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Drug Recognition Expert (DRE) Validation Study

Eugene V. Adler
Marcelline Burns

DRUG RECOGNITION EXPERT (DRE)

VALIDATION STUDY

Final Report to Governor's Office of Highway Safety

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Eugene V. Adler
Arizona Department of Public Safety

Marcelline Burns
Southern California Research Institute

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Authors: Eugene V. Adler and Marcelline Burns

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ABSTRACT

The method, procedures, and findings of a study of the scientific validity of an established Drug Recognition Expert (DRE) program in Arizona are reported. The DRE methodology for detecting and classifying suspected drug-impaired drivers was applied by trained officers of the Phoenix Police Department. The program was supported by comprehensive drug testing by the Arizona Department of Public Safety Crime Laboratory.

Study data were Drug Influence Evaluation records for 500 suspects who were evaluated over a 53 month period and the corresponding toxicological analyses of the suspects' specimens. The study used data base software developed for DRE data by the Southern California Research Institute.

The DREs' decisions about suspects' drug impairment status and their identifications of drug categories were highly accurate. Signs and symptoms, which were associated with specific drug categories, included dilated or constricted pupils, horizontal gaze nystagmus, and suspects' time estimates. Arrestees' characteristics and drug choices were examined. It is concluded that the DRE program, supported by the toxicology laboratory, is a valid method for detecting and classifying drug-impaired individuals.

Keywords:
Drugs and Driving
Toxicological Analysis
Drug Recognition Expert (DRE) Program
Drug Evaluation and Classification Program (DECP)

PROJECT STAFF

Arizona Department of Public Safety

Project Supervisor and Investigator . . . . . Eugene V. Adler

Southern California Research Institute

Contractor and Investigator . . . . . Marcelline Burns

Data Processor . . . . . Theresa Brown

Software Development/Consultant . . . . . Barbara Mauch

Arizona Governor's Office of Highway Safety

Program Manager . . . . . Tila Rendon

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ACKNOWLEDGEMENTS

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The DRE program requires the cooperative efforts of many individuals in law enforcement, the laboratory, and state and federal agencies. DRE-trained police officers are the foundation of the program, and we congratulate all of them for their achievements. In particular, we thank the Phoenix Police Department for agreeing to be the subject of study and for providing copies of Drug Influence Evaluations. Without the extensive contributions of Chief Dennis A. Garrett, Sergeant Dick Yost, Phoenix DRE Coordinator, Lt. Joe Klima, past Phoenix DRE Coordinator, and Officer Gary Huebner, the study could not have been accomplished.

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DRUG RECOGNITION EXPERT (DRE) VALIDATION STUDY

EXECUTIVE SUMMARY

In a research project sponsored by the Arizona Governor's Office of Highway Safety and supported by the Arizona Department of Public Safety (AZ-DPS) and the Phoenix Police Department (PPD), 500 records from an established Drug Recognition Expert (DRE) program were analyzed. Data base management and data analysis were conducted by the Southern California Research Institute (SCRI).

The study objectives were to evaluate the validity of the DRE methodology with records from an established program, to examine relationships between drug signs and symptoms and drug presence in specimens, and to study arrestee characteristics and drug choices.

Section One, the Problem Statement, describes the law enforcement problem which led to the development of a DRE program. An arrestee's low or negative breath alcohol test indicates that observed impairment is not due to alcohol. The officer must then make a decision whether to arrest or release, given that the impairment has some other cause. At issue is whether the decision will be made by an officer who has no specialized knowledge of drug effects or an officer who has been trained to recognize drug signs and symptoms.

Section Two briefly traces the development of the DRE program from its origin in Los Angeles to its application in Arizona and other states. The training program's initial development was within the Los Angeles Police Department (LAPD) with the assistance of scientists, physicians, and other experts. It evolved into a rigorous course of instruction in which officers are trained to recognize behaviors and physiological states associated with seven categories of psychoactive drugs. They perform a systematic, standardized 12-step evaluation to determine:

(1) whether a suspect is impaired;
(2) if impaired, whether the impairment is related to drugs; and
(3) if drugs, which drug category or combination of categories is present.

The program attracted widespread interest, and the National Highway Traffic Safety Administration (NHTSA) sponsored a laboratory study and a field study to examine the validity of the methods. NHTSA subsequently initiated DRE training for qualified agencies nationwide. Active units now exist in 24 states and the District of Columbia.

The DRE program was implemented in Arizona in 1987, and officers from 25 law enforcement agencies have been trained. There are 163 certified DREs statewide, with nearly 50 at both PPD and AZ-DPS.

Specimens obtained from arrestees were submitted to the AZ-DPS Central Regional Crime Laboratory for toxicological analysis. The laboratory provides scientific support for DRE units in all Arizona agencies (except the Mesa Police Department which has its own toxicology laboratory).

Section Three considers legal challenges to the DRE program. As expected, the validity and reliability of the methodology have been questioned. To date, the courts have supported the program.

Section Four discusses the specific purposes of this study. The findings provide information about:

Performance (accuracy, selectivity of DRE opinions)
A large portion of the data and analysis from this study focuses on the relationship between DRE opinions and laboratory results. Analysis of specimens provides objective corroboration of DRE opinions and the data which are necessary to assess the validity of the methodology.

Scientific validity of DRE methods
Study findings specifically address the question, "Do the DRE methods accomplish their stated purpose, i.e., the correct identification of drug impairment, as demonstrated by DRE opinions and specimen analyses?"

Types of drugs used by drug-impaired suspects
Information about drugs, drug combinations, and drug concentrations in specimens, which accumulate and change over the life of the DRE program, assists police agencies and laboratories to allocate resources effectively.

Signs and symptoms vs drug presence
A drug recognition methodology must be based on observable signs and symptoms which are demonstrably valid. A key focus of this study, therefore, has been the examination of evaluation data in relation to the specific drugs reported from specimen analysis. Note also that the DRE evaluations provide an otherwise unavailable means to study drug effects over a wide range of dose levels and drug combinations.

Socioeconomic factors
Drug availability and cost, weather, seasonal, entertainment, and athletic events, and the general economy are just some of the variables which may exert significant influence on drug use behaviors, which in turn affect DRE activities. A unit's activity also reflects agency policies and personnel, as well as the maturity of the program. Awareness of the influence of these variables is important for effective program management.

Program benefits vs costs

A DRE program's primary objective is to facilitate the enforcement of traffic safety laws, thereby reducing injuries, fatalities, and property damage. In the studied program, at least 378 drivers were removed from the roadway and prevented from driving in an impaired state. The safety benefit of DRE, however, is not without cost. The program makes significant demands on the police agency, and generates a requirement for specimen analysis which may tax laboratory resources. Costs may prove to be a formidable challenge to the DRE program.

Section Five describes the study method and procedures. A grant of funds was awarded in April 1993 by the Arizona Governor's Office of Highway Safety. The DRE records of PPD and the corresponding AZ-DPS toxicology reports were retrieved, copied and forwarded to SCRI. The 500 records represent the entire work product of the PPD DRE unit, and the sample contains no known bias. The cases meet the following criteria: 1) A driving-under-the-influence (DUI) suspect was evaluated; 2) the evaluation was performed by a certified DRE; and 3) the specimen obtained from the suspect was analyzed by the AZ-DPS Central Regional Crime Laboratory.

The DREs performed the 12-step evaluation in accordance with the program's national standards. The laboratory screened specimens by a comprehensive drug testing protocol and confirmed positives for forensically important substances by gas chromatography-mass spectrometry.

Data were entered into a computer data base, using software specifically developed for DRE records by SCRI under funding from the National Institute on Drug Abuse. Printed summaries of data for each arrestee were generated and checked for accuracy against source documents. Data summaries were obtained with the data base count capability, and analyses proceeded via logical interrogations of the data base and calculation of appropriate statistics. The data base resides in a computer dedicated to Arizona data.

Section Six reports study findings. On average, 9.4 evaluations were performed each month during the 53 month period of the records. There were more than three times as many male as female arrestees. In terms of 1990 census data for Phoenix, Hispanics are underrepresented and Caucasians are overrepresented. The distributions of licensed drivers or registered car owners would be more relevant comparison data but are not available.

Four drug categories appeared most often in specimens: depressants, narcotic analgesics, marijuana, and stimulants. Thirty DREs had examined suspects who had used drugs in one or more of these categories. Eighteen officers had encountered four categories, and seven officers had encountered five. DREs evaluate suspects who are under the influence of PCP, hallucinogens, or inhalants

NOT USEFUL WAY TO REPORT

less frequently, but because of the obvious and unique signs and symptoms of these drugs, loss of proficiency in identifying them is not expected to be a problem.

DREs recognize seven drug categories, but the specimen analysis identifies specific drugs and metabolites. This difference is a key to understanding study findings. The laboratory reported 813 drugs in the 500 cases. There was one drug in 163 specimens, two or more drugs in 253 specimens, and no drug in 68 specimens. Sixteen arrestees refused to provide a specimen.

NOT CLEAR

Of the 416 specimens for which the laboratory reported one or more drugs, the DREs correctly identified at least one drug in 378 specimens (91%). The laboratory identified at least one drug in support of the DRE opinion in 83.5% of cases for which the DREs identified one or more drug categories. Drugs were not found in specimens obtained from 26 individuals who were judged by the DREs not to be under the influence of drugs.

Preliminary investigation showed selected signs and symptoms to be uniquely related to the presence of specific drugs. The effects of narcotic analgesics and stimulants on pupil size were marked, confirming that pupil size is a reliable indicator for those categories. Horizontal gaze nystagmus was associated with benzodiazepines, barbiturates, and phencyclidine. Suspects' time estimates were related to type of drug, and drug effects on pulse and blood pressure were discernible as mild but real changes.

In order of decreasing frequency, marijuana, cocaine, benzodiazepines, morphine, methamphetamine, codeine, barbiturates, and phencyclidine were found in specimens. Illegal drugs predominated, but prescription drugs (benzodiazepines, butalbital, carisoprodol, and several narcotic analgesics) were also important. Cannabis emerged as the leading drug among men, benzodiazepines as the leading category among women. Impairment attributable solely to antihistamines or tricyclic antidepressants was infrequent.

Section Seven offers conclusions and interpretations of study findings. DRE opinions identified and classified drug-impaired drivers with a high level of accuracy. DRE positive opinions, which were entirely unsupported by analysis of a specimen, were few in number.

In terms of safety objectives, it should be noted that most of the 500 drivers could not have been arrested without the evidence of impairment obtained from the DRE evaluation, as corroborated by laboratory analysis of a specimen. Slightly less than one third of the arrestees had consumed alcohol, and only 5% had BrACs of 0.10% or higher.

IF BrAL > .10 WAS DRUG EVAL. ALSO DUI OR JUST ASSAULT DUI? IS PDT PART OF PROTOCOL?

The major conclusions of this study are:

- The DRE program is a valid method for identifying and classifying drug-impaired drivers.
- Certified DREs recognize drug-impairment and identify the category of drug(s).
- Observable signs and symptoms are associated with specific drugs.
- Monitoring DRE opinions and laboratory results will facilitate program management.
- The DRE program requires scientifically sound support by the laboratory.

I. PROBLEM STATEMENT

The ease of obtaining breath specimens together with the immediacy and low cost of breath alcohol concentration (BrAC) analysis have made it possible to estimate the prevalence of alcohol use among driver populations. As a consequence, the contribution of the single substance, alcohol, to traffic injuries and fatalities is reasonably well understood. Much less is known, or is likely to be known by the same methods, about other potentially impairing drugs.

The analysis of urine specimens can determine that a drug or metabolite is present, providing evidence that some unknown amount of drug was used at some unspecified time in the relatively recent past. This information alone, however, does not support estimates of drug prevalence in driver populations; i.e., it does not demonstrate conclusively that potentially impairing drugs were active in the driver at the time of driving. Such estimates require blood specimens, which are difficult to obtain and costly to analyze. Thus, data concerning the number of drivers who have an active drug, other than alcohol, in their bodies at the time of driving is sparse. Furthermore, the relationship of blood drug concentrations and impaired driving skills has not been established for many potentially impairing substances. Efforts to determine the role of drugs in traffic crashes continue, using a number of different methods (1, 2).

With or without information about the number of offenders or the causes of impairment, traffic officers are required as a routine duty to detect, test, and arrest impaired drivers. Notwithstanding the lack of scientific data, validated procedures, or department policy, officers are obliged to make timely decisions on a daily basis. In the case of alcohol, the suspect may or may not display gross signs of impairment, but breath test results provide immediate support for the decision to arrest or release. In contrast, if a zero or low BrAC suggests that other drugs may be impairing the driver, there are no immediate chemical test results to support a decision. An arrest/release decision must and will be made; the only question is whether it will be made by a traffic officer who has no specialized knowledge of drug effects or whether it will be made by an officer who has been trained to recognize the signs and symptoms of drug impairment.

II. HISTORY OF THE DRUG RECOGNITION EXPERT PROGRAM

A. The Los Angeles Problem

During the 1970's, Los Angeles Police Department (LAPD) traffic officers encountered an increasing number of obviously-impaired drivers whose BrACs were zero or low. The problems in evaluating, arresting, and prosecuting such drivers were the impetus for the development of a Drug Recognition Expert (DRE) methodology. A training program originated within the department, and with the assis-

tance of scientists, physicians, and other experts, it evolved over a period of several years into a rigorous course of instruction. It is designed to train officers to recognize behaviors and physiological states associated with seven categories of psychoactive drugs.

DRE-trained officers developed the knowledge and skill which enabled them to accurately identify drug-impaired drivers, as corroborated by laboratory analysis of urine or blood specimens. Los Angeles courts began to accept their expert testimony, the number of filings of drug cases increased, the number of guilty pleas increased, and the amount of time officers were required to be present in court decreased.

B. The National Problem

Drug use was not a problem which existed only in Los Angeles, nor was the need to properly identify, arrest, and charge drug-impaired arrestees unique to LAPD. Not surprisingly, the apparent success of the DRE program attracted widespread interest. In response to that interest, the National Highway Traffic Safety Administration (NHTSA) and the National Institute on Drug Abuse sponsored a study at Johns Hopkins University (3) to examine the validity of the methods. In a laboratory experiment, 80 subjects who had been administered a drug (amphetamine, marijuana, diazepam, or secobarbital) were examined by four LAPD DREs, using a standardized, abbreviated examination. The DRE identifications of drugs were correct for 80%, 97.5%, and 92.7% of subjects dosed with stimulants, marijuana, and depressants, respectively.

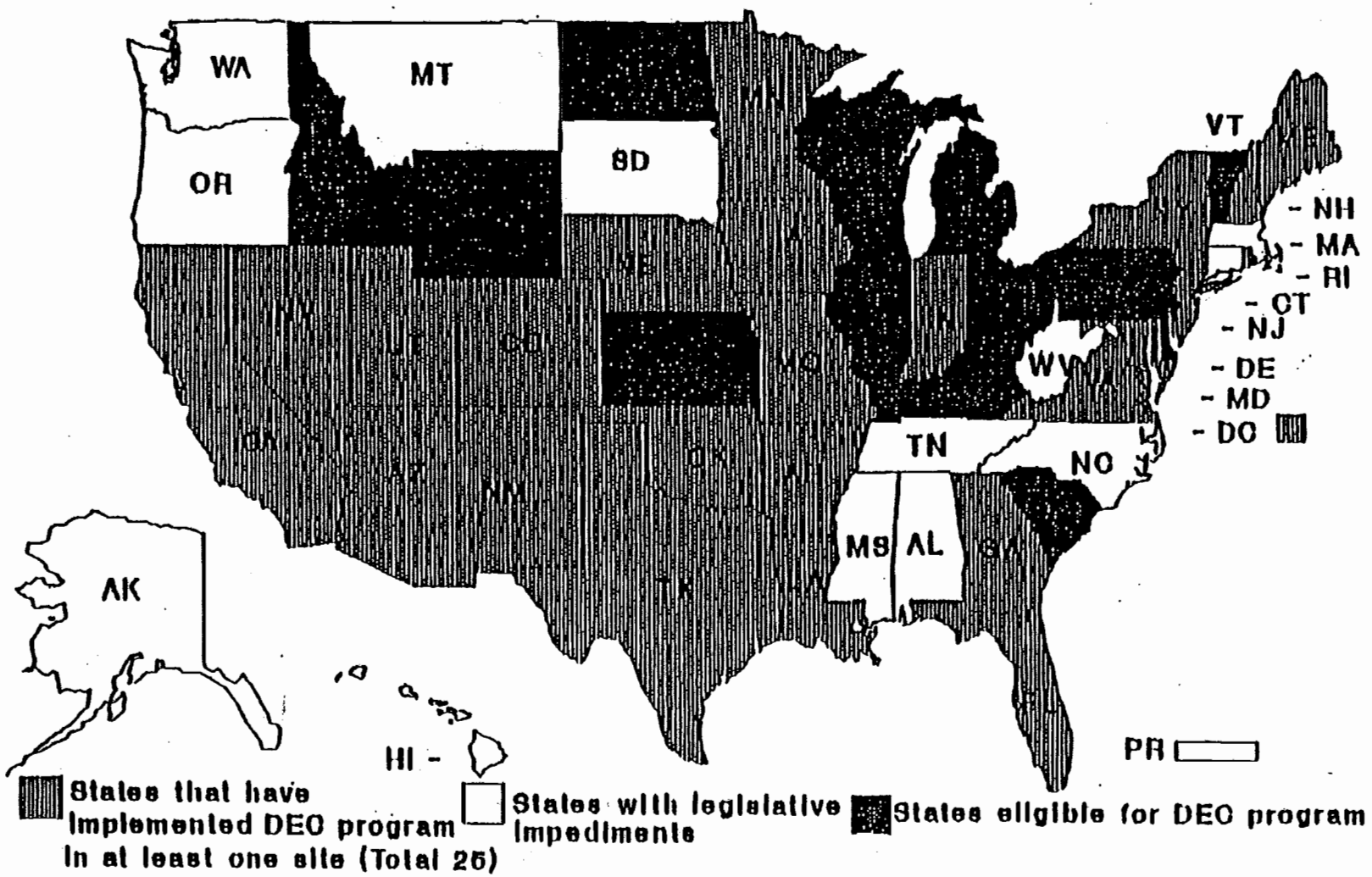
Similarly, in a 1985 field study, 25 LAPD DREs were highly accurate with regard to suspected drug-impaired drivers in the City of Los Angeles (4, 5). DREs correctly identified at least one drug in 87% of their evaluations and were correct in 94% of the cases where they judged a driver to be impaired by a drug other than alcohol.

NHTSA subsequently undertook a program to make DRE training available for qualified agencies throughout the United States. In cooperation with LAPD, they further developed the training curriculum, including instructor and student manuals, and other teaching materials. Initial DRE units were established in Arizona, Colorado, New York, and Virginia.

With overview by a Technical Advisory Panel and administration through the International Association of Chiefs of Police, the program continues to evolve. As can be seen in the figure which follows this page, active units of what is now called the Drug Evaluation and Classification Program (DECP) have been established in 24 states, the District of Columbia, Australia, Norway, and Canada. Approximately 3000 DREs and 800 instructors have been certified (6).

DRUG EVALUATION AND CLASSIFICATION PROGRAM (DECP)

FEBRUARY 1993



C. The DRE Program in Arizona

The training of Arizona DREs began in Los Angeles in 1987. Fourteen officers were trained during that year, as were two prosecutors and two scientists from the Arizona Department of Public Safety (AZ-DPS) Crime Laboratory. The training of officers, prosecutors, and crime lab personnel continued in Los Angeles into 1988. Beginning in 1989 and continuing in 1994, one (sometimes two) DRE schools have been conducted each year in Arizona.

A few Arizona candidates who attended a DRE school did not achieve certification, and a few DREs have lost their certification status. De-certification typically has occurred because an officer became inactive as a DRE as a result of transfer or promotion. At the present time, 163 law enforcement officers statewide are certified DREs. The Phoenix Police Department (PPD) currently has 47 DREs, including four supervisors.

The AZ-DPS Crime Laboratory provides toxicology support to all DRE agencies except Mesa Police Department, which has its own crime laboratory. The AZ-DPS Laboratory was established in 1969 and became a full service laboratory system with regional laboratories in Phoenix, Tucson, Flagstaff, and Mesa. Toxicological analysis of drugs is performed at the Central Regional Laboratory in Phoenix which serves over 250 city, county, state, federal, and tribal agencies in the state.

III. LEGAL CHALLENGES

As expected, defense attorneys in a number of jurisdictions have challenged the validity and reliability of the DRE methodology. Typically, they have moved to suppress evidence from DRE evaluations under the Frye standard. A list of DRE hearings and cases appears in Appendix II. To date, the courts have supported the program, but additional legal challenges are expected.

IV. SCIENTIFIC STUDY OF THE DRE PROGRAM

Socioeconomic variables exert significant but often unrecognized and unmeasured influence on drug use behaviors, which then affect the activities of a DRE unit. The drug evaluations conducted by DREs reflect the number of officers assigned to traffic duty and the number of drug-impaired drivers on the roadway. The latter is related to many variables, including drug availability and cost, season and weather, entertainment and athletic events, and the general economy. Also, a DRE unit's activity inevitably is a function of agency and laboratory policies, as well as the unit's personnel at a specific time.

A new program has different performance characteristics than a mature program, but whether the changes which occur over time will be a net gain or loss is not always predictable. To some extent, conditions will be unique to the site. For example, a diminution (if any) of the enthusiasm which characterizes new programs can reasonably be expected to be offset by gains in skill and experience. Whether benefits actually do accrue, however, depends on a number of local variables, including whether the program continues to be supported within the agency, by the laboratory, by prosecutors, and by the courts.

A retrospective study examined the performance of Arizona DREs, initially with 185 cases with subsequent expansion to 341 cases (7, 8). An 86% rate of correct identifications (drug subsequently found in a sample of the suspect's urine) is remarkably close to the overall correct detections in the Los Angeles field study (4, 5). A study of 526 Arizona cases also has been reported (9). Data from DRE programs in California, Texas, and Minnesota demonstrate similar rates at 88.2%, 81.3%, and 84.5%, respectively (10, 11, 12).

The DRE program is designed to identify suspected drug-impaired drivers, thereby making it possible to remove them from the roadway. A program benefits the agency and the community, not only in traffic safety but in drug traffic and crime suppression as well. These are worthy objectives, but they are not without cost. A DRE unit places high demands on a department initially for officer training time and subsequently for duty time. Frequently, laboratories are taxed as they stretch resources to handle the additional urine and blood specimens that the program generates. Within a difficult economy and a climate of accountability, nonproductive DRE units and inefficient laboratories likely will come under close scrutiny. Cost may prove to be the most formidable challenge to the DRE program.

In addition to providing data to answer questions about costs vs benefits, evaluation of DRE units will facilitate effective program management. The data will enable program coordinators to examine differences in units' activities as a function of time, location, staffing, and other variables. It will provide useful feedback on performance to the DREs themselves, and will serve as a source of scientifically sound data for the purpose of responding to legal challenges.

There is yet another reason why the records merit study. The body of drug information, which law enforcement needs, is woefully incomplete. The scientific literature about drug effects on performance and drug signs and symptoms is and likely will continue to be limited. Unlike the single substance, alcohol, there are many drugs, and the research community is unable to examine all potentially impairing substances, all dose levels, and all drug-drug, drug-alcohol combinations. Furthermore, scientific study frequently is not designed to obtain and/or report the specific data needed by law enforcement.

Research which requires the administration of dangerous substances to human subjects is restricted by ethical, safety, and legal constraints. Arrestees, in contrast, are not constrained by anything other than drug availability and their own choices. They sometimes are found to have ingested illicit and/or therapeutic drugs in dangerously high amounts and in unusual combinations. In such cases, the DRE gathers data which are not available elsewhere. The records, presently residing in the files of DRE units nationwide, are an underutilized resource.

To facilitate access to the information contained in Drug Influence Evaluation (DIE) records, data base software (NIDABASE) was developed by the Southern California Research Institute (SCRI) under funding from the National Institute on Drug Abuse (13). The study described in this report used that software to examine Arizona DIE records:

1) for scientific purposes;
2) to provide data relevant to legal issues;
3) to provide information about DRE performance to state and local coordinators and to the DREs;
4) to examine the relationship of signs and symptoms and the presence of a drug or drugs in urine; and
5) to establish an evaluation mechanism in the interest of program accountability.

V. METHOD AND PROCEDURES

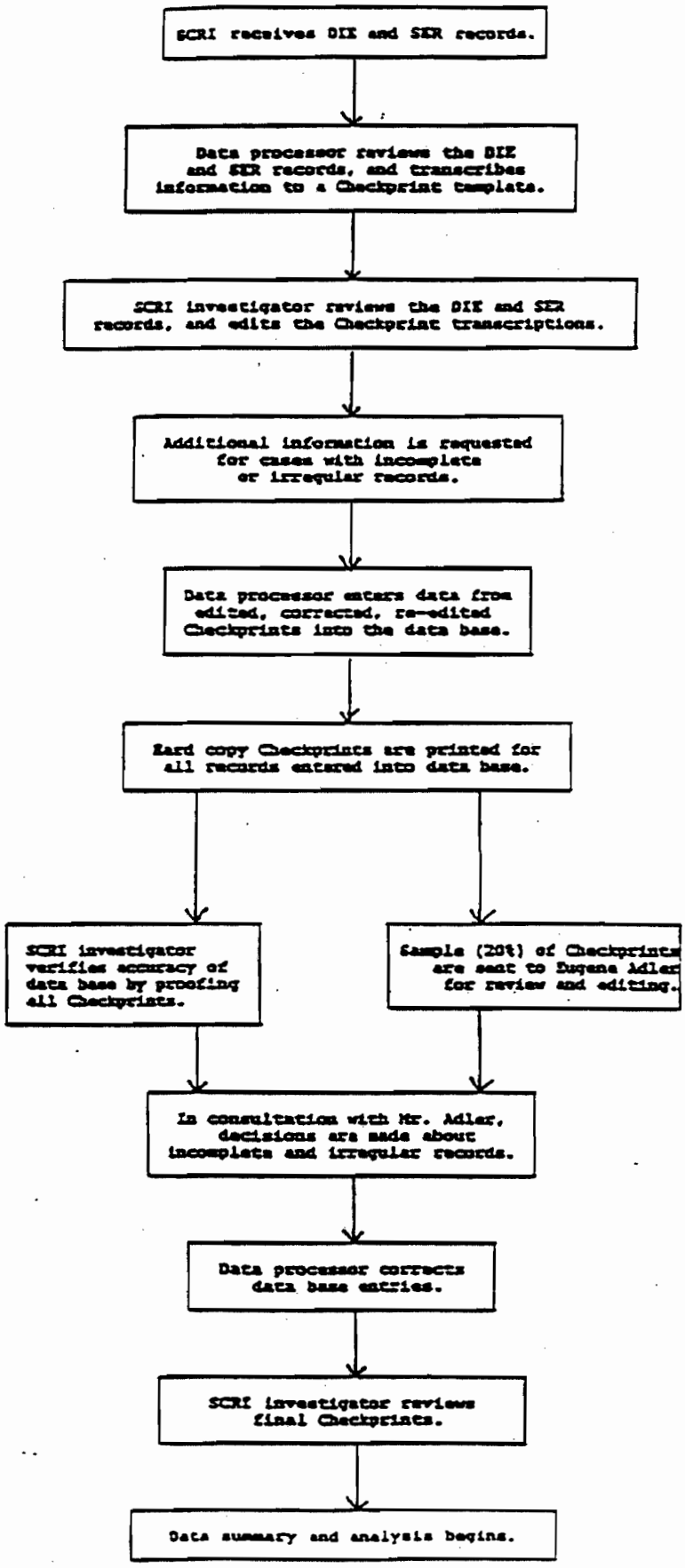
Study activities are graphed in Figure 1. A grant of funds from the Arizona Governor's Office of Highway Safety was awarded in April 1993. Records were received by SCRI in August 1993 at which time study activities were initiated at that site. Data analysis was completed in March 1994. This document reports study findings and completes the activities of this phase of study.

A. Study Records

Study data were obtained from Drug Influence Evaluation (DIE) records and the associated DPS Scientific Examination Reports (SERs) for suspects examined during the period January 1989 through May 1993. The total work product of the Phoenix Police Department DRE program over a 53 month period was retrieved, and the sample contains no known bias. The cases meet the following criteria:

- A DRE evaluated a driving-under-the-influence (DUI) suspect;
- The evaluation was performed by a certified DRE. (Evaluations performed by certification candidates during training were excluded.); and
- A specimen obtained from the suspect was analyzed by the AZ-DPS Central Regional Laboratory.

FIGURE 1
SCRI STUDY ACTIVITIES



B. Drug Recognition Experts

The evaluation forms, which can be seen in Appendix III, are the records of examinations of suspected drug-impaired drivers by certified DREs. Taking the latter part of the study (1992-93) as the point of reference, the officers who conducted the evaluations had served with the department ten years and had three years' DRE experience, on average.

C. Drug Evaluation Procedures

DRE examinations typically are requested by an arresting officer after he/she has obtained a breath test result which proves to be inconsistent with the observed driving and behavioral impairment. The examinations require as much as one hour's time, and are conducted most frequently in station houses where suspects are transported by the arresting officer. If the DRE is also the arresting officer, some preliminary information is obtained at roadside. When accident-involved suspects are transported to a hospital, a partial evaluation is conducted at that location.

The drug evaluation is a systematic and standardized procedure, which includes the following twelve steps (14):

1. Breath alcohol test *
2. Interview of arresting officer
3. Preliminary examination and first pulse
4. Eye examinations
5. Divided attention tests
6. Blood pressure, temperature, and second pulse
7. Dark room examinations and ingestion examination
8. Examination for muscle rigidity
9. Inspection for injection sites and third pulse
10. Interrogation, suspect statements, and other observations
11. Integration of all information as basis for evaluator's opinion
12. Toxicological examination

In all circumstances, the objectives of the evaluation are to enable the DRE to determine:

- whether the suspect is impaired;
- if impaired, whether the impairment is related to drugs; and
- if drugs, which drug category or combination of categories is present.

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* PPD obtains breath specimens for BrAC measurement with a gas chromatograph (Intoximeter, GCI Mark IV). The instruments were maintained by the City of Phoenix Police Crime Laboratory. They were operated in accordance with AZ-DHS regulations by officers who are DHS licensed GCI operators.

D. Toxicological Analysis of DRE Cases

1. Introduction

Study of the DRE program requires definition of the data to be examined, i.e., the Drug Influence Evaluations and the toxicology reports. A very large data set from a number of DRE sites and laboratories would provide the statistical power to examine numerous potentially important variables. It might also introduce error from significant but unrecognized differences between protocols and procedures. Mean values calculated from such heterogeneous data are potentially useful for monitoring driving-under-the-influence of drug (DUID) trends, but they do not serve an evaluation of DRE performance or the examination of the relationship of signs and symptoms with drug concentration in a specimen. To facilitate the objectives of this study, homogeneous data from a single program served by a single laboratory during a defined time period have been examined.

Numerous substances qualify as drugs of abuse, but few are actually common in DUID cases. Three illegal drugs predominated in this study: marijuana, cocaine, and methamphetamine. Knowledge has accumulated over the life of the DRE program about the specific drugs which are likely to be found most frequently in specimens obtained from DUID suspects. That knowledge aids in the appropriate utilization of laboratory resources.

Still, toxicologists confront numerous difficult decisions about specimen choices and analytical methods and schemes, as well as their ultimate philosophy of DUID case investigation. Which drugs should be tested for? Which cutoffs are appropriate? Should the screening panel be the same for all cases? Which screening positives should be confirmed, given a particular DRE opinion? When should quantitative analysis be performed?

It is imperative to find reasonable and effective answers to these questions in order to integrate toxicological support with the DRE program in a manner which significantly advances the overall goal of detecting drug-impaired drivers. The program, although systematic and standardized for the law enforcement officer, came to the toxicology laboratory somewhat like a kit requiring assembly. Both the program and scientific support continue to evolve.

Specimen choice is the subject of regular, sometimes acrimonious discussion among toxicologists. In DUID cases, the choice is constrained by legal, logistical, and budgetary issues, as well as by toxicological considerations. The quicksand of the subject matter is not germane to this report except for a brief comment on specimen choice as it applies to the study data.

Neither blood nor urine is perfect for analysis. Each has advantages and disadvantages, but the AZ-DPS Laboratory's recommendation to all its user agencies is that urine is the preferred sample to be routinely obtained. Urine can be com-

prehensively analyzed at reasonable cost for most substances involved in DUID cases. Toluene is an exception, and blood specimens are recommended when inhalants are suspected.

The AZ-DPS Laboratory acknowledges the occasional need for quantified drug and metabolite concentrations in blood. In serious accidents with injuries and fatalities, particularly if a driver's injuries limit the opportunity to directly observe drug signs and symptoms, the collection and analysis of both blood and urine may be recommended. Routine analysis of both, however, is typically not an option, and a choice must be made between the two fluids.

The forensic analysis of drugs in urine or blood must be as comprehensive, accurate, and systematic as possible. The design of the DPS Laboratory's toxicological protocol meets these criteria and permits scientifically valid evaluation of the DRE program. During the 53 month period from which the study data came, no significant changes were made in DRE evaluations, and only minor changes and improvements (as noted) were made in the toxicology protocol.

Strong quality assurance and reliable performance are prerequisites for providing accurate, qualitative toxicological data for both the support and the evaluation of a DRE program. The AZ-DPS Laboratory's quality assurance program, which predates DRE, incorporates quality control into all analyses. The lab also maintains a proficiency testing program (external and in-house), and it performs continual casework review to assure quality. External evaluation of lab performance is necessary. Note that the Arizona DPS Laboratory was accredited by the American Society of Crime Laboratory Directors (ASCLD) in 1982 and has maintained its accreditation status since that date.

From a broader view of laboratory assessment, the following professional organizations and agencies serve as references and standard bearers for laboratories involved in the DRE program nationwide: ASCLD, American Academy of Forensic Sciences, Society of Forensic Toxicologists, National Institute on Drug Abuse, and the College of American Pathologists. Also, the Toxicologists Advisory Group of the Drug Evaluation and Classification Program, which meets periodically with NHTSA, has produced a site assessment protocol for the evaluation of laboratories seeking entrance into the DRE program.

2. Screening

The increased volume of DUID cases generated by trained officers is compatible with the trend toward automation in the laboratory. DRE cases are particularly amenable to systematic, automated screening. The screening analysis must be as comprehensive as possible with few significant analytical blind spots. The objective is to achieve a high detection rate without allocation of laboratory resources to rare or forensically unimportant substances.

The primary screening process was a battery of seven radioimmunoassays (RIA), DPC Corporation, routinely applied to all incoming urine specimens (Table 1A). The battery was applied regardless of requests for less extensive, specific analysis, which may have accompanied the submission of the sample. For blood, a similar routinely-applied RIA battery (excluding cannabinoids) was implemented during the study period (January 1990).

TABLE 1A

Radioimmunoassays

RIA	Cutoff, Urine (ng/mL)	Cutoff, Blood (ng/mL)
Cannabinoids	50 (a)	- -
Cocaine/metabolite	300	50
Methamphetamine	500 (b)	25
Opiates	150	10
Barbiturates	100	100
Benzodiazepines	100	50
Phencyclidine	25 (c)	10

(a) This cutoff was reduced from 100 to 50 in 1990.

(b) This assay is less than 5% cross reactive to the l-isomer of methamphetamine.

(c) A sudden, unexplained decrease in phencyclidine cases occurred in 1990. Phencyclidine was eliminated from the RIA battery in January 1993, and since that time has been tested only by request.

The RIA battery does not detect all depressant and narcotic drugs, and secondary screening is sometimes required. In Arizona DUID cases, the most significant other drugs requiring secondary screening have been:

- carisoprodol and its metabolite, meprobamate
- methadone and its metabolites
- propoxyphene and its metabolites
- meperidine
- tricyclic antidepressants (especially amitriptyline)
- antihistamines

2 URINS OF SCREENING

Secondary screening by gas chromatography with flame ionization detectors (GC-FID) was performed throughout the entire study period (15). The rules governing secondary screening were as follows:

a. IF a DRE opinion includes depressants (other than alcohol) AND the RIA screening for barbiturates and benzodiazepines is negative (or does not lead to a confirmed depressant), THEN secondary screening for other depressants shall be performed.

b. IF a DRE opinion includes narcotic analgesics AND the RIA screening for opiates is negative (or does not lead to a confirmed opiate), THEN secondary screening for other narcotic analgesics shall be performed.

c. IF analysis of a miscellaneous drug (such as carisoprodol, ethchlorvynol, or meperidine) is specifically requested or indicated by the case history, appropriate screening for that substance shall be included in the case analysis.

3. Confirmation

The detection by screening of significant or potentially significant drugs was followed with confirmation by appropriate gas chromatography-mass spectrometry (GC-MS) procedures. The confirmation of so many substances in the numerous specimens generated by a mature DRE program is a formidable task, and it requires a set of confirmatory procedures designed to achieve the best compromise between sensitivity, simplicity, and efficiency.

Sensitivity entails sophisticated techniques, as does automation, but the application of a limited set of routine procedures can facilitate efficiency. Toward that objective, the number and complexity of confirmatory GC-MS procedures were minimized, and the analytical scheme was made as simple as possible. The GC-MS procedures for urine, which had been established prior to the period of this study, were not altered except for improvements in the sensitivity of the opiate and benzodiazepines procedures.

The simplest procedure was a rapid liquid-liquid basic extraction followed by full scan GC-MS in the electron ionization (EI) mode. Although almost any conventional basic extraction can work, convenient "TOXI-A" extraction tubes and "TOXI-A" discs (ANSYS Inc, formerly Toxilab Inc) were employed. Some case specimens required no further confirmatory analysis. This "TOXI-A" procedure sufficed for routine confirmation of phencyclidine, carisoprodol, meprobamate, and miscellaneous bases such as tricyclic antidepressants.

The "TOXI-A" procedure was generally inadequate for the routine analysis of methamphetamine, benzoylecgonine, opiates, and benzodiazepines. In some

cases, however, it did provide confirmation of methamphetamine, or free cocaine and/or methylecgonine. Overall, this is an extremely rapid, simple procedure which extracts many drugs and metabolites.

The confirmations of methamphetamine, cocaine/metabolites, opiates, and benzodiazepines were considered negative only after analysis by one of the specialized procedures discussed below with negative results. The TOXI-A procedure usually confirmed barbiturates, but attempts to confirm barbiturate positives were not considered exhausted until a special acidic extraction (employing "TOXI-B" tubes) was performed.

Analysis of benzodiazepines and opiates required hydrolysis, derivatization, and the selected ion monitoring (SIM) mode. If desired, the analysis of both opiates and benzodiazepines could be batched, sharing the same extraction and derivatization after providing each analysis with the appropriate internal standards, blanks and controls. The GC-MS Data System was programmed to monitor various combinations of selected ions during designated time windows throughout the run. In this way, eight benzodiazepines and/or metabolites, and six opiates, were readily confirmable.

There was no difficulty in analyzing the trimethylsilyl (TMS) derivatives of lorazepam, oxazepam, temazepam, desmethyldiazepam, desalkylflurazepam, hydroxyethylflurazepam, alpha-hydroxyalprazolam, and alpha-hydroxytriazolam.

The opiates routinely analyzed as TMS derivatives were morphine, codeine, hydrocodone, dihydrocodone, oxycodone, and O-6-monoacetylmorphine (found in approximately half the cases in which morphine was confirmed).

A special extraction was necessary for THC-COOH (9-carboxy-11-nor-delta-9-tetrahydrocannabinol), followed by derivatization and a reduced EI scan, M/Z 200-500. Table 1B is an index of the confirmatory procedures.

TABLE 1B

Index of Routine GC-MS Confirmatory Procedures (a)

	Procedure	Int. Std.	Hydrol?	Deriv?	MS Range
A.	TOXI-A (Basics)	Iprindole (b)	No	No	40-360
B.	Barbiturates	various	No	No	40-360
C.	Methamphet. (c)	N-Prop. amph.	No	TFA	50-200
D.	Benzoylecg. (d)	Scopolamine	No	TMS	75-375
E.	THC-COOH	delta-8 THC-COOH	Yes	TMS	200-500
F1.	Opiates	Nalorphine	Yes	TMS	SIM
F2.	Benzodiaz.	Bromazepam	Yes	TMS	SIM

(a) All the above procedures have in common these elements: liquid-liquid extractions; the GC column is crosslinked Phenyl Methyl Silicone 9.1 m x 0.2 mm x 0.33 mm film thickness; electron ionization mode; automated runs (autosampler), qualitative analysis; appropriate internal standards, blanks and controls.
(b) Other internal standards, such as SKF-525, may be used.
(c) This analysis includes ephedrine, pseudoephedrine, and amphetamine.
(d) An alternate procedure was also used for simultaneous analysis of cocaine, benzoylecgonine, and methylecgonine.

Regarding the analysis of blood specimens submitted by DREs, radioimmunoassay, supplemented by GC-NP screening, has been effective. Blind spots for some drugs in the analytical scheme remain a concern. Solid phase or liquid-liquid extraction followed by SIM-GC-MS appears to be effective in confirming drugs of interest (Table 1C). Continuing refinement of the laboratory's procedures for blood has established effective quantitative assays, which at this time have been applied to a limited number of DRE cases.

TABLE 1C

Current Blood GC-MS Confirmatory Procedures

Procedure	Extraction	Derivative	MS Range
Cocaine/BE	Liq/Liq	TMS	SIM
Methamp/Amp	Liq/Liq	TFA	SIM
Phencyclidine	SPE (a)	---	SIM
Opiates	SPE	TFA	SIM
Barbs	Liq/Liq	---	Reduced scan
Benzodiaz.	SPE	TMS	SIM
Basics, Misc.	Liq/Liq	---	Reduced scan

(a) SPE (solid phase extraction) procedures were derived from Varian Corporation procedures.

E. Data Base Entry

The data base software stores pertinent DIE and SER information on a computer hard disk and prints each record as a two page summary. This study's data resides in a computer dedicated to the Arizona project. The printed summary of information for each arrestee is referred to as a checkprint (Appendix III). As can be noted by inspection of the checkprint template, arrestees' names and other uniquely identifying facts are not recorded.

The procedures for data entry and verification are graphed in Figure 1. Initially, the project data processor transcribed information contained in the DIE forms and SERs to a paper template of the checkprint. The SCRI investigator reviewed the DIE forms and SERs together with the checkprint transcription. The corrected information was entered into the data base, which assigns sequential numbers to the records.

Printouts of the checkprints were proofed by the investigator, and the data processor made needed corrections. A twenty percent sample of checkprints was

drawn by taking every fifth sequential record, and copies were forwarded to Eugene Adler, DPS Laboratory, for review. Based on his review, the data processor made additional corrections to data base entries. The iterative process of proofing and correcting has produced a data base of highly accurate information.

F. Data Summary and Analysis

The Directory of Records contained in the data base appears in Appendix IV. Many of the data base entries are non-numeric (checkboxes, Yes/No, present-/absent). The data which are classificatory and nominal in character support descriptive statistics. For statistical analyses by computer, numerical data are exported from the data base to statistics programs. In addition, the program's Summary Count function is a convenient method for reporting a two-level structure of specified groups for which selected data are counted. Specified counts can be executed for all records or for a defined subset.

The Foxplus software permits direct interrogation of the data base to determine the relationships of any set of variables using commands written as logical expressions. Exhaustive exploratory analyses, which were performed using this very powerful capability, produced most of the findings reported in this document. Rank correlations and the t statistic have been calculated where appropriate.

VI. FINDINGS

A. Time Period and Number of Records

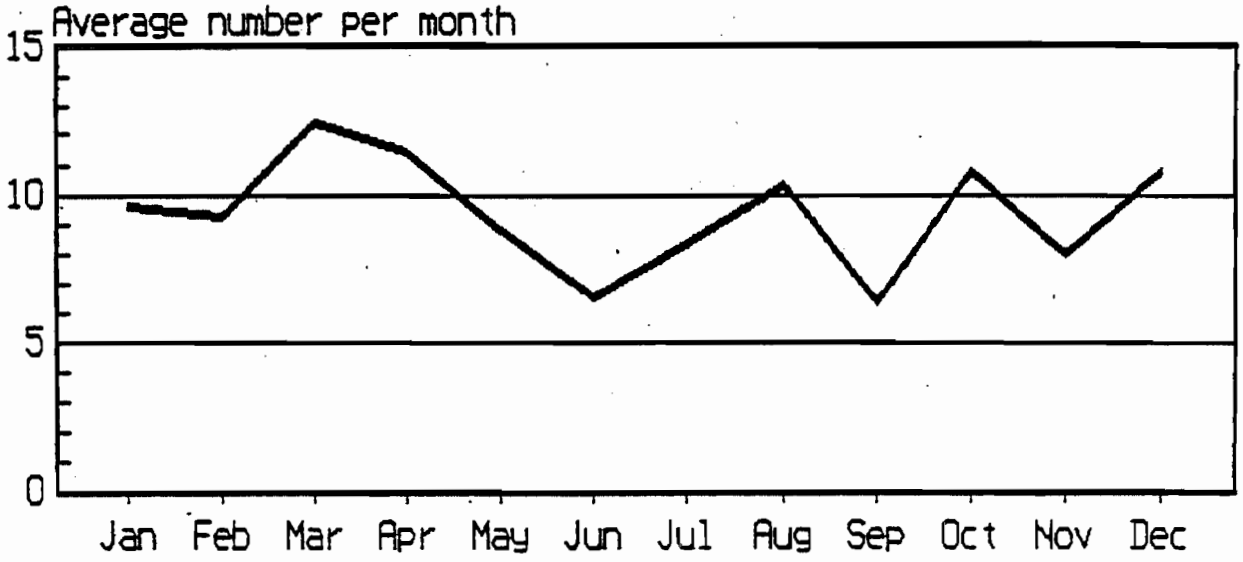
The data base covers the 53 month period, January 1989 through May 1993. It contains information obtained from the Phoenix Police Department and the Arizona DPS Laboratory with 500 DIE and SER records for 392 men and 108 women. An additional 27 records were examined but the data were not entered because the documents were incomplete.

The total numbers of records for each study year are:

1989	103
1990	136
1991	129
1992	77
1993	55

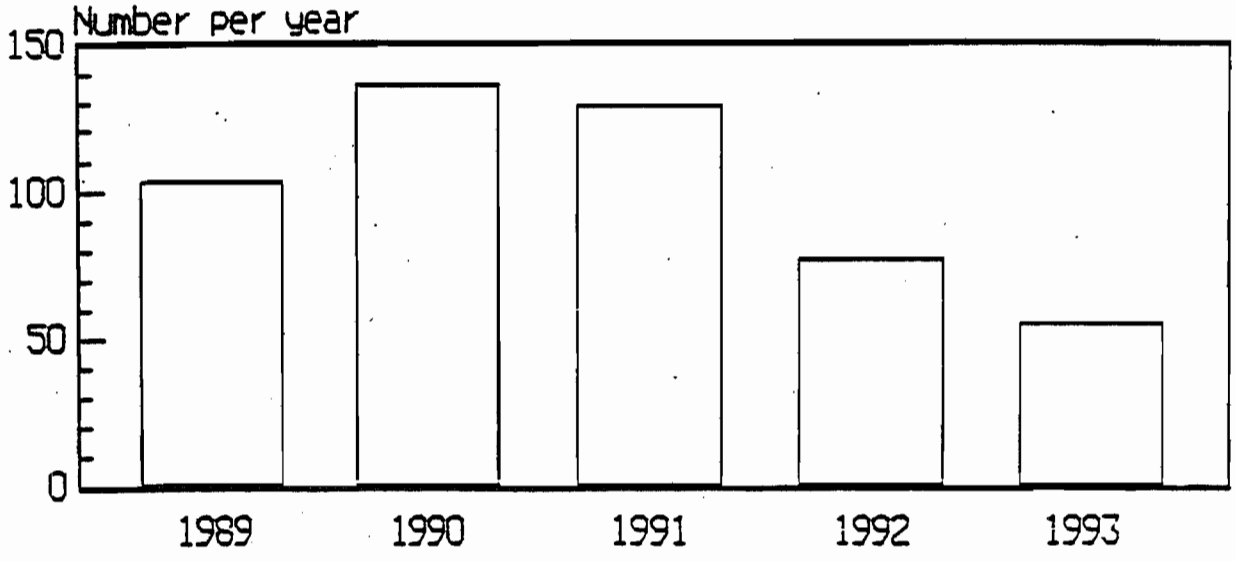
The mean number of drug evaluations performed per month across multiple years was 9.4 with a range of 6+ to 12 per month (Figure 2). In reviewing Figure 3, which graphs the number of evaluations by year, note that only 1990 and 1991 are comparable. New programs require some time period to become fully operational and 1989, the first year of full operations, may have differed from sub-

FIGURE 2
ARIZONA DRE VALIDATION STUDY
DRE Evaluations by Month
January 1989 - May 1993



53 months: 1989 - 1992 12 months
1993 5 months

FIGURE 3
ARIZONA DRE VALIDATION STUDY
DRE Evaluations by Year
January 1989 - May 1993



53 months: 1989 - 1992 12 months
1993 5 months

sequent years. The data base includes records for only five months of 1993, whereas records were obtained for twelve months of each of the other four years. Also, significantly fewer evaluations were performed in 1992 (1992 vs 1990 t -3.321, $p<.001$; 1992 vs 1991 t -2.575, $p<.05$).

During the study period, some officers were responsible for only a few evaluations whereas numerous evaluations can be credited to others. The numbers ranged from 1 to 33, with 23 DREs conducting ten or more evaluations and 14 DREs conducting fewer than ten. Among the latter were three officers who conducted one evaluation each (Figure 4).

B. Arrestee Characteristics

The age, gender, and ethnic characteristics of the 500 arrestees are summarized in Table 2. The arrestees were predominantly young adult males. There were more than three times as many men as women.

A wider age distribution for men than for women can be seen in Figure 5. Male arrestees were most frequently in the age group 20 - 29 years. The largest number of women were 21 - 40 years of age. Few female arrestees were under age 21, but almost 12% of the men fell in that age range. More than 5% of the men were older than age 50, and one woman was over age 60.

Almost 85% of the arrested drivers were Caucasian, 10% were Hispanic, and 6% were Black (Figure 6). No Asians were evaluated by DREs during the entire study period, nor were there any Hispanic females among the suspects. With the exception of five Black women, the female arrestees were Caucasian.

With the data at hand, it is not possible to conclude with certainty that members of one ethnic group are more or less likely than another to drive in a drug-impaired condition. If viewed in terms of the 1990 census data for the general population of Phoenix (5% Black, 20% Hispanic, 72% Caucasian), it appears that Hispanics are underrepresented and Caucasians are overrepresented in the sample of arrestees. However, the distributions of licensed drivers and/or registered car owners, data which are not available, would be more directly relevant and might or might not parallel the census data.

FIGURE 4
ARIZONA DRE VALIDATION STUDY
Evaluations Conducted by 37 DREs

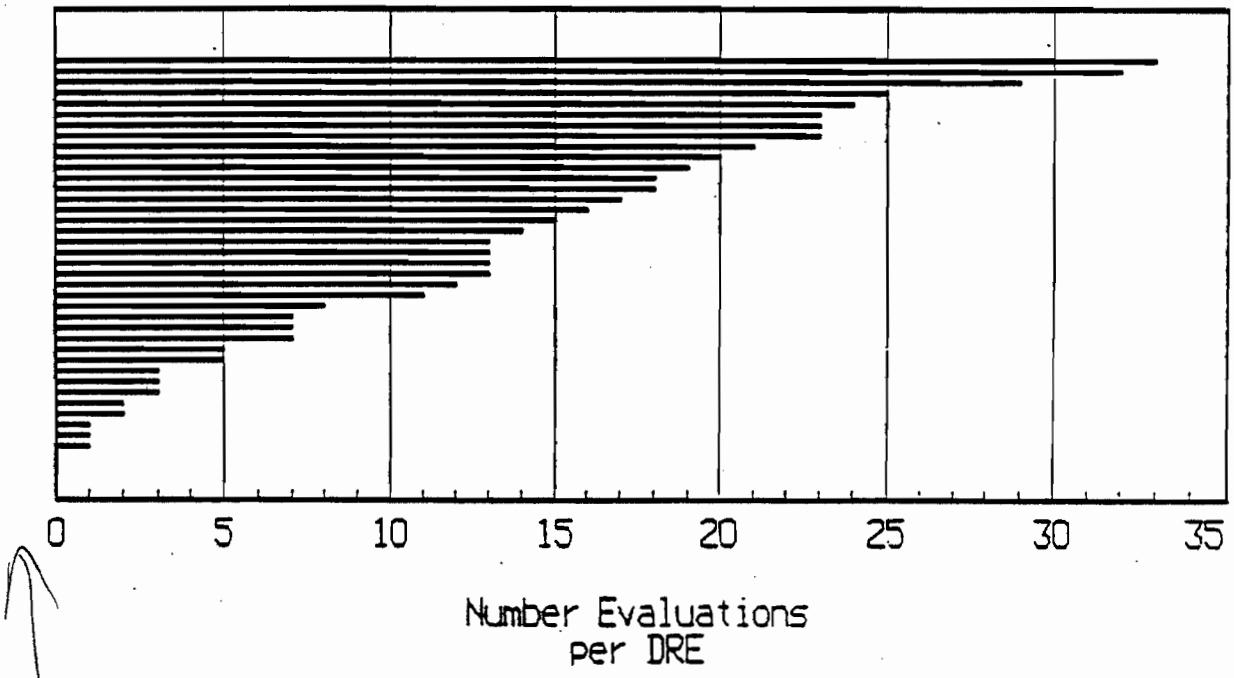
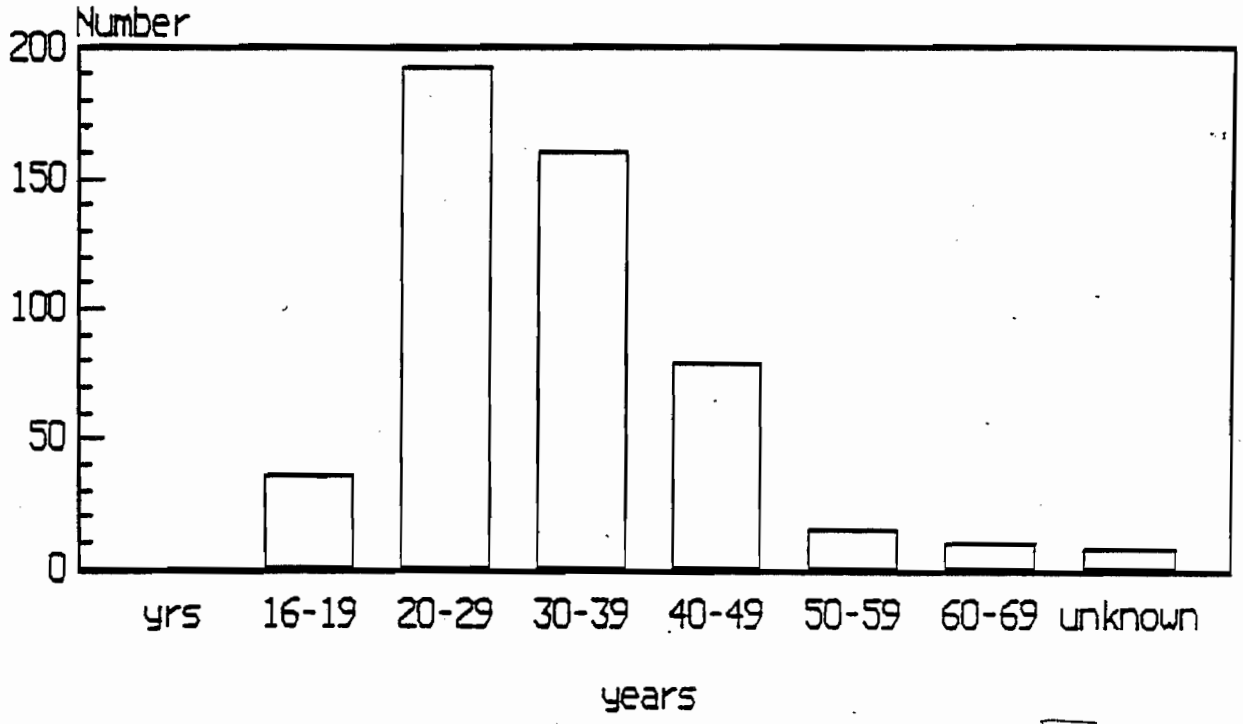


TABLE 2
ARIZONA DRE VALIDATION STUDY
, Gender and Ethnic Distributions
500 Arrestees

All Arrestees		Females		Males	
No.	%	No.	%	No.	%
52	10.4	7	6.5	45	11.5
190	38.0	42	38.9	149	38.0
156	31.2	44	40.7	112	28.6
71	14.2	12	11.1	59	15.1
14	2.8	0	0	14	3.6
9	1.8	1	0.9	7	1.8
8	1.6	2	1.9	6	1.5
500	100	108	100	392	100

All Arrestees		Females		Males	
No.	%	No.	%	No.	%
)	83.8	103	95.4	316	80.6
)	9.2	0	-	46	11.7
	6.2	5	4.6	26	6.6
	0.6	0	-	3	0.8
	0.2	0	-	1	0.3
	100	108	100	392	100

FIGURE 5
ARIZONA DRE VALIDATION STUDY
Ages, 500 DUID Suspects



SHOULD HAVE CORRESPONDED

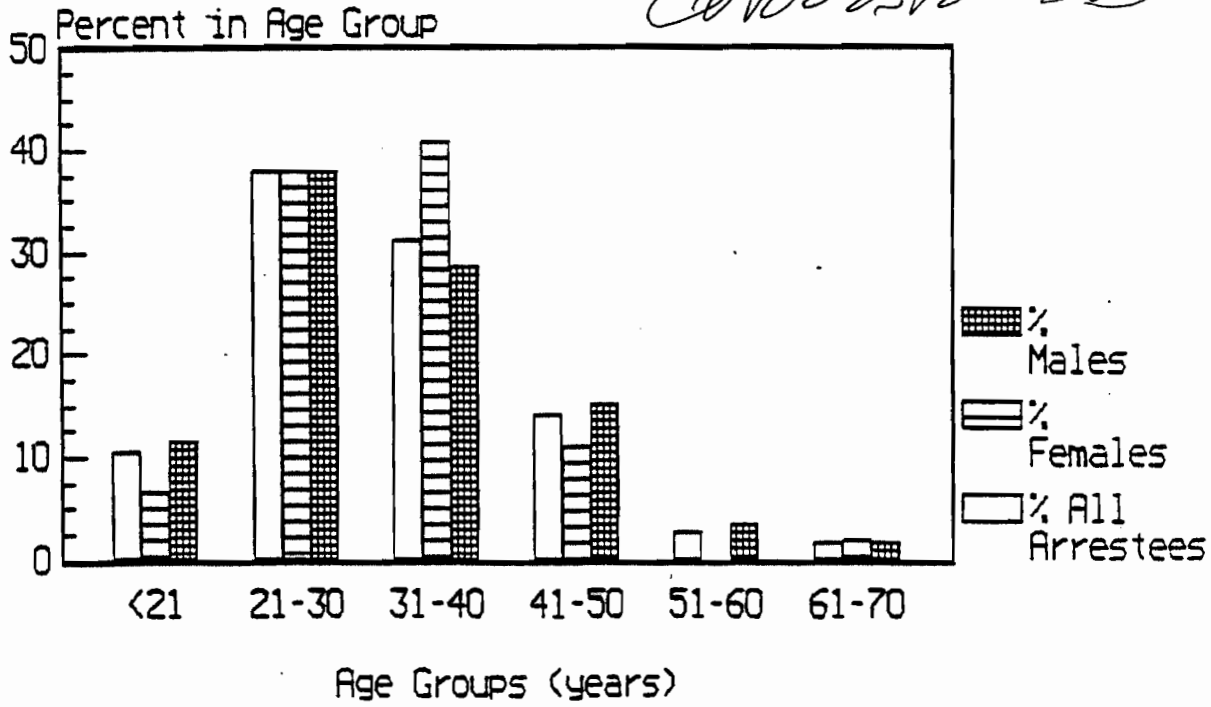
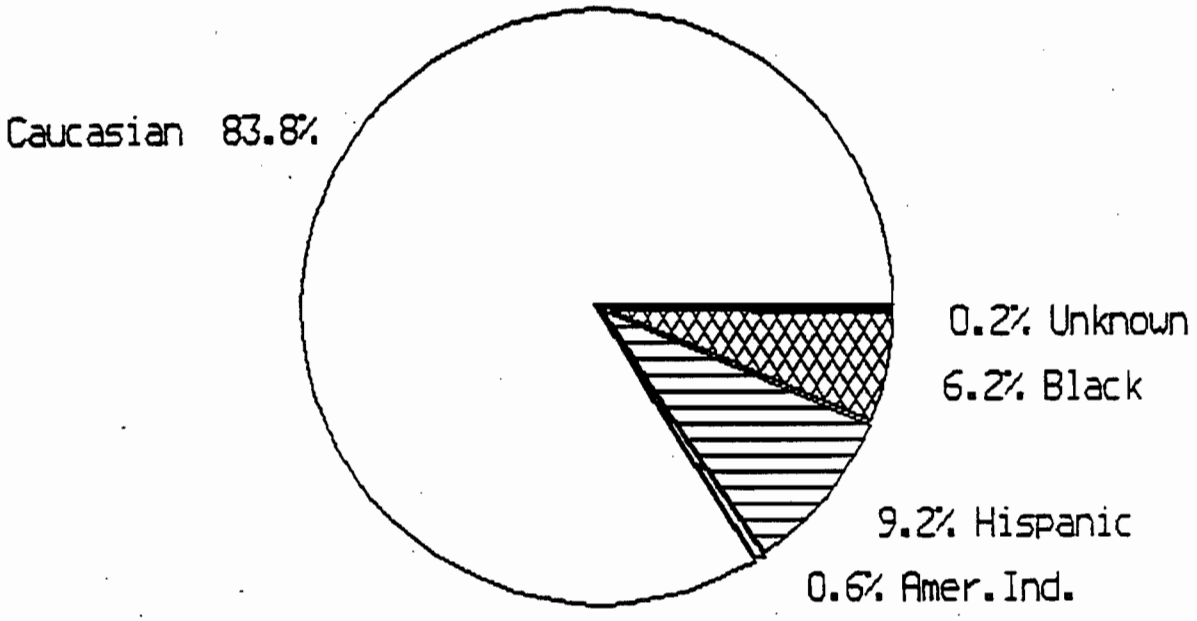


FIGURE 6
ARIZONA DRE VALIDATION STUDY
500 Arrestees - Ethnic Groups



Percent of Total Sample by Ethnic Group

With few exceptions, DREs did not record "employment status" of arrestees during the period 1989 - 1990. Although they began in 1991 to note the arrestees' occupations more frequently, the information is available overall for less than 20% of the group. With the occupation of 411 arrestees unknown, the value of the following information is extremely limited, and certainly cannot be generalized beyond the 89 arrestees to whom it applies.

	NUMBER	PERCENT
Unemployed	30	33.7
Unskilled	7	7.9
Semiskilled	18	20.2
Skilled	25	28.1
Professional	4	4.5
Student	5	5.6
Total	89	

C. DREs and Evaluations

Significant resources have been required to train Arizona officers in the DRE methodology, and it is reasonable to inquire about the benefits for law enforcement and the community at large. Is the unit meeting the objectives which underlie the adoption of DRE in Phoenix? Is the unit having an impact on traffic safety in Phoenix?

The number of DUID suspects evaluated by the unit and by individual officers can be taken as relevant measures of DRE activity. In general, arrests parallel evaluations except that evaluated drivers are not arrested if they are found to be "not impaired." Although an evaluation is requested only when there is evidence of impairment, the DRE may conclude at the end of an examination that the suspect is experiencing a medical problem, extreme fatigue, or emotional distress, and that no impairing substance is present.

When an evaluation does culminate in an arrest, the driver is prevented from crashing on that occasion. In that sense, the number of arrests is an index of the program's short term contribution to roadway safety. A more difficult query concerns the program's long term safety benefits. A satisfactory answer to that question will require analysis of a broader data set, which includes injury and fatality statistics over a longer time period.

The number of DREs who conduct evaluations over an extended period post-certification is an index of program activity. The PPD data show significant between-DRE variability. It should be kept in mind that whether a DRE does or does not examine drug-impaired drivers is related not only to the individual officer's assignments and motivation, but also to department priorities and budgets, the DRE unit policies, drug availability, drug cost, the weather, the economy, and other diverse, sometimes unrecognized influences. Such variables alter the number of drug-impaired drivers on the roadway at any given time, the number of traffic officers on patrol to detect them, and the number of DREs available to examine them. It is not possible to retrospectively identify and analyze all of these variables with available data and resources, but their impact should not be minimized.

The number of evaluations is, at least in part, a function of elapsed time since an officer's certification. As expected, an examination of the Phoenix data indicates that for most but not all officers, the premise of a time-number relationship is valid. Using the dates of first and most recent evaluations to approximate time-since-certification, it was found that the officer who conducted evaluations over the longest period of time (51 months) is also the officer with the largest number of evaluations (33). More broadly, if the analysis is restricted to those DREs who conducted ten or more evaluations during the study period, number is significantly related to time (Spearman Rank correlation, 0.67, $p<.005$).

Activity level is also important in terms of officers being able to maintain proficiency with DRE skills. It is an issue not only of the total numbers but of the particular drugs and drug combinations which are encountered. The study records were examined to determine how many times each DRE examined suspects under the influence of drugs in each of the seven categories. If most suspects in a particular locale are under the influence of the same drugs (marijuana or cocaine, for example), it might be possible to conclude that the DREs are very skilled in identifying those drugs, but to be uncertain about their skills with other categories.

The four drug categories which appeared most often in specimens were depressants, narcotic analgesics, marijuana, and stimulants. Thirty of the 37 DREs had examined suspects who had used drugs in one or more of these categories (1 to 15 suspects). Eighteen officers had encountered four categories, and seven officers had encountered five. Most, if not all, DREs in this study can be expected to maintain proficiency in the four most common categories.

The signs and symptoms associated with PCP, hallucinogens, and inhalants are obvious and unique and their recognition is not expected to be difficult even for officers who encounter them infrequently. It is concluded that loss of proficiency is not currently a problem for the participating DREs; if there is any risk at all, it will be limited to officers who conduct so few evaluations that they are likely to be placed on inactive status.

D. Toxicology Reports and DRE Opinions

An understanding of the toxicology findings, and of the DREs' opinions in relation to those findings, will be facilitated by a comparison of the DRE protocol vs the laboratory analysis. The differences between the data sources are a key to understanding the findings of this study. Reference to the checkprint template and the laboratory report in Appendix III is suggested.

A DRE identifies substances as belonging to one of seven drug categories. An opinion at the conclusion of the evaluation is recorded in the format illustrated below. (See page 2 of checkprint, "DRE OPINION.")

MEDICAL PROBLEM
STIMULANTS
PHENCYCLIDINE
HALLUCINOGENS
CANNABIS
INHALANTS
DEPRESSANTS
NARCOTICS
OTHER

The laboratory, however, reports the specific drugs which are confirmed. Positive toxicology findings are recorded in the data base in the following format. (See page 2 of checkprint,"TOXICOLOGY RESULTS.")

PCP
MORPHINE
CODEINE
COCAINE
MARIJUANA
BARBITURATES
VALIUM
METHAQUALONE
AMPHETAMINE
METHAMPHETAMINE
OTHER

The important distinction is that the laboratory is able to detect and report specific drugs whereas a DRE identifies and reports substances by category. Drug signs and symptoms do not permit him/her to distinguish between morphine and codeine, for example. Based on observations only, there is no unique sign or symptom which identifies a drug as amphetamine instead of methamphetamine. In these cases, a DRE identifies and reports "narcotic analgesic" and "stimulant."

Because it is not feasible to predict trends in users' choices or to provide spaces in the data base for all possible drugs, the software limits the checkboxes (see preceding page) to those which were detected most frequently in the Los Angeles area at the time the software was being developed. Diazepam (Valium) was the most commonly-abused benzodiazepine at that time. Presently, however, other benzodiazepines are frequently detected in specimens, and the checkbox "Valium" has been used in this study for the broader category, benzodiazepines. Methaqualone appears in the checkboxes because it previously was an abused drug, but there is no occurrence of it in the data base records. For other drugs reported by the laboratory, the "Other" box was checked with the drug's name typed into the space below. Other drugs in this study are listed in Appendix V.

Note that the drug checkboxes account for only five of the seven categories. Inhalants and hallucinogens were not allotted a space, because many laboratories do not have the capability to analyze them and they are seldom reported. The inhalants reported for suspects arrested during the time period of this study have been recorded under "Other."

The following example illustrates a difference between what is recorded for a single case for the DRE opinion and for the associated toxicology result. Suppose a DRE concludes that a suspect is under the influence of a depressant; he records his opinion on the DIE form as "Depressant." He obtains a specimen and submits it to the laboratory for analysis. If the laboratory detects methaqualone, a barbiturate or a benzodiazepine, it will be specifically recorded in the data base as such. If another depressant is detected, it will be recorded as "Other."

E. Toxicology Findings

Findings from the laboratory analysis of the specimens obtained from arrestees can be summarized briefly as follows:

Specimens (no.)	
163	1 drug detected
253	2 or more substances detected
68	No drug detected
16	Refusals (no specimens obtained)
500	

Single-drug detections are listed below:

Drug	Detected Alone (no.)
Marijuana	61
Cocaine	26
Benzodiazepines	16
Methamphetamine	13
PCP	8
Barbiturates	6
Morphine	3
Codeine	1
Other drugs	29
	163

In total, the detected drugs, reported in the checkprint as TOXICOLOGY RESULTS, are the following (Figure 7):

	Drug Detected (no.)
Marijuana	165
Cocaine	115
Benzodiazepines	108
Morphine	71
Methamphetamine	69
Codeine	65
Barbiturates	35
PCP	22
Amphetamine	18
	668
Other	145
	813

Table 3 lists rankings by frequency of detection for the total sample for men and women. They are tabled by gender and ethnicity in Table 4. Since there were many more male than female arrestees in the sample, their drug choices dominate the overall tallies. Marijuana was the drug-of-choice for Caucasian and Hispanic men whereas benzodiazepines ranked first among women. Cocaine, codeine, and marijuana were detected with approximately equal frequency in urine specimens obtained from female arrestees. Note that the women account for 22% of total group (108 of 500 arrestees), and their specimens account for 26% of detections (209 of 813 drugs). PCP was found twenty times in urine obtained from men, but only twice in specimens obtained from women.

FIGURE 7
ARIZONA DRE VALIDATION STUDY
Drugs Detected in Specimens

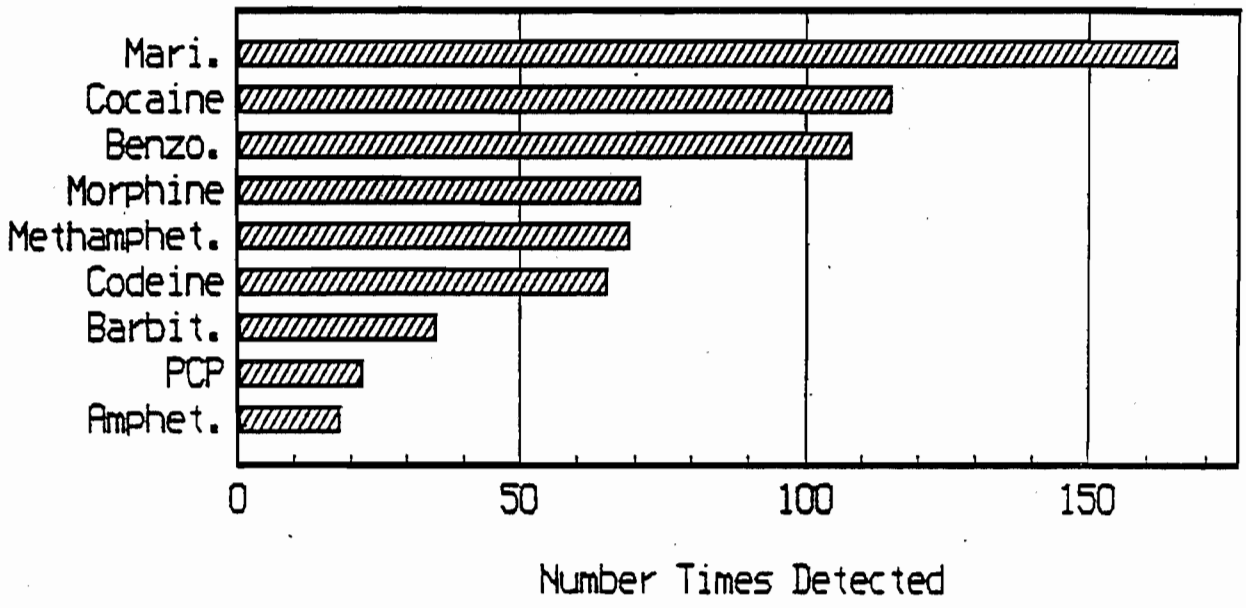


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TABLE 3
ARIZONA DRE VALIDATION STUDY
Positive Toxicology*: Ranks for 9 Drugs
500 Arrestees

	TOTAL SAMPLE N = 500		MALES N = 392		FEMALES N = 108	
DRUG	no.	Rank	no.	Rank	no.	Rank
Marijuana	165	1	144	1	21	4
Cocaine	115	2	92	2	23	2
Benzodiazepines	108	3	72	3	36	1
Morphine	71	4	55	4	16	7
Methamphetamine	69	5	52	5	17	6
Codeine	65	6	43	6	22	3
Barbiturate	35	7	17	8	18	5
PCP	22	8	20	7	2	9
Amphetamine	18	9	13	9	5	8
	668		508		160	

*Other drugs were identified in 145 specimens.

TABLE 4
ARIZONA DRE VALIDATION STUDY
Number of Drugs Detected, by Gender and Ethnic Group
500 Arrestees

	FEMALES N = 108		MALES N = 392			
	Black	Cauc.	Black	Cauc.	Hisp.	Other
	n=5	n=103	n=26	n=316	n=46	n=4
DEPRESSANTS						
Barbiturates	0	18	0	17	0	0
Benzodiaz.	2	34	1	67	4	0
NARCOTIC ANAL.						
Morphine	1	15	5	44	5	1
Codeine	1	21	4	34	5	0
STIMULANTS						
Cocaine	2	21	11	66	14	1
Amphetamine	0	5	0	12	1	0
Methamphet	0	17	1	49	2	0
MARIJUANA	2	19	9	119	16	0
PHENCYCLIDINE	2	0	12	4	4	0
OTHER DRUGS	2	47	1	86	7	2
TOTAL	12	197	44	498	58	4

The terms, which will be used to report DRE opinions as supported or not supported by analysis of specimens, are illustrated below.

Hit	Drug predicted by DRE, Drug found by lab.
Miss	Drug not predicted by DRE. Drug found by lab.
False Positive (F.P.)	Drug predicted by DRE. Drug not found by lab.
Correct Rejection	No drug predicted by DRE No drug found by lab.

TOXICOLOGY RESULTS

DRE OPINION	DRUG +	DRUG 0
DRUG +	HIT	FALSE POS.
DRUG 0	MISS	COR. REJECT.

The DRE methodology mandates both the standardized evaluation and the analysis of a specimen. Together, the evaluation and the analysis create a balance, which is designed to identify impaired suspects (minimize misses) and, equally important, to recognize that suspects are unimpaired (minimize false positives).
False positives occur whenever:

- the DRE misinterprets impairment signs and symptoms; or
- the DRE identifies signs and symptoms of a drug, but the limitations of the laboratory analysis result in a failure to detect it in the specimen.

Misses occur whenever:

- a suspect exhibits the signs and symptoms of a drug, but the DRE does not recognize them;
- the DRE associates a drug's signs and symptoms with another drug which is also present;
- the signs and symptoms of one drug counteract or mask the signs and symptoms of another drug; or
- the suspect was not impaired at the time of the evaluation and exhibited no signs and symptoms of impairment, but the drug or metabolite was detected in the urine specimen.

In the latter case, the DRE evaluation insures that the motorist will not be charged erroneously with being under the influence of a drug.

1. Positive Toxicology Specimens

The DRE opinions will be assessed in a variety of ways. An overview begins with 416 specimens for which the laboratory reported one or more drugs (Table 5). Looking just at those specimens which contained a drug(s), the DREs identified at least one drug in 378 specimens (91%).

2. All DIE - SER Records

In a more comprehensive analysis, DRE decisions will be assessed in terms of all data base records (Tables 5 and 6). Sixteen arrestees refused to provide specimens, and the total number of analyzed specimens for 500 suspects was 484.

The DREs identified at least one drug in 378 specimens, and drugs were not found in the specimens obtained from 26 individuals who the DREs judged not to be under the influence of drugs (Figure 8). Thus, the DRE decisions were supported by laboratory analysis for 404 (83.5%) of the 484 specimens, and were not supported in 80 cases (16.5%).

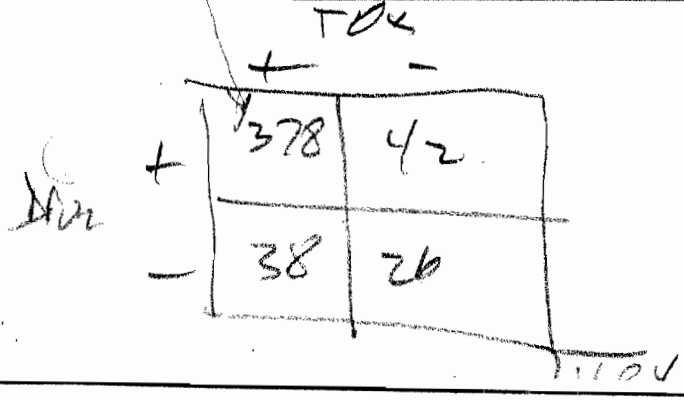
To more fully assess DRE performance, it is important to consider how decisions were right and wrong, by subsets of the arrestees, by drug category, and by other variables of interest (Figure 9). Misses or false positives occurred in 56 cases (Figure 10). Misses and false positives also occurred in combination with hits.

TABLE 5
ARIZONA DRE VALIDATION STUDY
DRE Identifications of Drug(s), by Specimen *

Classification	Number		
HIT	184		
HIT and FALSE POSITIVE	56		
HIT and MISS	115		
HIT and FALSE POSITIVE AND MISS	23		
TOTAL with one or more HITS		378	
MISS	14		
MISS and FALSE POSITIVE	24		
TOTAL with no HITS		38	
TOTAL: specimens in which one or more drugs were detected			416
FALSE POSITIVES	42		
CORRECT REJECTIONS (RULE OUTS)	26		
TOTAL: specimens in which no drugs were detected			68
REFUSALS: no specimens obtained			16
TOTAL: arrestees			500

* Classifications are per specimen with one or multiple drugs.

KEY TO CLASSIFICATIONS	
HIT	Drug(s) predicted and found.
MISS	Drug(s) not predicted but found.
FALSE POSITIVE	Drug(s) predicted but not found.
CORRECT REJECTION	Drug(s) not predicted or found.

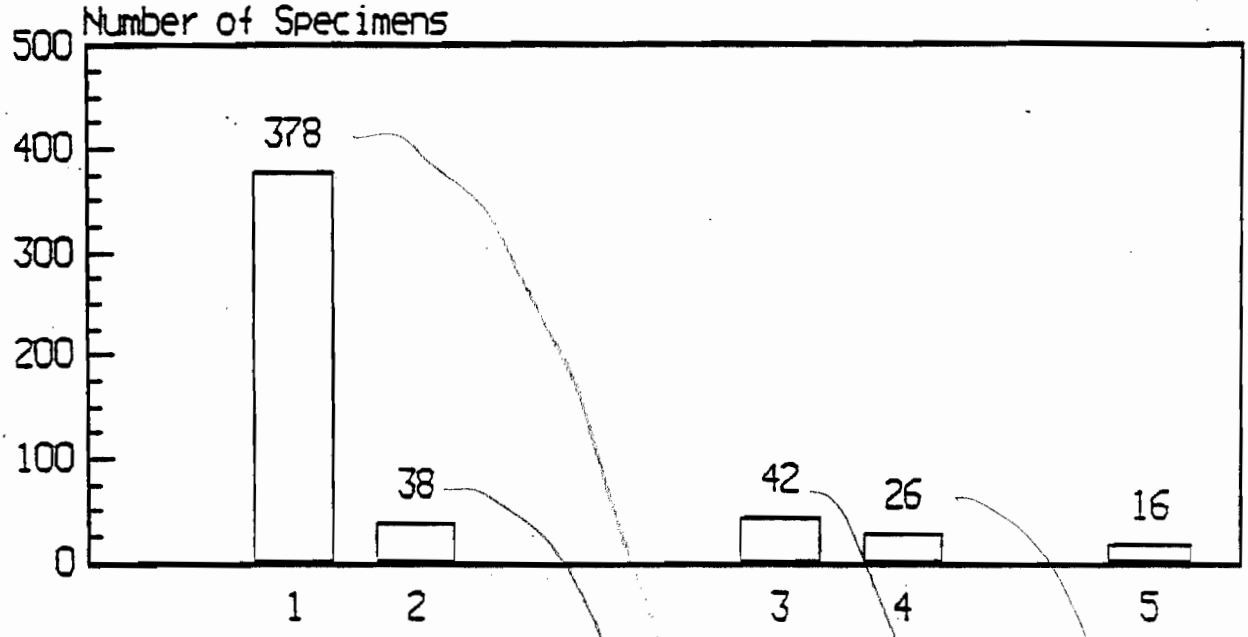


$$\frac{TP+TN}{TP+FP+FN+TN} = \frac{404}{484} = 83.5$$

TABLE 6
ARIZONA DRE VALIDATION STUDY
DRE Identification of Drugs, by Number of Drug Categories per Specimen

NUMBER CATEGORIES	NUMBER SPECIMENS	DRE OPINION	Number	Percent of Category
0	26	Correct Rejection	26	100.0
1	190			
		Hit	137	
		Hit + F.P.	7	
		With Hit	144	75.8
		Misses	8	
		Misses + F.P.	11	
		F.P. (no drug)	27	
		Without Hit	46	24.2
				100.0
Multiple	268			
		Hit (all drugs)	47	
		Hit + F.P.	49	
		Hit + Miss	115	
		Hit + Miss + F.P.	23	
		With Hit	234	87.3
		Misses (all drugs)	6	
		Misses + F.P.	13	
		F.P. (no drug)	15	
		Without Hit	34	12.7
				100.0
		Totals		Percent of Specimens
		Hits + Cor. Rej.	404	83.5
		Without hits	80	16.5
All Specimens	484			100.0
Refusals	16			
Total Number Records	500			

FIGURE 8
ARIZONA DRE VALIDATION STUDY
500 Arrestees



1	=	Hits
2	=	Misses
3	=	False Positives
4	=	Correct Rejections
5	=	Refusals

	+	−
+	378	42
−	38	26

FIGURE 9
ARIZONA DRE VALIDATION STUDY
Percent Correct Identifications & Misses
by Drug Category

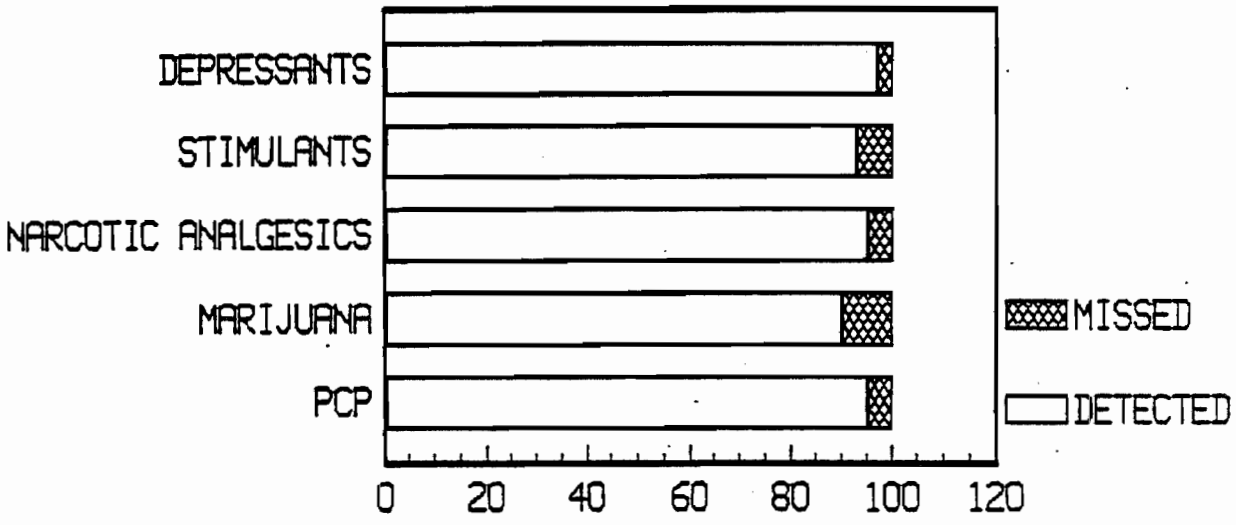
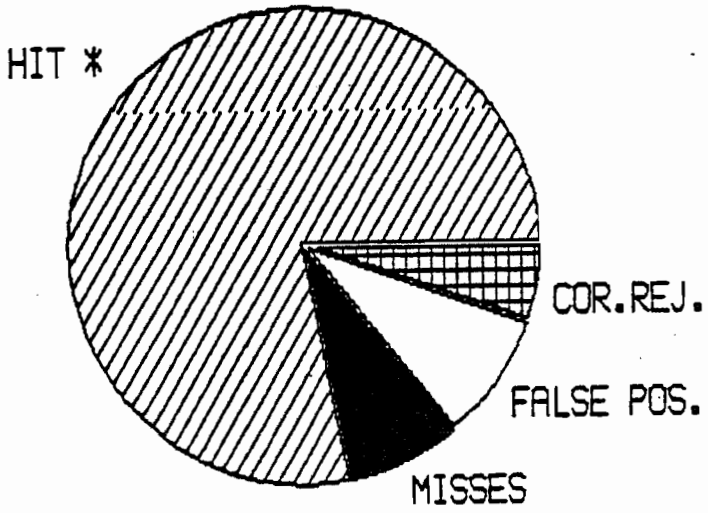


FIGURE 10
ARIZONA DRE VALIDATION STUDY
DRE IDENTIFICATION OF DRUGS
by Drug Category



* HIT - DRE identified at least one drug detected in analysis of specimen

The laboratory detected 813 drugs (668 checkbox drugs + 145 other drugs). Table 7 displays the DRE Hits and Misses for the 668 drugs, by drug category. As can be seen, cocaine and marijuana were missed most frequently. A miss together with a hit occurred in 115 cases (Table 6). That is, the DRE identified one or more drugs but also missed one or more. In total, one or more drugs were missed in 176 decisions.

From the viewpoint of traffic safety, failure to identify a drug can have serious consequences if it equates with failure to recognize impairment, and the misses require closer examination of the specific drugs that were missed. The 14 cases where all drugs were missed are listed below. Since five of these arrestees had used multiple substances, a total of 20 drugs were detected.

	All Drugs Missed 14 Arrestees
Narcotic analgesics	
Morphine	2
Codeine	1
Stimulants	
Cocaine	5
Methamphetamine	1
Marijuana	5
Depressants	
Barbiturate	1
Benzodiazepine	1
Carisoprodol/Meprobamate	1
Chlorpheniramine	1
Meprobamate	1
Other	
Lidocaine	1

Again, cocaine and marijuana appear most frequently. It is not possible to establish the reasons for misses retrospectively, but misses of cocaine and marijuana are not unexpected. Unless a large amount of stimulant has been ingested, the signs and symptoms typically are less obvious than the symptoms of other categories and can be very difficult to recognize. Cocaine is a fast-acting substance, and observable signs of use may be apparent at roadside but diminish significantly by the time of evaluation. The half-life of cocaine is approximately 90 minutes, but

its metabolite, benzoylecgonine (BE), can be detected in urine for 24 - 48 (possibly 72) hours, depending on amount ingested. Thus, it is possible for the laboratory to detect BE from cocaine, which was ingested at some time in the recent past, even though the suspect was not impaired at the time of the evaluation.

Similarly, the marijuana metabolite appears and can be detected in urine for days-to-weeks, depending on amount and chronicity of use. Because a specimen may test positive at a time when the suspect is not under the influence of marijuana, a DRE evaluation is crucial. Importantly, unless a marijuana positive from the laboratory is corroborated with evidence of impairment at the time of the evaluation, it does not speak to the question of drug influence.

In summary, misses can occur if a DRE fails to correctly observe, record, and interpret the signs and symptoms displayed by a suspect. They will occur if the parent drug has been eliminated from the body, but a metabolite, which is not itself psychoactive, remains in the urine. They will occur if one substance produces severe symptoms, as PCP does, which entirely mask the symptoms of other drugs. Also, although two or more drugs may have been used, differences in amounts used and each drug's time course may be such that not all substances yield signs and symptoms at the time of the evaluation.

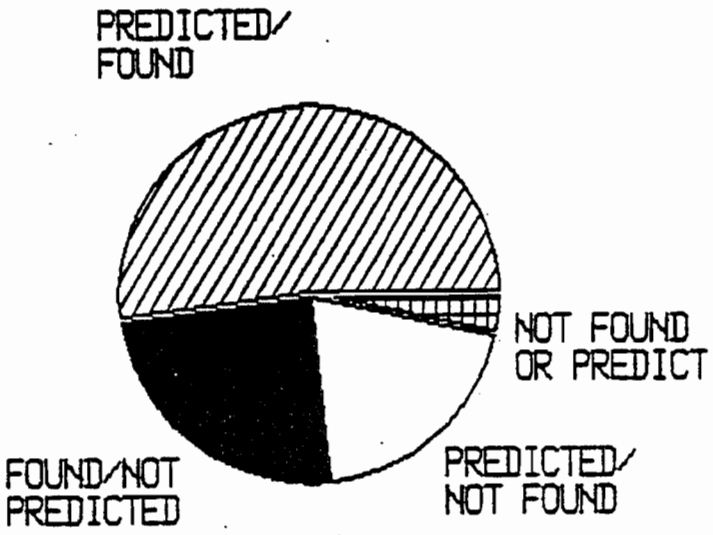
Although a true miss and the release of an impaired driver carries the greatest potential for harm, citizens are likely to be understandably distressed by false positive errors. In the PPD data, the DREs believed a drug was present 42 times when no drug was found in the specimen (Table 5, Figure 11). The drug categories, which the DRE believed to be influencing the suspects, are summarized below:

	False Positive (number)
Single Category	
Stimulant	12
Marijuana	7
Depressant	5
Phencyclidine	1
Inhalant	1
Narcotic Analgesic	1
	27
Two or More Categories	
Marijuana/Stimulant	6
Stimulant/Depressant	4
Stimulant/Narcotic Analgesic	3
Marijuana/Phencyclidine	1
Depressant/Inhalant	1
	15

TABLE 7
ARIZONA DRE VALIDATION STUDY
DRE Correct Identifications and Misses, by Drug
For 668 Drug Detections in 416 Specimens

	Number			
	DETECTIONS	CORRECT IDENTIFICATIONS		MISSES
		Number	Percent	
Marijuana	165	149	90	16
Stimulants				
Cocaine	115	104	90	11
Amphetamine	18	17	94	1
Methamphetamine	69	66	96	3
Depressants				
Barbiturate	35	33	94	2
Benzodiazepines	108	106	98	2
Narcotic Analgesics				
Morphine	71	67	94	4
Codeine	65	62	95	3
Phencyclidine	22	21	95	1
Totals	668	625	94	43
Other drugs	145			
Total: Drugs detected	813			

FIGURE 11
ARIZONA DRE VALIDATION STUDY
DRE IDENTIFICATION OF DRUGS
(Multiple Drugs per Specimen)



Ten of the arrestees admitted using a prescription drug, and one was in possession of marijuana. None admitted using an illicit substance, and most denied any drug use whatsoever. Stimulants and marijuana appeared most frequently as false positives, as they did for misses.

A more exhaustive analysis of misses and false positives, which is beyond the scope of this project, is recommended. The records now residing in the data base, together with the DIE narratives, will support an analysis of each component of the evaluation. The specific objective would be to examine by drug the specific signs and symptoms, suspects' admissions or denials, and drug possession for each miss and false positive. The relationship of misses and false positives to the time course of each drug, as well as to gender and age characteristics of the suspects, may prove to be variables which predict the errors. If specific signs, symptoms, combinations, and conditions are found to be reliably related to misses and false positives, that information can be incorporated into training and guidelines.

F. Signs and Symptoms and Drug Identification

The standardized evaluation enables a trained officer:

1) to determine whether a suspect is impaired;
2) to determine whether observed impairment is drug-related; and
3) to identify the category or categories of drug(s).

As a basis for that three-level opinion, DREs perform the 12-step evaluation in a prescribed, systematic manner and then integrate all of the obtained information. Diverse observations and measures are made during the evaluation, and the relative contribution of the various signs and symptoms to DREs' opinions has not been determined. The following questions are illustrative but not exhaustive of appropriate inquiry:

> Does each component of the evaluation (FSTs, eye examination, vital signs, etc.) contribute equally to the DRE's opinion? If not, which is more/less useful?
>
> Does the value of a particular component (or observation) differ by drug or drug combination?
>
> Does the validity and reliability of the method require all components of the evaluation under all circumstances and for all suspected drugs?

When a larger data set becomes available, these questions will be broadly addressed with appropriate and exhaustive statistical analysis. For the present, a data set of 500 cases supports the examination of certain key variables.

1. Eye Signs

The DREs rely on information obtained by examination of the eyes. Among other signs, they look at pupil diameter under various light conditions. For this study, the pupil diameter variable has been analyzed with two different data sets. First, a restricted set of cases, meeting the following criteria, was summarized:

- A single drug was detected in the specimen;
- The detected drug was cocaine, methamphetamine, or morphine; and
- The DRE identified the drug.

The analysis was limited to cases in which a single drug was detected in the specimen in order to obtain a clear picture of pupillary response to a drug without the possible influence of any other substance, and was further limited to those cases in which the DRE identified the drug. The narcotic analgesic-stimulant comparison was selected because the two drug categories are known to exert opposing effects on pupil size. With these restrictions, the analysis directly addresses the question of whether the magnitude of differences in pupil diameter, as observed by a DRE, was great enough to contribute to drug identification.

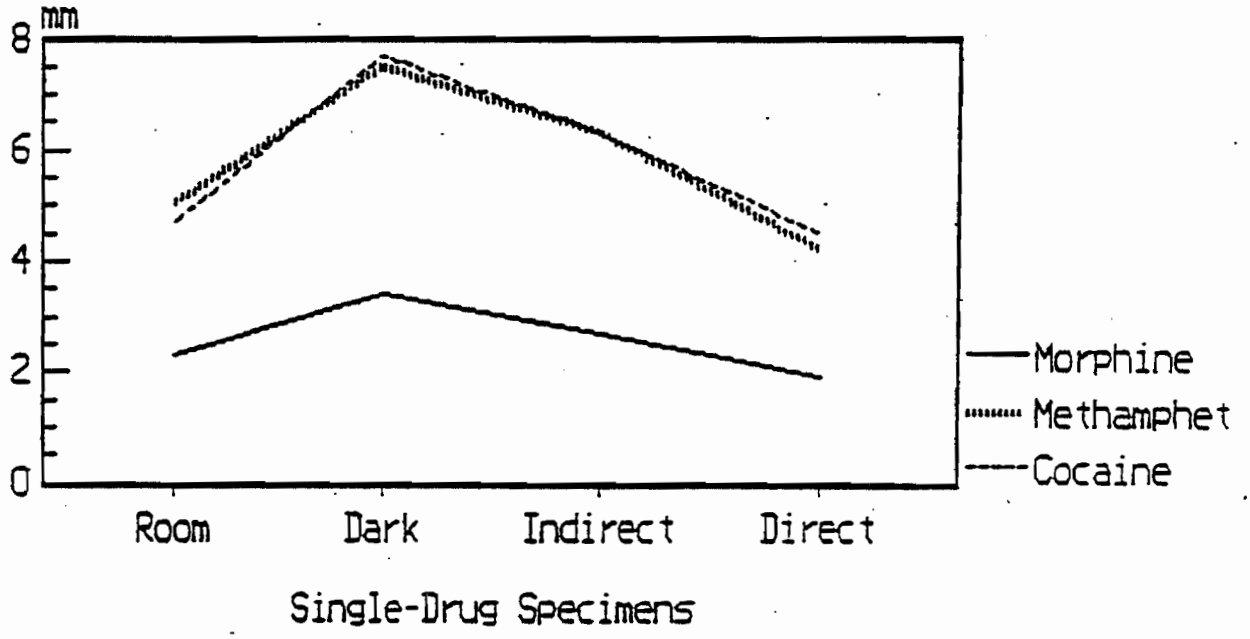
A t statistic was calculated for the difference in the darkness condition between observed pupil sizes of suspects under the influence of morphine or cocaine. The mean pupil sizes graphed in Figure 12, together with a t of -6.58 (21 df, $p < .01$), indicate that the DREs' observations of suspects' pupil sizes were important contributors to drug identification.

A second question focuses on the robustness of pupil measurement in the presence of several drugs since, as can be seen in Table 6, multiple drugs were more common than a single drug. This question has been examined with data for cocaine and morphine. Figure 13 graphs all cases in which either drug was detected, excluding the 29 specimens containing both drugs and also excluding cases with misses and false positives. The data restrictions permit a comparison of observed pupil sizes of suspects who were under the influence of either cocaine or morphine (but with other drugs present) when the DRE identified all drugs present. Again, the diameter of suspects' pupils in the darkness condition discriminated between the two drugs (t -3.97, 114 df, $p < .01$).

These data confirm that changes in pupil diameter in darkness reliably identify the two drug categories, narcotic analgesics and stimulants. A more extensive analysis is needed to examine the contribution of changes in pupil size and responsivity under other conditions and for other drug categories.

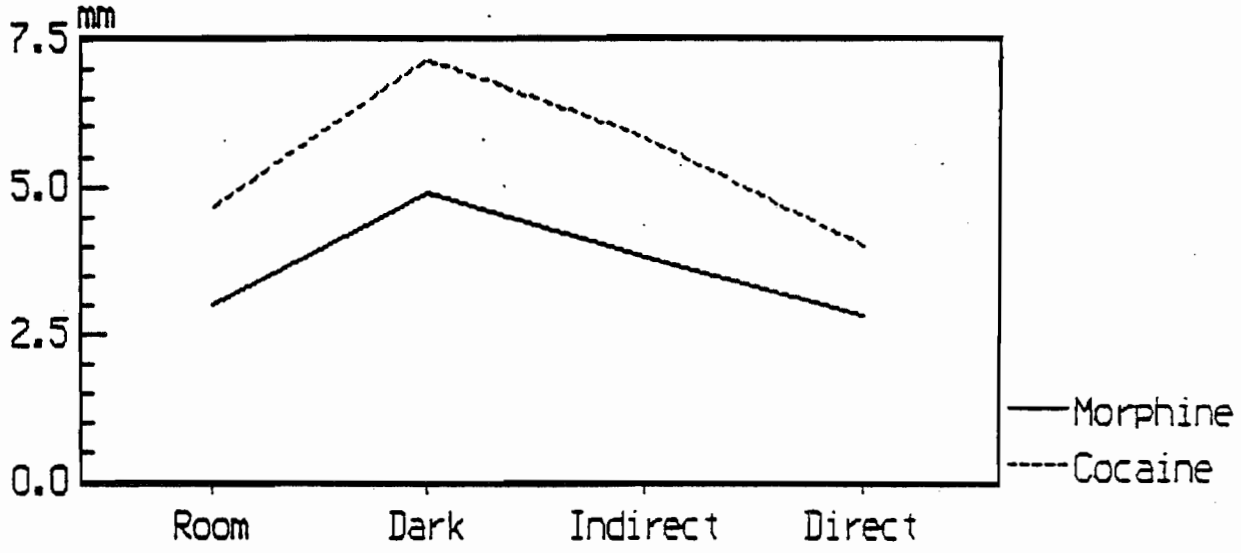
Table 8 summarizes other eye signs for all specimens in which each drug was found. Since the table includes multi-drug as well as single drug specimens, the

FIGURE 12
ARIZONA DRE VALIDATION STUDY
DRE Measurements of Pupil Size



Single-Drug Specimens

FIGURE 13
ARIZONA DRE VALIDATION STUDY
DRE Measurements of Pupil Size



Cocaine + Other Drugs and
Morphine + Other Drugs

NO. OF SUBJECTS HAVING EYE SIGN THAT A DRUG

% OF SUBJECTS

TABLE 8
ARIZONA DRE VALIDATION STUDY
Eye Signs Observed during Drug Influence Evaluations
Observations (Number, Percent) by Drug Group

EYE SIGNS (See key)		1	2	3	4	5	6	7	8	9	10	11	12
PCP	no.	**16**	18	0	**12**	4	11	**5**	5	**18**	**18**	14	**15**
	%	**73**	82		**55**	18	50	**23**	23	**82**	**82**	64	**68**
Morphine	no.	28	56	2	12	14	**49**	8	**39**	27	26	29	29
	%	39	79	3	17	20	**69**	11	**55**	38	37	41	41
Cocaine	no.	51	79	3	12	**29**	58	**31**	44	52	51	52	53
	%	44	69	2.6	10	**25**	50	**27**	38	45	44	45	46
Mari.	no.	104	127	1	28	33	61	**67**	54	97	95	**109**	108
	%	63	77	0.6	17	20	37	**71**	33	59	58	**66**	65
Barbit.	no.	**27**	29	0	**15**	**11**	**22**	4	**14**	**27**	**27**	**28**	**27**
	%	**77**	83		**43**	**31**	**63**	11	**40**	**77**	**77**	**80**	**77**
Benzodiaz.	no.	**75**	92	4	**30**	23	**74**	22	**45**	**70**	**69**	**76**	**76**
	%	**69**	85	3.7	**28**	21	**69**	20	**42**	**65**	**64**	**70**	**70**
Methamphet. & Amphet.	no.	40	43	1	5	**24**	31	18	31	33	33	39	39
	%	46	49	1	6	**28**	36	21	36	38	38	45	45

% = percent of arrestees with the sign whose specimen was positive for the drug
Underlined/Bold = drugs with ranks 1, 2, or 3 for each sign

Column	Eye Sign
1	HGN
2	Lack of convergence
3	Does not follow stimulus
4	Vertical nystagmus
5	Hippus
6	Droopy eyelids
7	Rebound dilation
8	Slow reaction to light
9	Lack of smooth pursuit, left
10	Lack of smooth pursuit, right
11	HGN at maximum, left
12	HGN at maximum, right

data cannot be used to examine the validity of separate eye signs. An analysis of signs and symptoms when two or more active drugs are present is a complex problem and is beyond the scope of this project. The Table 8 data are presented solely to demonstrate the patterns and trends associated with the various drug categories. As can be seen in the table, "lack of convergence" was recorded for more than half the suspects for all drugs. Thus, it contributes little to the discrimination of any specific drug. Similarly, the value of "not able to follow the stimulus" seems to be limited since it was recorded only 11 times. The other signs show clear-cut patterns despite the presence of multiple drugs in many of the specimens.

The underlined cells in Table 8 indicate ranks 1, 2, and 3 for each sign. To illustrate, "HGN present" is identified in the table as Eye Sign 1 (first column). Note that it was observed in 77% of the barbiturate cases, 73% of the PCP cases, and 69% of the benzodiazepine cases. The preponderance of underlined cells indicate that eye signs are strong predictors for PCP and depressants. Droopy eyelids are associated with morphine, and rebound dilation is associated with marijuana. Fewer underlined cells indicate that these eye signs are less useful for stimulants.

2. Vital Signs

DREs measure a suspect's blood pressure (one time) and pulse rate (three times) during an evaluation. The range of normal values for vital signs is moderately wide and these indices vary as a function of disease and other between-person physiological differences. For these reasons, blood pressure and pulse rate as independent signs and are not expected to have the diagnostic specificity for drugs of the all-or-none phenomena such as horizontal gaze nystagmus (HGN). They are, nonetheless, important cues if they reliably corroborate other observations. A striking disparity, such as depressed vital signs and other observations consistent with PCP, would be cause for further examination.

Table 9 summarizes the blood pressure and pulse rate data for the cases in which the DRE identified a single drug and the laboratory analysis of the specimen confirmed the opinion. Given the small number of cases which meet these strict criteria together with the variability of the measures, the between-drug differences do not reach statistical significance. Although the data in Table 9 are of interest, they should be interpreted cautiously pending replication.

The mean systolic blood pressure for PCP users was 141 mmHg (Table 9). For other drugs, note that the mean values do not exceed the upper limit of the 140/90 normal blood pressure range. The mean blood pressure for suspects under the influence of methamphetamine and PCP was relatively high, as expected. The mean blood pressure with morphine also was elevated in comparison to other

TABLE 9
ARIZONA DRE VALIDATION STUDY
Mean Blood Pressure and Pulse Rates *
As Measured During Drug Influence Evaluations

		BLOOD PRESSURE (mmHg)				PULSE RATES (bpm)					
		SYS		DIAS		1		2		3	
	n	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ	$\bar{X}$	σ
Barbiturate	7	124	11	85	9	83	20	84	17	88	18
Benzodiazepine	12	123	15	83	17	100	21	101	19	97	20
Cocaine	18	126	20	77	15	97	17	97	18	98	16
Marijuana	44	132	18	82	15	92	17	94	18	90	16
Methamphetamine	24	133	19	85	14	100	19	101	20	99	19
Morphine	8	135	20	81	13	93	20	99	17	99	20
PCP	5	141	24	87	4	116	27	101	25	116	6

* 1 Single drug was detected in specimens and was identified by the DRE without misses or false positives.

categories; this unexpected finding may be more instructive about the age and health status of heroin users than about drug effects per se. The finding must be considered highly tentative for the present.

Higher pulse rates (bpm) were recorded with methamphetamine and PCP and also with benzodiazepines. The latter also is an unexpected observation. It is possible, but entirely speculative, to note that it may also reflect arrestee characteristics.

3. Time Estimates

As suspects stand with eyes closed, arms at their side, and head tipped back, they are instructed to estimate a 30 second time interval. Restricting the analysis to cases with a single drug predicted and found, the mean estimates for each drug category appear below.

	Estimates of 30 sec.		
	mean	std. dev.	
Barbiturates	38	21	50% greater than 30 sec.
Benzodiazepines	38	20	64% greater than 30 sec.
Marijuana	26	12	69% less than 30 sec.
Morphine	27	8	67% less than 30 sec.
Cocaine	22	7	80% less than 30 sec.
PCP	20	7	All less than 30 sec.
Methamphetamine	18	7	92% less than 30 sec.

As expected, depressants tend to lengthen the time estimate and stimulants to shorten it. The estimate appears to be a strong predictor for cocaine, PCP, and methamphetamine. Although the variability in some categories weakens the sign in the individual case, in the context of other symptoms, the time estimates can be expected to serve the DRE well.

G. Arrestees' Drug Choices

Suspects sometimes acknowledge that they have used a drug or drugs. The following table summarizes: (1) arrestees' admissions; (2) in comparison to the number of times the substances were found in suspects' possession; and (3) the positive toxicologies.

	(1) Arrestee Admissions	(2) Drugs Found On Suspect	(3) Positive Specimens	
Narcotic	126	19	136	Morphine, Codeine
Depressant	122	22	143	Barbiturates, Diazepam
Marijuana	97	46	165	Marijuana
Stimulants	78	21	202	Amphetamine, Methamphetamine, Cocaine
PCP	8	1	22	PCP
Inhalant	3	2	4	Toluene

The high rate of narcotics admissions can be attributed to the addicts' prior experiences in the criminal justice system and their realization that track marks and constricted pupils are uniquely identifying signs. In contrast, marijuana and stimulant users, who may not have been arrested previously, are less likely to understand that the standardized examination enables the DRE to detect their drug use.

Typically, an admission occurs at the conclusion of the evaluation when the DRE has formed an opinion and confronts the suspect about his drug use. The suspect's statements are considered as part of the total evidence, but the DRE is aware that they may be true, partially true, or entirely misleading, and his opinion does not necessarily match the suspect's admission. In these data, when the suspect admitted use of a drug, the DRE identified the drug and it was found in the specimen for approximately 90% of the admissions (range by drug category = 85% to 100%).

VII. DISCUSSION AND CONCLUSIONS

The DRE methodology mandates both a standardized evaluation and the analysis of a specimen. Together, the evaluation and the toxicological analysis create a

balance, which is designed to identify impaired suspects (minimize misses), and equally important, to recognize unimpaired suspects (minimize false positives).

The findings from this study of a set of 500 DIE and SER records provide support for the validity of the methodology. There were few positive DRE opinions which were unsupported by laboratory analysis. The number of false positive opinions and the number of complete misses were low. An accuracy rate of approximately 85% is in agreement with earlier studies.

Analysis of the study records indicates that certain signs and symptoms (pupil size, field sobriety tests, time estimates) are strong indicators of specific drugs. Other signs and symptoms appear to be less strongly linked to a particular drug. Redundant and non-specific symptoms neither enhance nor detract from DRE accuracy, but if careful analysis of evaluation records leads to their identification, it is possible that the evaluation procedure can be simplified.

The DIE and SER records provide insight into the DUID population of Phoenix and their drugs of choice, and into the validity of the DRE methodology. As subsets of the data were examined, however, the numbers became so small as to lack the statistical power to answer questions about specific variables or the interaction of variables. For that reason, the reported relationship between toxicology findings and signs and symptoms are somewhat preliminary in nature. They serve to demonstrate the analytical power of the data base software and the kind of information that can be gleaned from drug evaluation and toxicology records. A number of longer range objectives will be realized as more data become available. In particular, the development of a composite symptom profile for each drug category, validated by analysis of DIE forms and toxicology records, will be undertaken when the number of records support the necessary analyses.

The substances found in this sample of arrestees were largely illegal drugs, although prescription drugs which have a high abuse potential were also found. Although there is a large number of drugs with a potential for affecting the central nervous system, only a limited number of different drugs were actually found in these arrestees. Note that antihistamines and tricyclic antidepressants were rarely a possible factor in causing impairment.

The AZ-DPS Laboratory's analytical protocol detected and confirmed most drugs of interest in driving impairment cases in Arizona. Occasionally, it was necessary to screen for miscellaneous substances (e.g., carisoprodol) by a supplemental secondary screening procedure other than the immunoassay battery. Omitting the secondary screening would have resulted in a lower corroboration rate for DRE opinions concerning narcotic analgesics and depressants, but the merits of the secondary screening must be weighed against the cost to laboratory resources.

A comparison of data obtained during this study with data reported by the U.S. Department of Justice (16) is relevant to assessing study findings. During the third quarter of 1992, urine samples were obtained from booked arrestees in 24 drug-use forecasting (DUF) sites. The following rates of "positive for any drug" were reported for Phoenix:

	% Positive
Juvenile Male Arrestees/Detainees	29
Male Booked Arrestees	54
Female Booked Arrestees	66

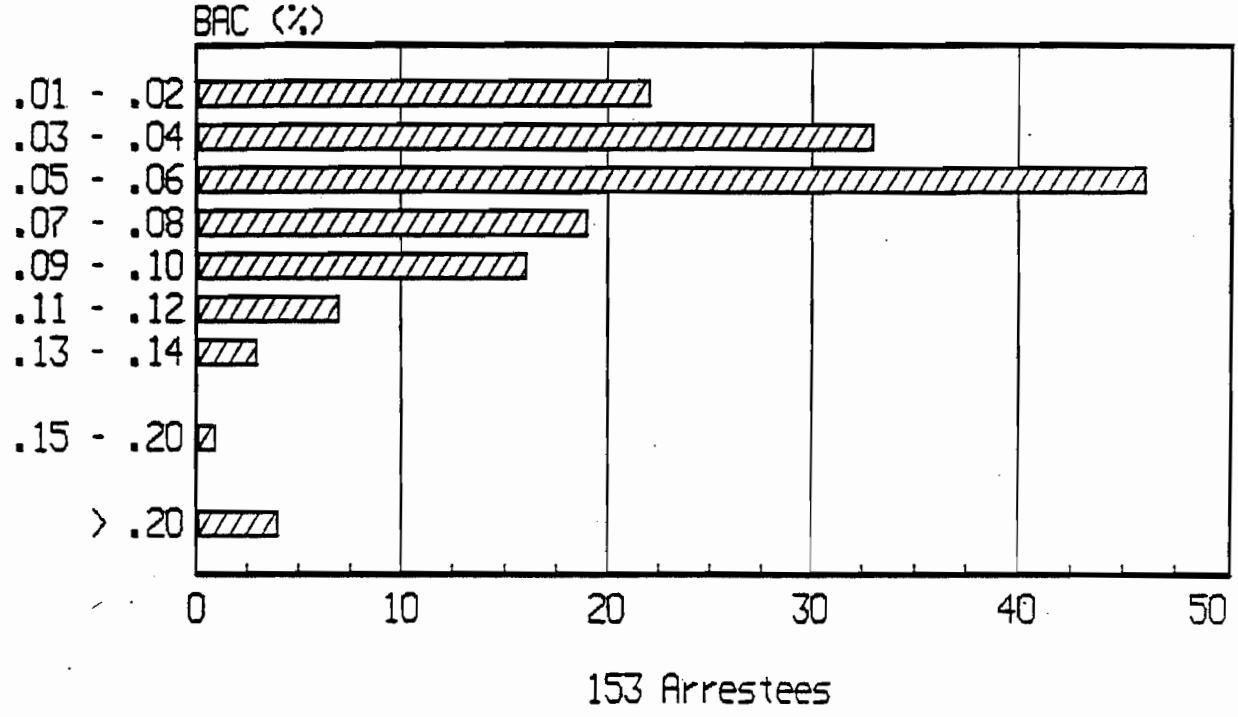
The number of men in Phoenix who were drug positive ranks 19th among 24 sites; i.e., fewer men were found drug positive in only five other cities. The rank for women is higher (13th).

In both the DUF and DRE data, marijuana and cocaine are top-ranked drugs-of-choice, confirming that these two substances are popular with both the general population of drug users and with drug users who drive. The comparisons suggest that, as expected, drug use by traffic offenders reflects drug use in the general population and that traffic officers arrest users of the most common drugs in a community.

Importantly, most of the drivers in this study could not have been arrested and prosecuted without the evidence of impairment obtained from the DRE evaluation and the corroboration by analysis of urine or blood. Figure 14 plots the distribution of positive BrACs in the sample of drug-impaired drivers. Slightly less than one-third of the arrestees had consumed alcohol, and only 5% of the positive BrACs were 0.10% or higher. The suspects with BrACs at and above 0.10%, including four above 0.20%, would have been charged with DUI with or without recognition of their drug impairment. Without the drug influence evaluation, however, the majority of these impaired drivers would not have been held or charged with an offense.

The PPD DREs have been responsible for the temporary removal of at least 378 drug-impaired drivers from Phoenix roadways. At a minimum, those drivers were prevented on at least one occasion from driving in a condition with the potential for harm to themselves and others. Whether the program exerts a longer term deterrent effect upon the arrested drivers, whether it influences the general driving population to avoid driving while impaired, and what the impact of such deterrent effects might be on traffic safety in general are questions which remain to be answered.

Figure 14
ARIZONA DRE VALIDATION STUDY
Distribution of Positive BACs



153 Arrestees

The major conclusions of this study are:

- The DRE program is a valid method for identifying and classifying drug-impaired drivers.
- Certified DREs recognize drug-impairment and identify the drug(s), by category, which cause the impairment.
- Observable signs and symptoms are associated with specific drugs.
- Monitoring DRE opinions and laboratory results will facilitate program management.
- The DRE program requires scientifically sound support by the laboratory.

REFERENCES

1. The incidence and role of drugs in fatally injured drivers. (1993) Traffic Tech, NHTSA Technology Transfer Series, No. 57. NHTSA, U.S. Dept. of Transportation.

2. Terhune, K.W., Ippolito, C.A., Jemdrocls. D.L. and Michalovic, J.G. (Calspan Corporation); Bogema, S.C. & Santinga, P. (Amer. Med. Lab.); Blomberg, R.D. & Preusser, D.F. (Dunlap) (1992) The incidence and role of drugs in fatally injured drivers. Vol.I. Final Report, NHTSA, U.S. Dept. of Trans.

3. Bigelow, G.E., Bickel, W.E., Roache, J.D., Liebson, I.A., and Nowowieski, P. (1985) Identifying types of drug intoxication: Laboratory evaluation of a subject-examination procedure. Report No. DOT-HS-806-753, NHTSA, U.S. Dept. of Transportation and National Institute on Drug Abuse.

4. Burns, M. (1985) Field evaluation of Los Angeles Police Department drug-impairment detection procedures. Final Report to NHTSA, U.S. Dept. of Transportation.

5. Compton, R. P. (1986) Field evaluation of the Los Angeles Police Department drug detection program. Report No. DOT-HS-807-012, NHTSA, U.S. Dept. of Transportation.

6. Minutes of the IACP DEC Technical Advisory Panel, St. Louis, Missouri. October 15, 1993.

7. Adler, E.V. and Bourland, J.A. (1990) Arizona's drug recognition program: A performance assessment. J. Southwestern Assoc. Forensic Sci., Vol. 12, No. 1.

8. Adler, E.V. and Bourland, J.A. (1990) Arizona's drug recognition program: A performance assessment (updated report). DRE Newsletter.

9. Adler, E.V. and Bourland, J.A. (1991) Arizona's DRE program: A comparison of DRE opinions to toxicology results. Abstracts, American Academy of Forensic Sciences, 43rd Annual Meeting.

10. Harvey, D. C. (1993) DRE Confirmation and Drug Classification Trends. DRE Newsletter, Vol.5, No. 3, 1993.

11. Louie, P. (1990) Report on the Drug Recognition Evaluation (DRE) Program in Harris County, Texas. J. Southwestern Assoc. Forensic Sci., Vol. 12, No. 1.

12. Hardin, G., Meyer R. R., and Jejurikar, S.C. (1993) Corroboration Study: A Comparison of DRE Opinions to Toxicology Evaluations of Impaired Drivers in Minnesota. Abstracts, 1993 Joint Meeting of the Society of Forensic Toxicologists and the California Association of Toxicologists.

13. Burns, M. (1990) Development and Pilot Test of a Computer Data Base of Drug Evaluations of Impaired Drivers. Final Report, National Institute on Drug Abuse Order 89M079578301D.

14. Drug Evaluation and Classification Training Program, The Drug Recognition Technician School, Student Manual, 1991 Edition, NHTSA, U.S. Dept. of Transportation.

15. Bourland, J. (1989) The analysis of drugs of abuse in urine utilizing Toxilab and GC/FID. SWAFS J., 11, 37-49.

16. Drug Use Forecasting, Third Quarter 1992, Quarterly Report. (1993) National Institute of Justice, U.S. Dept. of Justice, Washington, D.C.

ARIZONA'S DRE PROGRAM: A Comparison of DRE Opinions to Toxicology Results

EUGENE V. ADLER, BS, D-ABFT and JAMES A. BOURLAND, BS

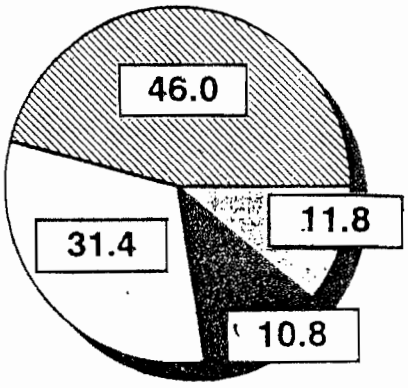
ARIZONA DEPARTMENT OF PUBLIC SAFETY

526 DRE CASES
Statistical Analysis of Results

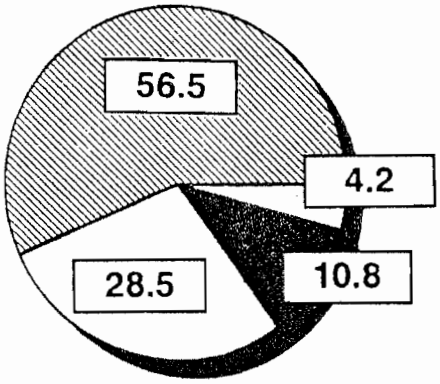
KEY

- PREDICTED, FOUND
- NOT PREDICTED, NOT FOUND
- PREDICTED, NOT FOUND
- NOT PREDICTED, FOUND

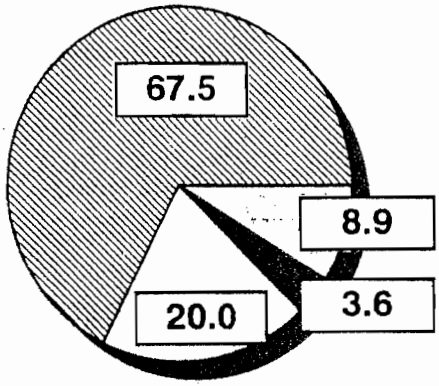
STIMULANTS



CANNABIS



DEPRESSANTS



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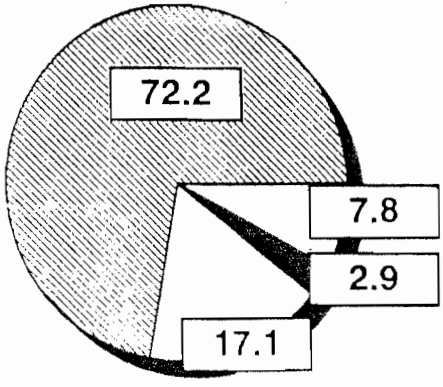

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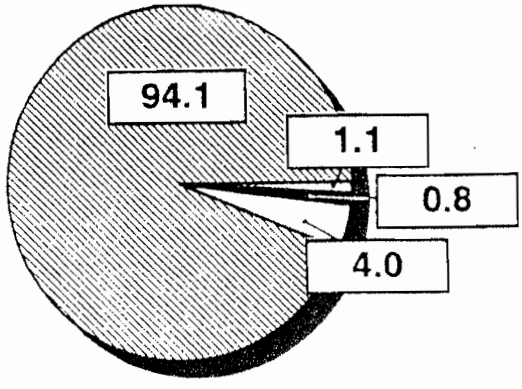

MOST COMMON DRUGS DETECTED IN DRE CASES

Arizona Department of Public Safety, Central Regional Crime Laboratory
Compiled by James A. Bourland

CANNABIS
9-carboxy-11-nor-delta-9-tetrahydrocannabinol, a metabolite of THC (a cannabis constituent)

STIMULANTS
Cocaine
Methylecgonine (a metabolite of cocaine)
Benzoylecgonine (a metabolite of cocaine)
Methamphetamine
Amphetamine
Ephedrine\pseudoephedrine
Norephedrine\norpseudoephedrine
Phentermine
Diethylpropion

NARCOTICS
Morphine
6-monoacetylmorphine (a metabolite of heroin)
Codeine
Methadone
Methadone-primary metabolite
Propoxyphene
Norpropoxyphene (a metabolite of propoxyphene)
Hydrocodone
Oxycodone
Dihydrocodeine

DEPRESSANTS
Oxazepam
Meprobamate
Carisoprodol
Butalbital
Desmethyldiazepam
Temazepam
Amitriptyline
Nortriptyline
Alprazolam
Lorazepam
Imipramine

DEPRESSANTS - Continued
Desipramine
Diazepam
Diphenylhydantoin
Fluoxetine
Phenobarbital
Alphahydroxyalprazolam (a metabolite of alprazolam)
Alphahydroxytriazolam (a metabolite of triazolam)
Secobarbital
Amobarbital

PCP
Phencyclidine

HALLUCINOGENS
Lysergic acid diethylamide
Psylocin
Mescaline

INHALANTS
Toluene

DRUG EVALUATION AND CLASSIFICATION PROGRAM

FREQUENTLY ASKED QUESTIONS ABOUT SCIENTIFIC SUPPORT

1. **In the Los Angeles and Arizona Field Validation Studies, the overall confirmation rate (correspondence between DRE opinions and subsequent toxicology results) was 86-87%. Why can't it be 100%? Is 86% good?**

   86% is excellent.

   The DRE evaluation itself, which involves a complex human subject who may be under the influence of several drugs, is not perfect - no diagnostic screening procedure is. However, it does have a high predictive value (accuracy). This has made possible, for the first time, the routine identification by law enforcement officers of drug impairment caused by drugs other than alcohol.

   Laboratory testing focuses on the most common and significant drugs in DUI-drug cases. Conversely, testing cannot always detect every possible drug which may have caused the symptoms observed by the DRE.

2. **Are laboratory drug tests reliable?**

   Yes, absolutely, if performed by qualified forensic toxicologists who take steps to ensure the quality of the testing program.

3. **Can the laboratory routinely determine impairment due to drugs other than alcohol by quantitating drug levels in blood or urine?**

   No. There are no unequivocal correlations between drug levels and driving impairment on which to base practical DUI-drug enforcement efforts. This is fundamentally different from the case with alcohol, a simple drug for which such correlations are straightforward and indispensable.

   Therefore, the evaluation and prosecution of DUI-drug cases depends upon careful observation and classification of the drug impairment itself, corroborated by laboratory analysis to demonstrate the presence of the drugs.

Arizona's Drug Recognition Program: A Performance Assessment

Eugene V. Adler, B.S., D-ABFT
James A. Bourland, B.S.
Arizona Department Public Safety
Central Regional Crime Laboratory
Phoenix, Arizona

THE DRUG RECOGNITION PROGRAM:

In the field of forensic toxicology, it has been difficult to develop straightforward correlations between drug levels and impairment, as exist for alcohol. A more practical approach to the evaluation and prosecution of DUI-drug cases was developed by Los Angeles Police Department: the drug recognition program. Selected officers receive intensive training enabling them to become certified drug recognition technicians (DRT's). One key program objective, readily measurable, is the training of officers to first, recognize if chemical impairment is present, and second, to determine the class(es) of drugs causing the impairment: cannabis, CNS depressants, CNS stimulants, hallucinogens, phencyclidine, narcotic analgesics, inhalants, and, or course, alcohol.

Laboratory analysis of a biological specimen, urine or blood, provides necessary and sufficient corroboration of impairment by establishing the presence of the drug class(es) believed to be causing impairment. (Alcohol, however, is analyzed by incorporating breath testing in the drug recognition evaluation.) An excellent overview of the program is the Bureau of Justice Assistance Drug Recognition Program Monograph, April 1989.

The efficacy of the drug recognition procedures was demonstrated in two landmark validation studies.[1,2] Despite these convincing demonstrations, and the ongoing success of Los Angeles' program, the widespread acceptance and encouragement of this program by the scientific community has been gradual. As of yet, there have been no evaluations of the performance of the newer drug recognition programs outside California. A drug recognition symposium, presented at the November, 1989, SWAFS meeting, included a tabulation of the results of 185 actual cases in Arizona.[3] Reports from Texas' and Colorado's programs were also presented. Arizona's results have been updated to include 341 cases, which will be examined in this report.

ASSESSMENT OF OVERALL PROGRAM PERFORMANCE:

The correlation between the DRT's opinions and subsequent analytical results is a key measure of program performance. These correlations reflect primarily (but not exclusively) two factors working together: 1) the degree to which DRT's can actually recognize drug impairment, and 2) the ability of the laboratory to provide effective scientific support (identify the drugs). These correlations are only roughly comparable from state to state, due to geographical distributions of drug categories and differences in specimen types analyzed by laboratories. Nevertheless, correlations offer an interpretable and objective assessment of a program's performance; they provide a feedback mechanism for optimizing the scientific support and the DRT's skills. The use of a few well standardized statistics, based on the field validation study[2], should be encouraged:

Overall correlation: The percentage of cases in which at least one drug category predicted by the DRT was corroborated by the laboratory. (See Table 1)

Drug category correlation: The percentage correlation for each individual drug category. (See Table 2)

Arizona's results are given below.

TABLE 1
OVERALL CORRELATION: ARIZONA 341 CASE COMPILATION MARCH 1990
RESULTS OF URINE TESTING VS DRT OPINION

DRT Opinion	# Of Cases	Correlations	% Correlation
Stimulants	89	76	85
Cannabis	53	48	91
Depressant	42	35	83
Narc Analgesics	30	28	93
Dep/N.A.	27	24	89
Stim/N.A.	23	16	70
Cann/Stim	20	17	85
PCP	19	17	89
Stim/Dep	15	13	87
Cann/Dep	10	8	80
Cann/N.A.	5	4	80
Stim/Dep/N.A.	3	3	100
PCP/Dep	1	1	100
Cann/Dep/N.A.	1	1	100
Cann/Stim/PCP	1	1	100
Cann/Dep/PCP	1	1	100
Cann/Stim/N.A./Dep	1	1	100
TOTAL	341	294	86

The overall correlation was 86%, a singular commentary on the DRT's abilities to determine drug impairment due to specific drug categories other than alcohol. The DRT's correctly predicted one (or more) drug categories in 294 of 341. (Actually, this figure only approximates the "true accuracy" of the DRT's, since the laboratory cannot detect and confirm 100% of the drugs present and involved in causing symptoms.)

TABLE 2
DRUG CATEGORY CORRELATIONS
ARIZONA 341 CASE
COMPILATION - MARCH 1990

Drug Category	Times Predicted by DRT	Times Found by Lab	% Correlation
CNS Stimulants	152	114	75
CNS Depressants	101	68	67
Cannabis	92[a]	77	84
Narcotic Analgesics	90	62	69
Phencyclidine	22	19	86
Hallucinogens	—	—	—[b]
Inhalants	—	—	—[b]

[a] Cannabis testing was implemented in the middle of the compilation period. Only cases where cannabis was requested and analyzed were counted. It has become the most commonly detected drug.

[b] Insufficient data

During most of this study, radioimmunoassays (THC, cocaine, methamphetamine, phencyclidine, morphine, barbiturates and benzodiazepines) were utilized as the primary screening method. Confirmations were by gas chromatography-mass spectrometry. Additional "secondary" screening by a gas chromatographic procedure[4] was performed in all cases involving a DRT opinion of narcotic analgesics or CNS depressants. This was necessitated by the "blind spots" of radioimmunoassay for drugs such as synthetic narcotics and carbamates. Earlier in the study, this gas chromatographic method was successfully used as the main screening procedure for all the drug categories except cannabis, hallucinogens (LSD) and inhalants. Even earlier, the Toxi-Lab thin layer screening system was briefly utilized. Our experience suggests that a combination of chromatographic and immunological screening methods provides excellent analytical results for the drug recognition program. Regardless of changes in screening procedures, our overall correlation never ranged outside 81-88%.

Our correlation percentages are repeated and compared to those reported in the Los Angeles field validation study[2] (which utilized blood specimens):

Drug Category	Arizona	LAPD
CNS Stimulants	75	33
CNS Depressants	67	50
Narcotic Analgesics	69	85
Phencyclidine	86	92
Cannabis	84	78
Overall	86	87

The drug recognition program has, above all, attempted to develop and instruct a "systematic, standardized" program which, in principle, should operate with similar characteristics and efficacy in any state (given satisfactory laboratory support). The above comparison suggests that this is happening.

CONCLUSION:

The correlations between DRT's opinions and laboratory results are readily obtained and provide an assessment of the technical performance of a drug recognition program. These statistics can provide a feedback mechanism for monitoring and evaluating the effects of variables on program performance.

The effectiveness of the drug recognition program in Arizona has been demonstrated by the excellent results obtained in a significant number of actual "driving under the influence of drugs" cases.

REFERENCES

1. Bigelow, Bickel, Roache, Liebson & Nowowieski, Identifying Types of Drug Intoxication: Laboratory Evaluation of a Subject Examination Procedure, U. S. DOT, 1984.
2. Compton, Field Evaluation of the Los Angeles Police Department Drug Detection Procedure, U. S. Dept. of Transportation Rep. No. DOT HS 807 012 (1986).
3. E. Adler, Arizona's Drug Recognition Program, Drug Recognition/Evaluation Symposium, SWAFS, Nov., 1989.
4. J. Bourland, The Analysis of Drugs of Abuse in Urine Utilizing Toxi-Lab and GC/FID, SWAFS Journal, 11, 37-49, Nov., 1989.

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