countermeasures

As in the case of alcohol-impaired driving, society's principal countermeasure approach to the problem of drugs and driving is **legal**. Legal countermeasures to drug-impaired driving include two broad strategies: the indirect approach of restricting the availability of substances that can impair driving performance (and cause other undesirable public health consequences); and the direct approach of using punishment to discourage drivers from operating vehicles while under the influence of drugs.

Drug Control Laws. Both federal and state laws restrict the manufacture, distribution, possession, and use of substances that can be abused. These drug-control laws seek to reduce problems stemming from improper drug use by forbidding persons likely to abuse them from having access to them. This approach is found, though to a lesser extent, with

respect to alcohol: a limited number of licensed distributors are permitted to sell alcoholic beverages, and certain classes of persons (chiefly minors) are forbidden access to them. In the case of drugs other than alcohol, access to therapeutic drugs capable of being abused is generally restricted to the health-care system, and access to nontherapeutic drugs of abuse is essentially forbidden. The most important drug-control laws are the controlled-substances acts. The federal controlled-substances law, called The Comprehensive Drug Abuse Prevention and Control Act of 1970, limits the manufacture of designated drugs, regulates their distribution, supervises both, and provides punishments for violators. State law consists not only of controlled-substances acts (which are generally patterned after federal law) but also laws and regulations that govern the practice of medicine and pharmacy. These professional regulations in effect govern the distribution and use of drugs, since many substances other than alcohol are primarily distributed through the health-care system.

Driver-Control Laws. It is common knowledge that drug-control laws do not prevent drug abuse, nor do they prevent unauthorized persons from possessing or using drugs of abuse. It is also well known that many freely available drugs have the potential to impair driving ability; packages containing prescription and over-the-counter remedies often contain warnings against driving after using them. Nevertheless, in spite of these attempts at control, many persons do drive after using impairing substances, and these persons represent a traffic safety hazard.

Thus society has reacted to the presence of impairing drugs in an automobile-oriented society by enacting legislation aimed at discouraging, or **detering**, drug-impaired driving through punishment and the threat of punishment. For about half a century, state vehicle codes have forbidden driving while under the influence of drugs (DUID) and have made such conduct punishable by criminal penalties (fines and confinement to jail) and administrative sanctions (loss or restriction of driving privileges). All states today prohibit drug-impaired driving. Still, drug-impaired driving has attracted little attention in comparison to drunk driving; moreover, prior to

about 1960, the level of public concern over drugs and driving was low.

Enforcement of DUID laws parallels that of drunk driving laws, although a much lower priority is placed on the drug-impaired offender. Police training for DUID law enforcement is based on the same observations of driving behavior as drunk driving. Once a driver is stopped, the decision to arrest for DUID is usually based on the driver's possession of drugs other than alcohol, visible impairment with no odor of alcohol, or admission of drug use. In some cases, an arrest is originally made for drunk driving and, following chemical tests that indicate the driver had not been drinking, the charge is amended to DUID. Arrests for DUID are comparatively rare among impaired-driving arrests. Statistics indicate that about one drug-impaired driving arrest is made for every one hundred drunk driving arrests. Compared to drunk driving, DUID conviction rates are lower and plea bargaining is more frequent because of the greater difficulty of proving guilt in DUID cases. Sanctions for DUID tend to be similar in severity to, or somewhat more severe than, those imposed on convicted drunk drivers. Drug-impaired drivers, like alcohol-impaired drivers, are also sanctioned by having administrative action taken against them by the driver-licensing authority. Mandatory license suspensions for those convicted of driving while under the influence of drugs or alcohol are commonly provided for by state law, and courts often impose license suspensions or restrictions as part of the sanctions for impaired driving. On occasion, drivers with drug or alcohol problems are referred to medical review panels within driver-licensing authorities, and sometimes their retaining driving privileges is conditioned on obtaining treatment or abstaining from impairing substances (Joscelyn et al. 1980).

Enforcement of DUID laws, although procedurally similar to the enforcement of drunk-driving laws, is made more difficult by several factors. First of all, unlike BAC measurements for alcohol influence, there are no quantitative measurements equating other drug concentration with impairment of driving performance. Sometimes it is possible to show that the drug concentration in a given driver's body greatly exceeded the therapeutic concentration or even approached a toxic level, or to introduce

expert testimony that a driver had used an impairing quantity of a nontherapeutic substance such as marijuana. Second, because blood is the only body fluid that can yield meaningful findings regarding drug presence and concentration, chemical testing for drugs other than alcohol is much more difficult to carry out than testing for alcohol; the latter is commonly done using inexpensive, widely available, and sometimes portable breath-testing equipment. Third, since drugs other than alcohol are often used in combination with one another or in combination with alcohol, both physical and chemical evidence can fail to indicate what specific substance resulted in driving impairment. All of these problems hinder the proof of guilt at a DUID trial.

Problems of Legislation Related to DUID. In most states the practical difficulties of proving guilt of DUID are compounded by provisions of state law that further hamper the gathering of evidence for use in a DUID trial. Although every state has a law prohibiting DUID, and has a so-called "implied-consent" law that facilitates and governs the use of chemical test evidence, there is considerable difference among state provisions. The model driver-control laws related to DUID are found in Sections 6-205.1, 11-902, and 11-902.1 of the Uniform Vehicle Code (UVC), prepared by the National Committee on Uniform Traffic Laws and Ordinances (1979). A small number of states, such as Georgia, have adopted state laws similar to those of the Code, but most states' laws have one or more substantial departures from the model provisions. Typical weaknesses of state laws include:

- **Narrow definition of "drug."** The Uniform Vehicle Code prohibits driving while under the influence of "any drug" but many state laws use definitions such as "controlled substance" or "narcotic drug," or exclude legal therapeutic drugs from the definition. Such legislation is underinclusive with respect to impaired drivers whose drug influence--legal or not--still presents a safety hazard.
- **Restrictions on testing.** The Code allows for blood, breath, or urine tests, and allows the arresting officer to choose what test is to be given. Many state laws, however,

either limit the officer to a breath test, or allow the driver to choose from among available tests and thus avoid a blood analysis. Such legislation permits a driver who is under the influence of substances other than alcohol to avoid the discovery of evidence of drug influence.

- **Failure to cover "polydrug" use.** The Code's DUID provisions prohibit driving while under the influence of any combination of impairing substances. Many state laws fail to deal with combined influence (alcohol and other drugs; other drugs combined) and present possible difficulties in prosecution.

- **Lack of power to analyze specimens for other drugs.** Many states' implied-consent laws apply to alcohol only and do not allow for the introduction of other drug analyses into evidence at a trial. The Uniform Vehicle Code allows the introduction of evidence of alcohol, other drug, or combined concentrations in trials.

Weaknesses of existing state laws have contributed to prosecutors' problems in handling DUID cases. Many prosecutors are of the opinion that the chances of obtaining a conviction in a DUID trial are poor, especially when the only evidence available consists of the officer's testimony about the driver's physical condition and driving performance, with no chemical evidence pointing to drug consumption or influence. Plea bargains to less serious charges such as reckless or careless driving, or dismissals of DUID charges, are common outcomes of DUID arrests.

Our companion volume, Alcohol, Drugs, and Traffic Law (Joscelyn and Ruschmann 1981), discusses in more detail the deficiencies of existing legislation and makes recommendations for legislative reform.

Health Countermeasures

Health countermeasures involve the health care system either by changing the manner in which it delivers drugs to patients or delivers information related to drugs and their effects; or by enlisting their help in treating and rehabilitating those who have drug-related problems.

One well-known, **direct** countermeasure directed at drug-impaired driving uses the legal system to "find" impaired drivers who are dependent on alcohol or other drugs and refer them to appropriate treatment

programs. Referrals are frequently made by courts or driver-licensing authorities in connection with the sanctioning process, typically as a condition of the offender's retaining driving privileges. Health countermeasures operating in concert with legal countermeasures are sometimes called the health/legal approach (Jones, Joscelyn, and McNair 1979).

Indirect health countermeasures also exist. One such countermeasure is treatment of drug abuse and dependence problems in general; the treatment program may deal with substance abuse and highway safety. Many of those who are referred to treatment programs are referred by the legal system, and others are directed there by their employers. For example, federal agencies are required by regulation to implement drug and alcohol abuse programs for their employees, and all branches of the military report that they conduct education and treatment programs directed in part at drug abuse. Another class of indirect health countermeasures parallels public information efforts; health care professionals who dispense drugs are informed of the adverse effects of drugs on human performance, including driving performance, and countermeasure efforts sometimes attempt to change prescription practices (Joscelyn et al. 1980).

Public Information and Education Countermeasures

In drugs and traffic safety, public information and education countermeasures may be considered a part of health countermeasures in general, or as activity supporting other countermeasures. They include both classroom-oriented programs (educational programs) that impart drug-related information; and more informal information-dissemination efforts (public information programs). Education programs range from general courses such as those that deal with driving or public health and focus only tangentially on drug-impaired driving, to more specific areas such as drug and substance abuse and courses aimed at health professionals and highway safety specialists. Public information countermeasures include efforts by both government and private entities (such as pharmaceutical

manufacturers' associations) and are generally aimed at increasing awareness about the impairing effects of drugs on driving ability.

Generally, both the literature and contacts with operational agencies at the state and local level indicate little activity has occurred in the past to educate and inform the public about the effects of drugs on driving and on the magnitude of the drug and driving problem. The lack of activity is not surprising in light of the lack of knowledge about drugs and driving that could support countermeasure programs. Recently, we contacted 190 state and local agencies to determine whether they had specific programs for education, public information, or referrals. Only three programs were identified, all in the area of driver education. No specific drug and driving programs were found in the areas of general health education, substance abuse education, professional medical education, or professional education for highway specialists (Joscelyn et al. 1980).

Technological Countermeasures

Unlike alcohol and highway safety, where technology has played a major role in detecting and prosecuting offenders and a lesser role in preventing impaired driving, technological countermeasures to drug-impaired driving are less developed. This remains the case despite marked advances in the state of the art in drug detection and quantitation. One primary reason why this is so is the lack of BAC-equivalents for drugs other than alcohol, combined with a widely held belief that chemical tests for drugs are still not worth the expense of time and funds. Other difficulties with present chemical test procedures is that blood is the only substance that can be analyzed for meaningful results, and testing equipment is neither convenient nor widely available. Efforts are underway to develop portable drug screeners for roadside use in law enforcement.

Systems Countermeasures

The systems approach to a problem is a methodical combination of several countermeasure approaches. In alcohol and traffic safety, the former Alcohol Safety Action Project (ASAP) applied the systems approach

to the problem drinking driver and later to all drinking drivers. ASAP, which operated between 1969 and 1975, was a federally sponsored program that operated in selected jurisdictions throughout the United States. Individual projects were conducted at the local level and emphasized improved law enforcement, more efficient traffic court procedures, public information, and special efforts to counsel and assist drivers. No nationwide program comparable to ASAP has been conducted for drugs other than alcohol, and none are anticipated soon at either the federal or the state level.

DIRECTIONS FOR FUTURE ACTIVITY

Although present knowledge does not conclusively show that drugs other than alcohol and driving represent a priority highway safety problem, there exists enough evidence—including the impairing potential of many drugs, and the widespread use of drugs by the driving population—that points to the existence of such a problem. This is supported by anecdotal evidence from the field that a drug and driving problem has become more serious in recent years.

So far, society's response to the perceived drug and driving problem is similar to its response to the alcohol and driving problem earlier in this century. Research is underway to better define the problem, and to support countermeasure development. The legal system—both criminal and administrative—is the means by which society applies countermeasures to manage the perceived risk created by drugs and driving.

At the broadest level, future activity in drugs and highway safety should be directed at improving both the problem-definition process through improved research in drugs and highway safety, and the societal response to that problem through more effective countermeasures to drug-impaired driving.

Improved Research in Drugs and Highway Safety

Operating motor vehicles is a basic way of life in the United States. Traffic crashes are a significant cause of deaths and associated losses,

especially among young adults; total crash losses exceed \$35 billion per year (National Safety Council 1980). That being the case, allocating efforts and funds to increase understanding of safe and deficient driving performance appears to be a wise use of resources. To better define the drug and driving problem, and to develop and implement more effective countermeasures, it is necessary to continue both experimental and epidemiological research in this area. Much of the research to date has been fragmentary and poorly coordinated, and is subject to methodological criticisms. On a global level, these problems should be addressed as further drug and driving research proceeds. Within the respective areas of epidemiology and experimentation, a series of specific, critical issues should be examined.

Experimental Research. Past experimental research, with few exceptions, has been fragmentary, has lacked depth, and has uncertain meaning for practical concerns of traffic safety. Some substances have been studied many times with mixed results; findings for many others are almost nonexistent. If future research is to advance the state of knowledge about the effects of drugs on driving, several critical considerations must be addressed. The first of these is **realistically determining whether a specific drug presents a hazard to highway safety**. If an experiment is to be relevant to traffic safety efforts, it should ensure that characteristics of drug use (such as dosage, frequency of consumption, time of use, and circumstances of use) match those of the general population, and that research subjects match the user population. This has not been the case in much research to date, and the study results have, as a result, had limited usefulness.

The second consideration is **better measurement of drug effects on driving-related performance**. Not enough is known about the actual driving task, the performance skills and other factors that influence driving. Unless the factors that determine safe driving are known, it is quite difficult to measure impairment of safe driving performance. Thus basic research on the actual driving task is needed, and laboratory

techniques should reproduce the driving task more exactly and completely.

The third major consideration is **developing standards for determining whether drug concentration has rendered a person incapable of driving safely.** In alcohol-impaired driving prosecutions, BAC is the standard by which impairment is measured. For drugs other than alcohol, BAC-equivalents are theoretically possible but none have yet been established. For some drugs, they may never be established because of differences in the way people respond to drugs and variances in the amounts of drugs in subjects' blood. Therefore, alternative approaches to measuring other drug impairment—for example, roadside behavioral tests—should be explored.

Fourth, future experimental research should deal with **what experimental designs most effectively assess the effects of drugs and combinations of drugs.** Drug effects vary widely from drug to drug, and from user to user. Some therapeutic drugs, for example, enhance driving performance when they are used to treat impairing medical conditions. More generally, drug effects vary with dose, frequency of use, physiological and psychological condition of the user, and the user's ability to compensate for their effects. With this in mind, designs of experimental studies should not only examine impaired performance per se, but also "real-world" factors that may mitigate the impairing effects of drugs.

Finally, future research should **ensure validation of laboratory and other experiments by intermethod comparison.** Research to date has varied so widely from experiment to experiment that even studies purporting to measure the same behavior or the effects of the same drug have produced widely different results.

Epidemiologic Research. The purpose of experimental research is to assess the potential traffic safety risk of drugs other than alcohol. Although experimental research can show that certain drugs, taken in sufficient quantities, can impair skills believed to be related to driving, they cannot by themselves establish a causal link between drug use and an increased risk of traffic crashes. This is the function of epidemiologic

research. Methodologies used in epidemiologic research have received more attention than those in experimental research. One shortcoming of past research on drugs and driving is the lack of **comparisons between populations of crashed drivers and "at risk" or noncrashed drivers.** Without such comparisons, no objective statement about the relative probability of having a drug-involved crash is possible. The importance of conducting at-risk studies cannot be stressed enough. Even so, substantial constraints exist on this type of research. It is still necessary to identify approaches that will result in acceptable levels of cooperation by drivers stopped at the roadside and asked for data or specimens; pilot studies addressed to the cooperation issue should precede large-scale surveys of drug use in the driving population. Another problem found in roadside surveys of drug use that does not exist with respect to alcohol is that only blood specimens will yield acceptable results, which rules out the use of convenient, portable, or nonintrusive testing procedures. The alcohol literature contains a great deal of roadside survey results pertaining to alcohol use by the at-risk population. These provide the basis for drug and driving research using roadside surveys.

Future epidemiologic research should **concentrate on a broad range of drugs at therapeutic or effective concentrations.** Much prior research has been based on drug dosages that differ greatly from those generally taken by the user population. For therapeutic drugs, the therapeutic concentration or normally prescribed dosage is most typically found in the population. For nontherapeutic drugs, the equivalent measure is an "effective concentration," that which will produce an unacceptable impairment of safe driving ability. At the very least, the range of drugs should include those that are of greatest interest to traffic safety at therapeutic and effective levels. When necessary, state efforts should be supported with highway funds to increase the analytic capability of agencies involved in this form of research.

A variety of agencies now conduct epidemiologic research and refer specimens to several laboratories that vary in their quality and capability for detection and quantitation. The comparability of analytical results

obtained from different laboratories remains uncertain at best, especially when quantitative measurements are compared. Until **quality control and proficiency testing** establish the validity of comparing data from separate sources, a single, qualified laboratory should be used for projects in which findings must be consistent with one another for later comparison and interpretation.

Finally, the use of **other sources of information on patterns of drug use and driving** should continue. National, state, and local questionnaire studies concerned with drug use should contain questions related to traffic safety, especially respondents' drug and driving experience. This kind of data is admittedly subject to biases and cannot distinguish among specific drugs, but in spite of that, some assessment of pertinent attitudes and behavior in different driving-age populations that use drugs—both licit and illicit—would assist in estimating the scope and magnitude of the drug and driving problem.

More Effective Countermeasures to Drug-Impaired Driving

Countermeasure approaches to drugs and driving have paralleled those used to combat alcohol-impaired driving. The chief means of social control directed against a drug-impaired driver are legal; in particular, punishment and the threat of punishment are used to discourage persons from driving while impaired. Other countermeasures are used as well, but the level of activity, both on an absolute basis and in comparison with the level of activity devoted to alcohol-impaired driving, is comparatively low.

Legal Countermeasures. Existing state laws intended to prevent driving while under the influence of marijuana or other drugs are in disarray. A drug-impaired driver could escape prosecution because a chemical test cannot be requested; by choosing a test such as breath that will not reveal the drug being used; by using a substance that does not fit a narrowly defined category of "drugs"; or by using drugs and alcohol in combination. At least one of these loopholes exists in the laws of all but twelve states. Law revision is needed if legal countermeasures to drug-

impaired driving are to be relied on. Our companion volume, Alcohol, Drugs, and Traffic Law (Joscelyn and Ruschmann 1981), contains specific recommendations.

The need for more effective laws has been recognized by the drafters of the Uniform Vehicle Code. Model legislation has been drafted that addresses each of the major shortcomings of existing state law. States should be encouraged to adopt the substantial provisions of the UVC related to alcohol, other drugs, and driving. The experience of the states that do adopt new laws and of those states that now have similar provisions in effect should be evaluated. Problems in enforcement, prosecution, adjudication, and sanctioning should be identified. The effectiveness of legislation in reducing such problems should be assessed. The National Committee on Uniform Traffic Laws and Ordinances should be supported to assist states in developing legislation and, if necessary, to revise the Uniform Vehicle Code to address new problems.

Public Information and Education Countermeasures. While the existence of a serious drug and driving problem has not yet been confirmed by research, there is sufficient evidence of a problem to warrant some effort to promote public awareness. Large-scale public information and education campaigns and other special programs requiring heavy expenditures are not appropriate because of the lack of a knowledge base to support such efforts. On the other hand, limited use of existing programs, such as the National Highway Traffic Safety Administration's "402 program" of assistance to state and local jurisdictions, is indicated. Information and education countermeasures directed at drugs and driving should take the form of:

- driver education,
- general health education,
- drug abuse and substance abuse education,
- professional medical education,

- professional education for highway safety specialists, and
- public information and education "campaigns" for both the general public and special audiences, such as pharmacists.

Knowledge about drugs that have the potential to impair driving should be shared with those who use them and with those who have responsibilities for highway safety management. What is known can be shared by including drug and driving information elements in existing education and public information programs that address both drug and highway safety issues.

A major shortcoming of existing information and education programs dealing with drugs and driving is their fragmented nature and the lack of a comprehensive approach to the problem. Most present programs deal with drugs and driving peripherally as part of some other topic, such as drug abuse or alcohol and traffic safety. Mechanisms for developing a more integrated approach dealing with all aspects of the drug and driving problem need to be expressed.

No program of public information and education can succeed without effective materials. To develop such materials, the first step is to conduct an in-depth analysis of present programs, what they contain, and how their message is disseminated. The results of this analysis should be collated, indexed, and made available to researchers and practitioners in the field.

The information area also includes the function of linking researchers, policymakers, and practitioners in the fields of traffic safety and drug abuse. The drug and driving field, as a whole, includes several areas of research, each of which involves many disciplines. At the same time, so-called action programs to deal with the drug and driving problem have been initiated at state and local levels. With both increasing interest and activity in this area, the need to integrate and transfer information relevant to drugs and highway safety has arisen. Specifically, a central clearinghouse for information on drugs and driving is needed. Such a clearinghouse would:

- Maintain and update collections of literature and other materials pertaining to all topic areas including research, methodology, legislation, and action programs;
- Prepare bibliographies that provide ready reference to sources of information; and
- Provide, upon request, information that can be used by researchers and practitioners alike.

In addition to collecting and disseminating research reports and other information on drugs and driving, the clearinghouse could collect state and local data on the detection and measurement of drugs in drivers, integrate findings from contributing agencies, and analyze the continuous flow of information from the field. This basic function of such an information clearinghouse would be to link research to define the problem and action programs to deal with the problem. The problem of drugs and highway safety is one in which a clearinghouse, to which state and local officials can turn to for information and other support, is needed. The clearinghouse could not only provide needed information but also lead to the establishing of "networks" among state and local agencies that face similar problems and are engaged in similar activity.

What is known also needs to be considered as decisions are made to allow additional substances to enter the marketplace. The introduction of new drugs, similar to those shown to have the potential to impair driving, and which are identified as playing causative roles in traffic crashes, should occur only after acquiring evidence that allows a complete weighing of the risks and benefits of the drug. The risk potential of a new drug to highway safety should be included in this risk-benefit analysis. This responsibility falls within the purview of the Department of Health and Human Services and its agencies.

Technological Countermeasures. In drugs and traffic safety, development of countermeasure approaches has paralleled that of alcohol crash countermeasures. One specific standard of drug impairment is sought, especially by those in the legal system through which most control

forces are directed at the drug and driving problem. Development of a BAC-equivalent for other drugs dictates a heavy emphasis on technological countermeasures, especially devices that can detect and quantitate drugs in body fluid specimens. Unlike alcohol, however, other drugs are more complex, more varied, more likely to produce a wider variety of effects on their users, and more apt to behave differently from one another when metabolized in the human body. That being so, developing BAC-equivalents, even for a small number of drugs, will require much larger-scale experimental research on the relationship between drug concentrations and effects on driving performance than occurs today. It will also require a great increase in personnel, equipment, and facilities for conducting drug analyses. Even if such resources are available and affordable, the development process is likely to take years. Once equivalent measures are developed, they must gain legal acceptance--a long process that will require, at a minimum, the legal changes outlined earlier as well as expert testimony in court to establish the scientific validity and fairness of objective drug-impairment measures.

The anticipated outlay of resources to develop BAC-equivalents is so great that it may not be justified in light of the likely benefits to be gained. Also to be considered are practical and political obstacles; for example, citizens may resent new laws permitting more intrusive testing procedures, or higher taxes to support testing and research. While abandonment of the search for BAC-equivalents is not recommended, examination of the premises underlying this search should take place.

Specifically, at this point in the examination of the drug and driving problem, some basic policy analyses should be performed. Whether it is wise to continue following the alcohol experience in dealing with drugs and driving should be carefully examined. In particular, the feasibility of developing and relying on the BAC-equivalent concept should be evaluated. The feasibility of using means other than chemical analysis to prove guilt of drug-impaired driving should be examined. More generally, an examination should include a detailed review of whether it is feasible to continue relying on the criminal justice system as the major social control

system for drug-impaired driving. Alternative control measures that rely on administrative approaches using nonpenal sanctions should also be considered.

SUMMARY AND CONCLUSIONS

Research is underway to assess the magnitude of the problem created by drug use by the driving population. Experimental research seeks to define the relationship between drug concentrations in the body and driver impairment. Epidemiologic research seeks to identify the actual risk of various drugs to highway safety. Countermeasures that have been used to deal with alcohol--including legal, health, education, and public information--are under development and limited implementation. In particular, the establishment of a BAC-equivalent for drugs other than alcohol is sought but may not be feasible.

With the exception of alcohol, present knowledge does not establish any drug as a priority highway safety concern. Research has established that many drugs have the potential to impair driving behavior and that these drugs are used by people who drive. Research findings and reports of operational agencies document crashes that involve drivers who have used drugs. Drivers arrested for impaired driving are found to have used drugs--alone and frequently in combination with alcohol or other drugs. **The frequency with which drug-impaired drivers drive and are involved in crashes is not known.** The frequency of arrests for drug-impaired driving is much less than that for alcohol-impaired driving. Preliminary data suggest that about one hundred arrests are made for alcohol-impaired driving for every one arrest for drug-impaired driving. Estimates for crash involvement cannot be made on the basis of existing data.

Present knowledge supports the need for further inquiry to establish the nature and magnitude of the drug and driving problem. While objective data do not exist to support statements that the drug and driving problem is increasing, it is the perception of operational personnel--including police, prosecutors, health specialists, drug abuse experts, and highway safety specialists--that the problem has increased in recent years. These views

should not be ignored. They establish the need for careful inquiry to develop the necessary objective data to define the problem. Of greatest need are epidemiologic data on drug use among drivers representative of both crash- and non-crash-involved populations.

Present knowledge also indicates that examination of the drug and driving problem should consider a broader range of drugs than controlled substances and marijuana. Other psychoactive drugs, including antidepressants, major tranquilizers, outpatient anesthetics, and medications available over the counter for self-treatment are also of interest.

Knowledge about the patterns of drug use suggests that polydrug use should be a major concern. In particular, the combined use of alcohol and other drugs in conjunction with driving is a priority interest. Such use may produce impairment deliberately when drugs are abused or inadvertently when medications are used in combination with social drinking.

The state of knowledge suggests directions for the future. Efforts need to be undertaken to define the problem. Nevertheless, some actions can be taken now on the basis of existing knowledge. There are major policy issues that should be examined to focus future activity. Improvements in both epidemiological and experimental research are indicated. Experiments should be carried out under conditions that more realistically account for drug use patterns in society as well as what skills are required to drive safely. Epidemiological research, to be meaningful, must compare crashed (both killed and living) and noncrashed (both arrested and "at risk") driver populations. Research studies should be designed and carried out in a more consistent manner to ensure comparability across studies. The form of countermeasures to the drug and driving problem will be shaped not only by the problem definition resulting from research, but also by a societal determination whether the legal system should remain the primary risk-management system directed at the drug-crash risk. Specifically, so much time, money, and personnel may be required to establish reliable, objective standards of drug impairment that are legally acceptable that the legal approach may be as costly as the problem, or at least more costly

than other, effective strategies. For example, a BAC equivalent for many drugs of interest is not presently available and may never be available for some drugs. If reliance on the legal system continues, then present laws that often contain loopholes allowing drug and driving suspects to escape prosecution must be amended. Information regarding drugs and driving is not plentiful when compared to the body of information related to alcohol and driving. What information exists is often not effectively presented to the public, and is not handled in a manner that allows for exchange among researchers, practitioners, and policymakers.

In sum, available knowledge indicates that a potentially serious drug and driving **may** exist, but its magnitude has not been established by reliable scientific evidence. The problem appears serious enough to trigger formal responses by society, chiefly the passage and enforcement of laws to prevent it. However, a large-scale commitment of additional resources to attack the perceived drug and highway safety problem should not be made until further research more clearly defines its magnitude.

WHAT CAN BE DONE?

Although the magnitude of the drug-crash problem has not been determined with precision, enough is known now to support formal action by society. A number of actions can—and should—be taken at the state and local level to reduce the drug crash risk.

To date society has relied primarily on the legal system to control social risks such as traffic crashes and the losses they produce. Other countermeasure approaches, including health and public information strategies, are available and they should be used as well.

Specific actions related to **law generation and enforcement** that can be taken by units of state and local government include:

- **Revision of state laws to eliminate "loopholes" that impede prosecution of drug-impaired drivers.** Provisions that restrict the admission of chemical test results into evidence, allow a driver to choose a test other than blood, or exclude licit drugs from the scope of their coverage unnecessarily restrict the efforts of law enforcement agencies to deal with impaired driving.

Our companion volume, Alcohol, Drugs, and Traffic Law (Joscelyn

and Ruschmann 1981), contains specific recommendations for law revision and model legislation taken from the Uniform Vehicle Code.

- **Reliance on qualitative evidence to establish guilt of drug-impaired driving.** Even though no BAC-equivalent exists for any substance other than alcohol, the absence of quantitative standards for other drug impairment does not excuse failing to diligently prosecute cases of driving while under the influence of drugs. Before the BAC concept was developed and accepted, drunk driving was proved by qualitative evidence such as driving errors, poor performance of coordination tests, and the odor of alcohol. Similar evidence should be relied on to prove impairment by other drugs.

Prosecuting attorneys and police officers should be given reliable information regarding proof by behavioral evidence of drug-impaired driving and should receive appropriate training.

In the past many legal countermeasures, especially those relating to alcohol-impaired driving, have been supported by information and education "campaigns" intended to increase public awareness of and support for countermeasure activity. In addition, information and education efforts also have been directed towards specialized audiences who are in a position to impart essential information to individual drivers about traffic safety. Specific actions relating to **information and education** include:

- **Identifying more clearly the target audiences for public information and education programs.** In particular, two subpopulations with contrasting drug usage patterns should be priority targets of information and education efforts. The first of these consists of **drug-sensitive users**, especially elderly persons, who regularly consume one or more therapeutic drugs and whose driving ability is impaired as a result. Many of these users are not aware of whether, and to what degree, their driving skills are affected. They need specific information that addresses that topic.

The second subpopulation consists of **drug experimenters**, chiefly young adults who abuse licit drugs, use illicit drugs, and use alcohol and other drugs in combination. Most of the drug use within this group is recreational. Their information needs include what impairing effects are likely to follow the use of drugs, and what actions society will take if drug-impaired driving occurs.

- **Directing information and education programs at those within the health-care system.** Most licit drugs are controlled and therefore legally available only through the health-care system. These therapeutic substances are prescribed by physicians and are dispensed by pharmacists. Both groups' distribution patterns may contribute to the prevalence of drug-impaired driving by licit drug

users. Since most of this contribution is inadvertent, information programs informing physicians and pharmacists of the impairing potential of therapeutic drugs likely will result in changed distribution policies. The aid of state and local health departments, state regulatory agencies such as boards of pharmacy, and professional societies should be enlisted in this effort.

Increasing attention has been paid to health-oriented countermeasures that treat substance abuse problems underlying such law violations as impaired driving. With respect to alcohol-impaired driving, the treatment functions of the health-care system have been coordinated with the sanctioning function of the legal system, and a **health/legal** approach has been adopted toward the drinking driver. The same approach can be directed at the driver who misuses other drugs.

Specific actions relating to **health and health/legal strategies** include:

- **Using law-enforcement agencies as "case finders" for persons who abuse or misuse drugs other than alcohol.** The police currently perform this function by "finding" persons who abuse alcohol in the course of their enforcement of drunk driving laws. The adjudication and sanctioning process is often used as a means of channeling alcohol offenders into appropriate treatment programs. Probation status or retention of driving privileges is often conditioned on seeking treatment for underlying alcohol problems.

Many drug-impaired drivers are not recreational drug users but rather users of impairing therapeutic drugs. Often these drivers are not aware of the degree to which they are impaired or of the traffic crash risk they present while driving. That these offenders are not drug abusers or recreational drug users is a fact that should be known by treatment personnel who handle referrals from the courts.

- **Supplementing legal sanctions with treatment programs rather than substituting treatment for sanctions.** Treating offenders with drug problems is sound policy from both a practical and a humane standpoint. However, prior study of health/legal approaches to drunk drivers indicates that merely treating an impaired-driving offender does not significantly improve that person's driving (e.g., Nichols et al. 1978). The only countermeasure that has been proven effective is license revocation or suspension. Drug abusers and recreational users who operate vehicles while impaired should receive driving sanctions whether or not they are referred to treatment.

On the other hand, the therapeutic user who is not aware of his

or her impairment, or of the hazard that impairment creates, has not engaged in the type of conduct that licensing action attempts to deter. Treatment and information about drug effects are more appropriate responses to impaired driving by this type of user.

All of the countermeasures we described can be implemented in the immediate future by units of state and local government. These countermeasures do not necessarily represent the most effective strategies possible. Research that will lead to more effective countermeasure approaches should continue; however, changes in the direction of that research are indicated.

Specific actions related to **research** include:

- **Conducting epidemiologic studies to determine the prevalence of drug impairment in the crashed and arrested driving populations.** Epidemiological research to date has consisted of a few studies of drug prevalence, chiefly among fatally injured drivers. Most of these studies have exhibited methodological flaws, and comparisons among studies and to noncrashed populations are not possible. Research is needed to determine more clearly how prevalent drugs are among the crashed and at-risk populations, and what drugs and classes of drivers are most frequently represented.

A word of caution must be added, however. To achieve usable epidemiological data, rigorously designed and controlled studies must be carried out. These are costly and time-consuming. While isolated or small-scale studies with few controls appear to save time and money in the short run, their contribution to the state of knowledge in drugs and driving will be minimal.

- **Allowing experimental research to proceed at the national rather than the state and local level.** Experimental research into driving behavior is even more complex and costly than epidemiological research. The time and expense associated with such studies is probably too great for state and local governments to conduct or finance. Nationwide studies with rigorous controls appear to be the only feasible approach for obtaining usable experimental data.

In some widely reported studies, crude closed-course driving tests have been conducted to determine drug effects on driving ability. Reliance on these studies is misplaced because these tests do not produce accurate measures of driving performance, in large part because the testing situation induces artificially enhanced performance.

In sum, not enough is known about the drug and driving problem to

justify an unequivocal conclusion that it should take priority in traffic-safety programs. However, enough is known about it to justify societal action. Near-term strategies involving legal, health, and public information countermeasures are available and should be implemented at the state and local level. Research to further define the drug and driving problem and support countermeasure development should continue, especially at the national level. While the problem is being more precisely defined, state and local jurisdictions should deal decisively with identified drug-impaired drivers.

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