3 - DETECTION AND MEASUREMENT OF DRUGS

INTRODUCTION AND BACKGROUND

In comparison with the alcohol literature, relatively little information is available regarding the true incidence and prevalence of illegal drug use in reckless driving and impaired driving crashes. Breath-alcohol testing has established a scientifically sound basis for the estimation of the prevalence of alcohol use among reckless drivers (Dubowski, 1992). However, the principal problem with estimating "drugged" drivers has been the relative unavailability of drug detection methods / devices to routinely test for illegal drugs. In general, such testing capabilities have been limited to highly specialized forensic laboratories (Joscelyn, Donelson, Jones et al., 1980; Turk, McBay, and Hudson, 1974), and even there, have not used routinely.

Available epidemiological research examining drugs other than alcohol indicates that cannabis is by far the most prevalent drug detected in impaired drivers, fatally injured drivers, and motor vehicle crash victims (Marquet, Delpla, Kerguelen et al., 1998; Morland. J., 2000; Risser, Stichenwirth, Klupp et al., 1998; Verstraete and Puddu, 2000; Walsh, Buchan, and Leaverton, 1997) [(1)]. Other drugs occurring with relatively high frequency are benzodiazepines, cocaine, opiates and the amphetamines (e.g., MDMA, methamphetamine, and d-amphetamine sulfate). While many other drugs are found in injured or killed drivers, these five categories of drugs (i.e., cannabis, benzodiazepines, cocaine, opiates and amphetamines) appear to makeup the majority of the problem as currently understood. While new technology has made available new devices for drug detection, there appear to be a number of practical reasons why we do not have better data on the true prevalence of drugged driving:

- Police are generally not trained to look for drugs other than alcohol.
- Specimen collection requires special equipment and training
- Many state laws limit police to a single test, and the initial test is usually a breath test.
- Most state laws do not provide for additional penalties for combination of alcohol and drugs; therefore if the suspect exceeds the BAC limits there is no incentive to look for drugs.
- Crime labs often cannot provide results in a timely manner to meet court deadlines and to relate test results to time of drug-taking; thus, prosecutors must drop the drug charge, and as a consequence police lose interest in collecting specimens for drug testing.

In an earlier update of this subject, Joscelyn et al. (1980) provided an excellent summary of the state of the art in the detection and quantification of drugs in body fluids. This discussion included detailed descriptions of the general techniques including: thin-layer chromatography (TLC), gas chromatography (GC), gas chromatography-mass spectrometry (GC/MS), Immunoassay (IA), and high-pressure liquid chromatography (HPLC). Over the last 20 years of technological advances much has changed, but it is surprising how much lab practice has remained the same. In this update we will describe new methodological and technological innovations, and summarize some of the current thinking about detecting drugs in drivers.

A variety of specimens can be assayed for drugs, including urine, blood, sweat, saliva, and hair, among others. Each specimen is unique, and each offers different patterns of information about drug use over time illustrates the general relationship between drug effects and the detection periods in various specimens. Each specimen has strengths and weaknesses about the level of information that can be gained about drug use. State laws generally stipulate which specimens may be tested for drugs for criminal justice applications. (See Chapter 6 for a discussion of criminal justice countermeasures.)

Figure 3-1: Drug Detection Periods in Various Specimens

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GENERAL METHODS AND SPECIMENS FOR DRUG SCREENING

Blood Testing

Due to the invasiveness of the collection procedure and the cost of laboratory analysis, routine screening of blood for drugs in drivers has generally been viewed as impractical. Augsburger (2002) recommends a three-step laboratory-analysis process for determining the effect of drugs on driving performance. However, in recent years, forensic laboratories have seen an increasing number of specimens for determination of drugs in blood as a result of "zero tolerance" laws and better trained police officers who have been trained to recognized drivers under the influence of drugs (Moeller and Kraemer, 2002). This is especially true in Europe where several European countries (e.g., Sweden, Germany, and Belgium) have enacted per se laws for driving under the influence of drugs. These laws stipulate urinalysis as the preliminary screening test, and require a blood test if the urine is positive for drugs. Under these laws, any level of prohibited drug detected in the blood is considered evidence of driving under the influence.

In terms of attempting to link drug concentrations to behavioral impairment, blood is probably the specimen of choice. However, forensic toxicologists generally have failed to agree on specific plasma concentrations that could be designated as evidence of impairment (Consensus Development Panel, No Date). The lack of consensus about per se levels of drugs where impairment could be deemed makes it difficult to identify, prosecute or convict drugged drivers in most states.

Oral Fluid (Saliva) Testing

Mixed saliva, which is the most accessible matrix used for the detection of drugs, consists primarily of secretions from the submaxillary (65%), parotid (23%) and sublingual (4%) glands (Kintz, 1999). Detection times for drugs in oral fluids are roughly similar to that in blood, approximately 1-24 hours. (See Kintz for an extensive discussion on detection times by drug.) Oral fluids normally contain the parent drug substance rather than drug metabolites such as are present in urine. Collection of oral fluid is generally considered less invasive than either blood or urine, and could be an excellent matrix to tie recent drug use with behavioral impairment.

Typically the analysis of oral fluids is conducted in a laboratory. There are a number of new rapid immunoassay tests and other analytic methods (e.g., ion scanning, up-converting phosphor technology) that have recently become available and may eventually be suitable for use at the roadside. The current problems with oral fluid testing whether done in the lab or potentially at the roadside include:

- Some drugs inhibit salivary secretions (e.g., MDMA) making collection difficult.
- There is no consensus on cutoff levels for confirmation of drugs in saliva.
- Oral fluid assays for most drugs of abuse are still in the developmental stage, and an accurate/reliable assay for cannabis (the most prevalent drug tested in drivers) is still illusive to diagnostic manufacturers.
- There are no nationally established standard methods for oral fluid drug testing, nor are there any certification programs currently available.

Recent evaluations of available rapid point-of-collection oral fluid tests with drivers indicate the specificity, sensitivity and positive predictive values for drugs of abuse have been poor (Verstraete and Puddu, 2000). Cannabinoids appear to be especially difficult to detect in oral fluids, as very little drug is excreted into the saliva. At this time, none of the currently marketed rapid devices appears to be able to accurately and reliably test for marijuana at cutoff levels that would be helpful in enforcing laws dealing with driving under the influence of drugs (DUID). A number of rapid point-of-collection saliva tests for alcohol are available and have been approved by the Food and Drug Administration (FDA). Some on-site alcohol devices have been included by NHTSA on their conforming products listing as suitable for use as screening test devices in the Department of Transportation (DOT) workplace testing programs (See the NHTSA internet site, http://www.nhtsa.dot.gov/).

Sweat Testing

Drugs are excreted in the sweat mostly in the form of the parent compound. The collection of sweat over time can produce a cumulative record of prior drug use. According to Kintz (1999), since sweat is a cumulative medium, a positive result should not be regarded as "conclusive evidence of driving under the influence (much like urine), but rather as an indication of recent exposure." Sweat testing methods for drugs have recently been approved by the FDA, and include a sweat patch collection device. This patch is designed to collect drugs of abuse from human skin. The patch (from Pharmchem Labs, Menlo Park, California) can be worn for periods up to several weeks, followed by removal, and sent to a laboratory for analysis. This device can measure cumulative drug use over time but would not be suitable for roadside testing due to the lengthy time required to produce a sufficient sample and the requirement for laboratory analysis. Another sweat testing device, Drugwipe (manufactured by Securetec), has been tested on drivers in a number of European evaluations (Verstraete and Puddu, 2000) with mixed results. A major problem with sweat testing is the low concentrations of drugs/analytes detectable in sweat, producing a high variability in detection capability across individuals. Currently, there are no national standards for the detection of drugs in sweat, and there are no certification programs for sweat testing.

Hair Testing

While the technology for assaying hair for drugs of abuse has progressed somewhat over the last 15 years, there remain many unresolved issues: for example, it is still unclear how drugs actually enter the hair. Because hair only grows at a rate of about one-half inch per month, it is not suitable for the detection of recent use. Therefore, it is highly unlikely that hair could serve as a viable specimen in DUID testing.

Urinalysis

The drug testing methodology for urinalysis is well established. With the advent of workplace testing, where large numbers of drug tests are conducted daily in the United States, urinalysis methods have become the standard by which other technologies are being compared. Drugs and drug metabolites are detectable in urine for several days after the drug has been used. This several-day window of detection can overlap with intoxication, impairment, and being "under the influence," and can extend even beyond these states of behavioral impairment. Therefore, while a positive urine test is solid proof of drug use within the last few days, it cannot be used by itself to prove behavioral impairment during a focal event. There are national standards for urine testing in place as well as national certification programs for laboratories performing forensic urine drug testing. A number of states with per se "zero tolerance" laws are currently using urine tests to enforce their laws under which the prosecutor must show only that the driver of the car had prohibited metabolites in his/her system.

DRUG SCREENING TECHNOLOGY

As Joscelyn et al. (1980) pointed out,

In almost all most cases the analyst does not know which - if any -drug(s) are present in a body fluid specimen. Systematic analyses, called drug screens, are required. The analyst can only find those drugs his instruments can detect and identify, at concentrations within the limits of sensitivity of his methods. Because drugs number in the thousands, he will analyze specimens for those drugs of interest whose presence can reasonably be expected. Other drugs will go unnoticed. Costs of extensive drug screening and requirements for special methods to detect certain drugs or groups of drugs limit the range of drugs for which analyses are performed. (see reference)

Joscelyn and associates then outlined the salient characteristics of analytical methods in a table reproduced below as **Table 3-1**

Table 3-1: Characteristics of a Method to Detect and Measure Drugs in Body Fluids[a]

Characteristic	Definition<
Sensitivity	The ability of a method to detect the presence of drugs or classes of drugs.
Speed	The time from start to end of the analytical process using a method.
Simplicity	Usually related to the speed of a method, the requirement for little training for technicians and often associated with highly automated

	procedures.
Reliability	The dependability of a method. Its ability to reproduce accurate and precise results day-to-day.
Accuarcy	The degree to which a method produces results consistent with actual values.
Precision	The consistency with which a method reproduces results when measuring the same sample.
Economy/Cost	Economic considerations include time of analysis, number of samples processed in a single run, degree of training required of personnel, price of obtaining (and maintaining) instrumentation, price of chemicals and other reagents used in analytical procedure, and overhead of analytical laboratory or other facility.
Safety	The degree to which personnel using a procedure are exposed to risk of injury or long-term toxicity associated with chemicals required by a method.
[a]After Joscelyn, Donelson, Jones et al. (1980)	

In 1980, TLC and GC were the state of the art and the most commonly used screening procedures. In 2002, most laboratories use immunoassay screening technology with GC/MS confirmation. Immunoassays are sensitive, selective, rapid and large numbers of samples can be processed simultaneously. GC/MS techniques (and sometimes tandem MS/MS) are used to separate drugs, specifically identify with the drugs's "fingerprint," and quantify the amount of the drug in the specimen. Over the last 20 years the cost of using these technologies have become affordable, and most laboratories now have the equipment, the assays and the expertise to identify the most commonly used drugs.

Over the last decade, diagnostic manufacturers have developed new immunoassays that are more specific and more sensitive to target drugs. Laboratory techniques evolving from high-volume workplace drug testing research and development have been integrated into most forensic laboratories, thus improving accuracy, reliability, and efficiency. Clearly, there have been significant improvements in laboratory assays for drugs of abuse. However, the reliance solely on the forensic laboratory to assay all specimens in all cases creates a limiting factor for prosecuting DUID cases, because there are simply not enough forensic resources currently available.

Some of the most recent advances in drug testing have been the developments in the rapid point-of-collection testing products. There are at least 50 rapid point-of-collection-testing (POCT) immunoassay devices currently available on the commercial market. While most of the currently available devices are designed to test urine and can be used at a police station, some of these new devices are designed to test oral fluids and could eventually be used at the roadside.

These POCT devices could be used by police officers to routinely screen impaired driving suspects for illegal drug use and obtain drug test results immediately, as they currently do with alcohol tests. Having immediate screening results would permit the officer to confront the driver

with the drug test result, and make an initial charge. Confirmation testing in a toxicology lab would generally be required. However, if the driver admits to drug use, additional laboratory testing may not be required for prosecution.

A number of these devices have been used successfully by police to test drivers for recent drug use (Buchan, Walsh, and Leaverton, 1998; Hersch, Crouch, and Cook, 2000; Verstraete and Puddu, 2000). In a series of studies funded by the National Institute on Drug Abuse, Walsh et al. (1997) demonstrated the feasibility of having police officers use urine testing devices to test DUI suspects for recent use of drugs of abuse.

NHTSA has also recently completed a project in which police officers in Houston, Texas and Long Island, New York evaluated five on-site urine testkits (Triage®, TesTcup5®, AccuSign®, Rapid Drug Screen®, and TesTstik®) with DUI suspects. The officers participating in this project were certified "Drug Recognition Experts" (DRE) who had been trained in the NHTSA-approved "Drug Recognition and Classification Program." Overall results indicated a 36% positive rate for illegal drugs (mostly cannabis, cocaine, and MDMA). GC/MS confirmation of all on-site test positives (and some negatives) indicated that the kits performed well, and the DRE officers participating in the study "favored the use of on-site devices in the enforcement of impaired driving laws" (Hersch, Crouch, and Cook, 2000).

The European Union has recently funded a major drugs/driving study called "ROSITA" (Roadside Testing and Assessment) evaluating rapid urine, sweat, and saliva POCT drug testing devices in eight European nations (Verstraete and Puddu, 2000). The principal conclusions of that two-year study were: (1) that roadside drug testing is sorely needed, and (2) that the need is so great that in some countries, police officers would rather use an imperfect device/method than wait for a more suitable one. The device evaluations in the ROSITA project indicated that, while police favored the oral fluids as the preferred matrix, "the present generation of on-site oral fluid tests are insufficiently sensitive and/or specific to give reliable results for most classes of drugs." Sweat testing devices performed poorly. While rapid urine tests are clearly not perfect, they may be suitable for a rapid preliminary screening test. In the ROSITA device evaluations, several urine drug tests satisfied the criteria for accuracy, sensitivity, and specificity when compared with a reference method, although none scored highly for all drug categories.

THE FUTURE IN DETECTING DRUGS IN DRIVERS

Having an immediate drug test result obtained from a POCT-type test would permit the officer to confront the driver with the drug test result and make the DUID charge. At this time, however, only the urine based POCT technology appears to provide the accuracy and reliability required, and use of this technology is not yet widespread. With the advent of more "zero tolerance" laws, we may see the use of this technology grow. The development of sweat and oral fluid technology holds great promise for the field, but the most recent evaluations indicate that it may be a few more years before the desired sensitivity, specificity, accuracy, and reliability are attained.

SUMMARY AND CONCLUSIONS

For more than twenty years, medical and traffic safety researchers have been aware that the prevalence of illegal drug use among impaired drivers, especially those in motor vehicle crashes, is not negligible (Lundberg, White, and Hoffman, 1979; Williams, Peat, Crouch et al., 1985). However, the lack of forensic resources and technology to routinely and rapidly test for drugs has limited efforts to accurately document the scope of the problem or enforce DUID laws. There have been significant technological advances in drug testing technology during the last five years, but generally this new technology has not been integrated into DUID enforcement or crash investigations.

In 1980, Joscelyn and associates found that most state and local agency forensic laboratories were overworked and underfunded, and that most the drug analyses were limited to fatally injured drivers, or to those impaired driving cases where the BAC level was below the illegal limit.

In the year 2002 not much has changed. State and local forensic laboratories continue to lack sufficient resources to routinely test for drugs. As the problem of drugged driving appears to be on the increase, there is a real need for federal and state agencies concerned with traffic safety to provide additional support to enhance forensic capabilities. However, the forensic community also needs to take a look at the new POCT technology and attempt to integrate this technology with laboratory testing into a more efficient and cost-effective system. Until there is adequate capability for rapid, cost-effective drug testing, the majority of drugged drivers will not be identified or prosecuted.

[1]Epidemiologic literature on drugs other than alcohol is reviewed in Chapter 5.

Back to Top Table of Contents Continue to 4 - Experimental Research