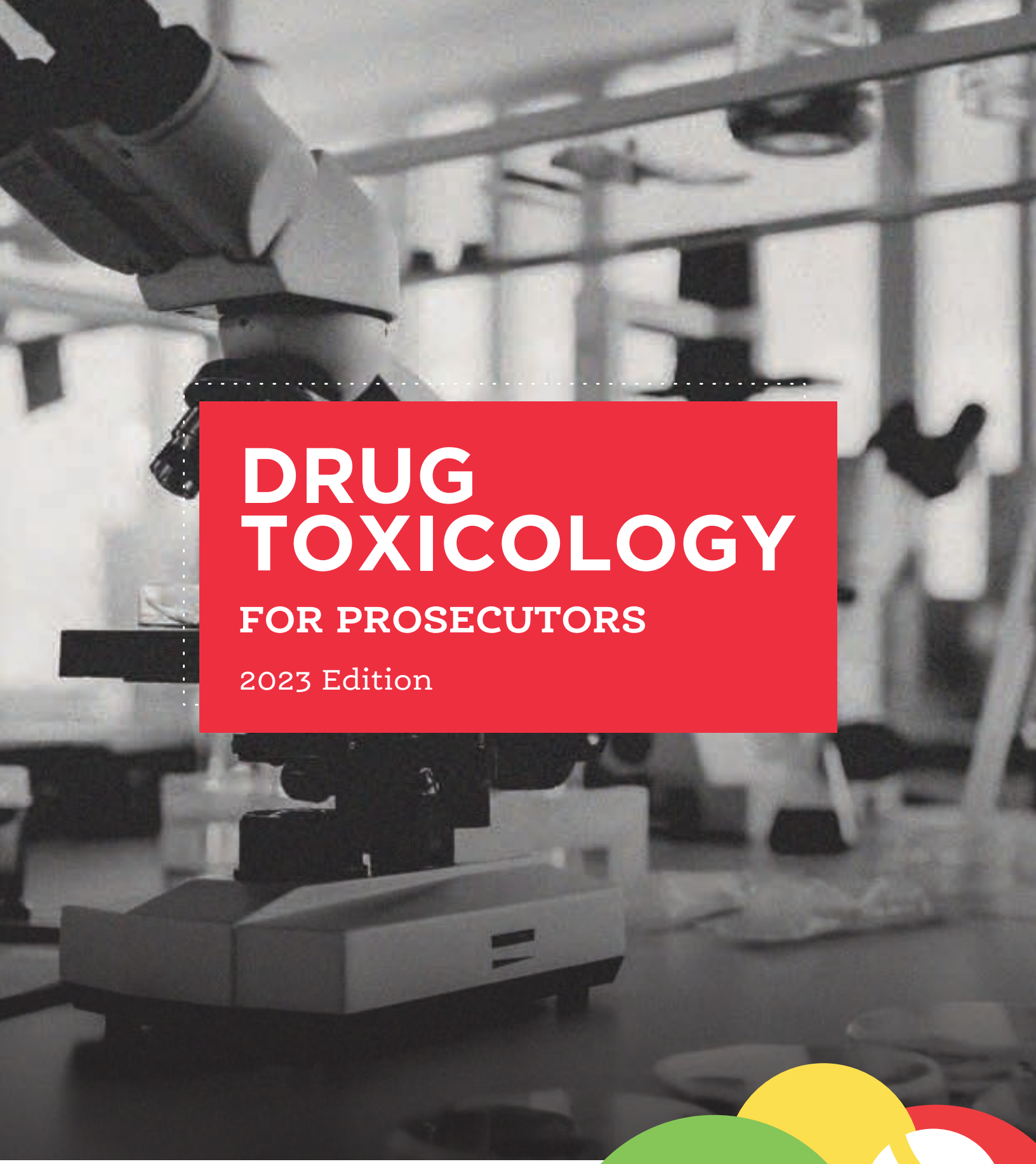

DRUG TOXICOLOGY

FOR PROSECUTORS

2023 Edition

National District Attorneys Association

NTLC NATIONAL TRAFFIC LAW CENTER NDAA

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National Alliance to Stop Impaired Driving
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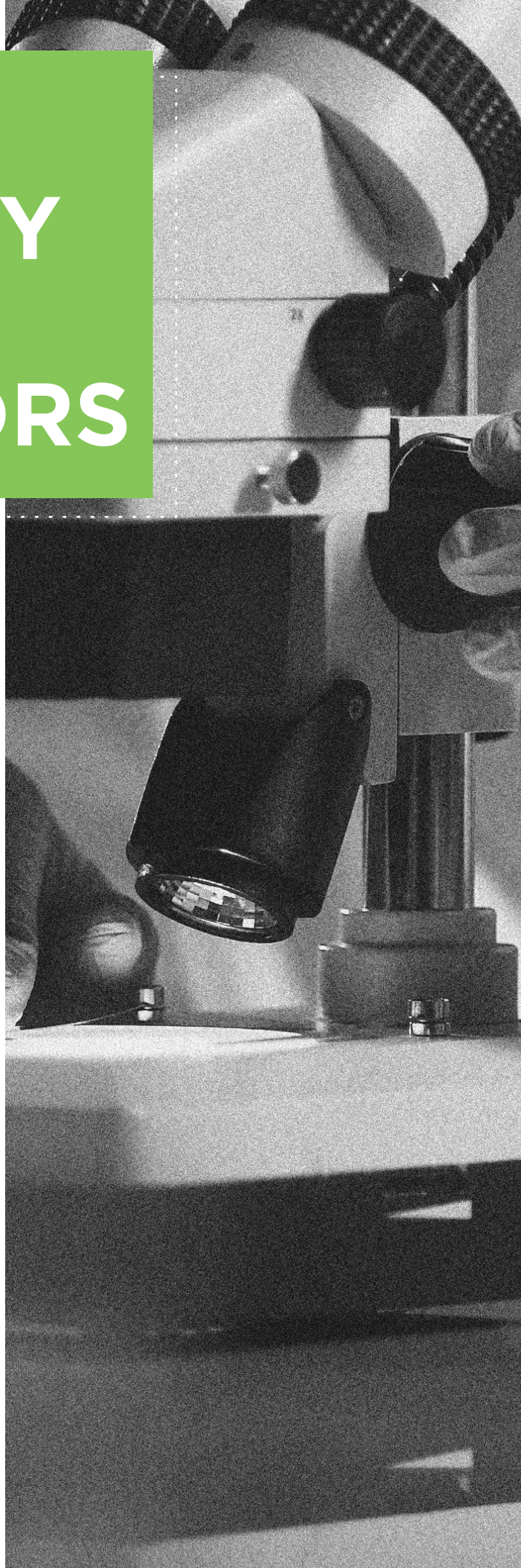
DRUG TOXICOLOGY FOR PROSECUTORS



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Preface To The 2023 Edition

The National Traffic Law Center's Monograph Series has been relied upon by prosecutors for almost two decades. Covering a wide range of topics, from crash reconstruction to the admissibility of horizontal gaze nystagmus evidence, these monographs are a valuable resource to the legal community. When *Drug Toxicology for Prosecutors* was first published in 2004, it attempted to provide prosecutors with a basic understanding of drug effects, impairment, and approaches to testing.

Although the risks and dangers associated with driving under the influence of drugs (DUID) remain, there have been numerous developments that have impacted this area. Emerging drug threats and the proliferation of novel psychoactive substances (NPS) have significantly altered the impaired driving landscape. Recommendations regarding toxicological testing for impaired driving investigations had not been published at the time of the first monograph. These were first developed in 2007[1] and have been updated three times as of this report.[2] These recommendations were the basis for a minimum standard for the analytical scope and sensitivity of toxicological testing in blood for impaired driving investigations.[3]

Although epidemiological data and drug prevalence in DUID is still dominated by many of the same impairing substances (*i.e.*, cannabinoids, central nervous system depressants and stimulants), operational laboratories that provide testing, and experts that provide testimonial support face many new challenges. NPS and new synthetic drugs are considerably less studied and shifts in drug use due to the opioid epidemic, decriminalization of cannabinoids, and other factors, place greater demands on the forensic toxicology community.

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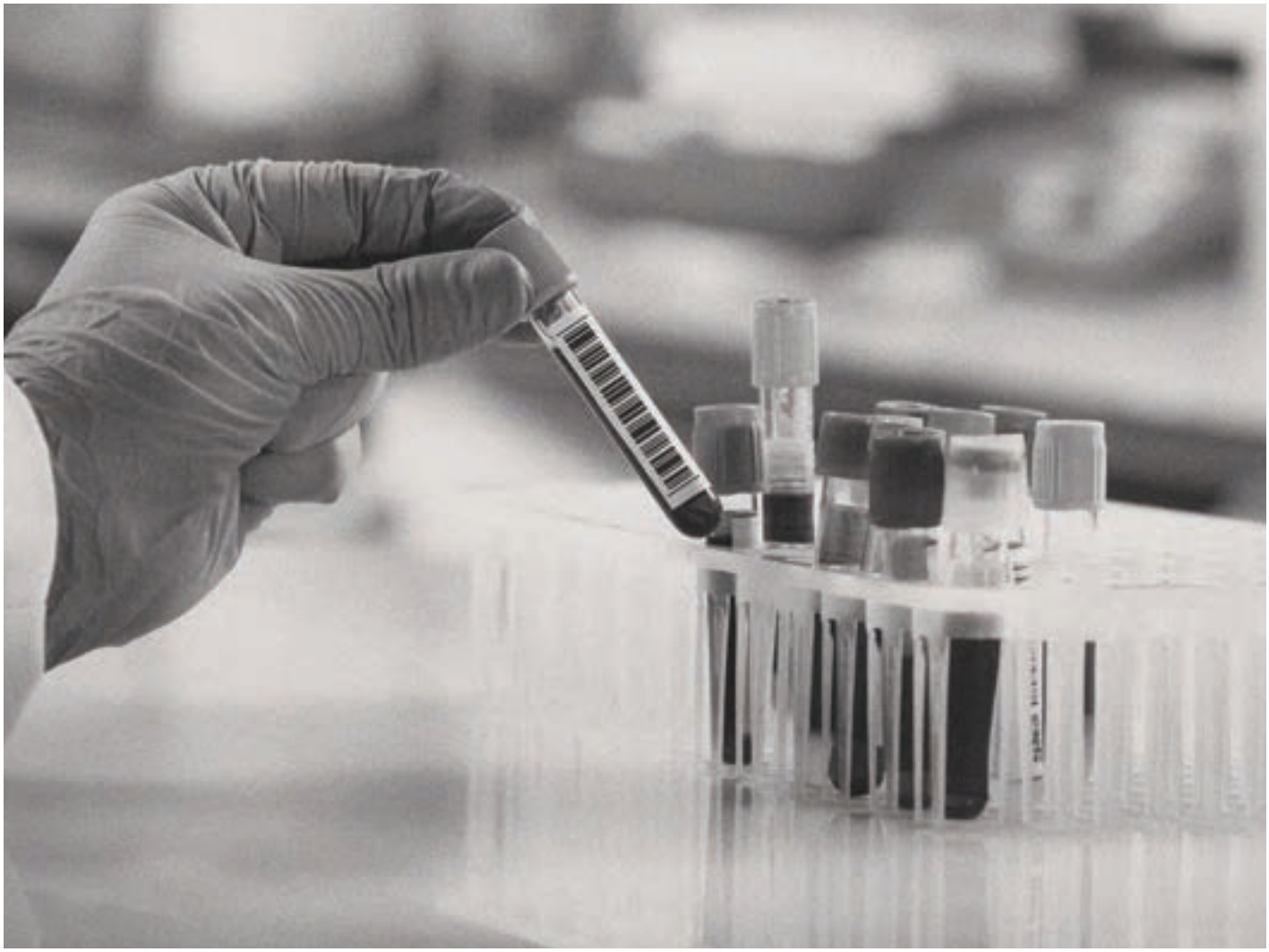
[1] Farrell, L. J., Kerrigan, S., & Logan, B. K. (2007). Recommendations for toxicological investigation of drug impaired driving. *Journal of forensic sciences*, 52(5), 1214–1218. https://doi.org/10.1111/j.1556-4029.2007.00516.x

[2] D'Orazio, A. L., Mohr, A., Chan-Hosokawa, A., Harper, C., Huestis, M. A., Limoges, J. F., Miles, A. K., Scarneo, C. E., Kerrigan, S., Liddicoat, L. J., Scott, K. S., & Logan, B. K. (2021). Recommendations for Toxicological Investigation of Drug-Impaired Driving and Motor Vehicle Fatalities-2021 Update. *Journal of analytical toxicology*, 45(6), 529–536. https://doi.org/10.1093/jat/bkab064

[3] ANSI/ASB Standard 120. Standard for the Analytical Scope and Sensitivity of Forensic Toxicological Testing of Blood in Impaired Driving Investigations, First Edition (2021). https://www.aafs.org/asb-standard/standard-analytical-scope-and-sensitivity-forensic-toxicological-testing-blood

This new edition presents a clear and concise update on important issues from a prosecutorial standpoint. Drug prevalence, pharmacology, specimen selection and analytical testing are all discussed. Expert testimony is also addressed, including the limitations and challenges associated with the interpretation of results. It is without doubt that this new and updated monograph will continue to serve as a trusted resource to prosecutors that are engaged in this field.

Sarah Kerrigan, PhD.
Sam Houston State University



Acknowledgements

This second edition of *Drug Toxicology for Prosecutors* monograph would not have been possible without the support and funding of the Foundation for Advancing Alcohol Responsibility (Responsibility.org), the enthusiastic encouragement of Responsibility.org's Government Relations and Traffic Safety Vice President and Director of the National Alliance to Stop Impaired Driving **Darrin T. Grondel**, and the dedicated efforts of the following professionals at the National Traffic Law Center:

Joanne E. Thomka, Director
M. Kimberly Brown, Senior Attorney
Erin Inman, Staff Attorney

The second edition built upon the foundation of the version of this monograph originally published in 2004. It was the result of the dedicated work of **Dr. Sarah Kerrigan**, Chair, Department of Forensic Science and Director, Institute for Forensic Research, Training and Innovation, Sam Houston State University.[4] This updated edition was also the result of a collaborative process that drew on the knowledge, expertise, and patience of many dedicated traffic safety professionals,[5] including the following:

Amy Miles, Director of Forensic Toxicology, Wisconsin State Laboratory of Hygiene, University of Wisconsin School of Medicine and Public Health, and National Resource Toxicologist
Jennifer Limoges, Associate Director of Forensic Science / Toxicology, New York State Police Forensic Investigation Center
Kyle Clark, National Drug Evaluation and Classification Program, International Association of Chiefs of Police
Emily Thompson, Assistant Attorney General, State of Wisconsin Department of Justice and Wisconsin Traffic Safety Resource Prosecutor

[4] At the time she worked on the original version of this monograph, Dr. Kerrigan worked as Former Bureau Chief, New Mexico Department of Health, Scientific Laboratory Division, Toxicology Bureau.
[5] All the authors and reviewers participated voluntarily and none received any remuneration from the Foundation for Advancing Alcohol Responsibility, the National District Attorneys Association, or the National Traffic Law Center.

National Traffic Law Center

The National District Attorneys Association's National Traffic Law Center (NTLC) is a resource designed to benefit prosecutors, law enforcement, judges, and criminal justice professionals. The mission of the NTLC is to improve the quality of justice in traffic safety adjudications by increasing the awareness of highway safety issues through the compilation, creation and dissemination of legal and technical information and byproviding training and reference services.

When prosecutors deal with challenges to the use of breath test instruments, blood tests, horizontal gaze nystagmus, crash reconstruction, and other evidence, the NTLC can assist with technical and case law research. Likewise, when faced with inquiries from traffic safety professionals about getting impaired drivers off the road, the NTLC can provide research concerning the effectiveness of administrative license revocation, ignition interlock systems, sobriety checkpoints and much more.

The NTLC has a clearinghouse of resources including case law, research studies, training materials, trial documents, and a directory of expert professionals who work in the fields of crash reconstruction, toxicology, drug recognition, and many others. The information catalogued by the NTLC covers a wide range of topics with emphasis on impaired driving and vehicular homicide issues.

NTLC is a program of the National District Attorneys Association (NDAA). NDAA's mission is to be the voice of America's prosecutors and to support their efforts to protect the rights and safety of the people.

For additional information, contact NDAA or NTLC, 1400 Crystal Drive, Suite 330, Arlington, Virginia 22202, (phone) 703-549-9222, (fax) 703-836-3195, or visit www.ndaa.org.

Introduction

Impaired driving is illegal, extremely dangerous, and has life-altering consequences. Impairment is impairment, regardless of the substance causing the impairment. It does not matter what type of drug a person has taken, whether it was legal, or even if that drug is properly prescribed or purchased over-the-counter: the risk of death or serious injury is the same. Prosecutors are frequently challenged by drug-impaired driving cases due to the complexity of the scientific evidence involved. New and/or inexperienced prosecutors often face a highly-trained and specialized defense bar that is well-versed in impaired driving case law and who use well-established tactics to defend their clients. A drug-impaired driving prosecutor must understand the science, law enforcement detection training, and terminology related to drugs—knowledge and skills that were never taught in law school. To successfully prosecute a drug-impaired driving case, a prosecutor will need to effectively examine expert witnesses, both for the State and the defense. This requires proper preparation in order to be effective. A drug-impaired driving prosecutor will also need to develop skills to properly present these cases to jurors, including those who may possibly be sympathetic to an impaired driving defendant.

To help prosecutors prepare for the difficulties of dealing with toxicological evidence in drug-impaired driving cases, the National Traffic Law Center (NTLC) previously published *Drug Toxicology for Prosecutors*. Published in 2004 thanks to a contribution from a charitable foundation, this monograph covered topics such as alcohol vs. drug-related driving, how drugs can impair driving, common drug effects, and preparing the toxicologist for testimony. This monograph has been available for free and may be downloaded from the National District Attorneys Association website at www.ndaa.org.

Although many of the topics in the 2004 monograph are still relevant by today's standards, this version updates the information making it more relevant to today's drug-impaired driver. This updated version of *Drug Toxicology for Prosecutors* was developed to assist prosecutors and law enforcement in understanding and preparing for the unique challenges often faced in drug-impaired driving cases. It will also assist prosecutors in effectively preparing and presenting these complex cases to a successful conclusion.

Drug-Impaired Driving Challenges

All states have laws establishing a prohibited alcohol concentration (PAC) at which the law deems an individual is guilty of an impaired driving offense. Generally, in this country, this "per se" concentration is 0.08 g/100 mL, although it is lower in some instances.[6] Alcohol impairment, as it pertains to driving, is a well-studied area. However, driving under the influence of drugs (DUID) is not. According to the National Highway Traffic Safety Administration (NHTSA), impaired driving continues to increase. From 2019 to 2020 there was a 14.3 percent increase in fatalities for crashes where alcohol was considered a factor.[7] Of further concern, 56 percent of drivers involved in a crash, between October and December 2020, including fatal crashes, were positive for one or more drugs.[8]

Overall, alcohol-impaired driving rates continue to climb, and the number of drug-impaired drivers matches this trend. It is important to note, however, that not all forensic toxicology laboratories provide the same scope of testing for drugs. Where one laboratory may be able to test for thousands of illicit, prescription, over-the-counter (OTC) and novel psychoactive substances (NPS), another laboratory may not have the same capability. Also, many laboratories limit testing due to a lack of resources. All of this means the number of drug-impaired drivers documented today is not an accurate accounting of the total DUID problem. Due to the limitations in testing, and challenges in drug reporting, the amount of drug-impaired driving is being underrepresented.

Much is understood about the effects of alcohol on human performance and driving; those cases tend to be less complicated for a toxicologist to interpret. Impaired driving cases involving drugs are much more difficult to test and interpret. DUID casework can include illicit drugs, prescription drugs, OTC medications, and NPS. Each of those groups poses its own unique complexities for the prosecutor and toxicologist. In order to convey the effects of drugs and how they relate to driving performance to a jury, the toxicologist must have specific education and training, and the prosecutor must have a general understanding of drug toxicology.

[6] In Utah, for instance, the per se concentration is 0.05 g/100 mL. The Federal Motor Carrier Safety Administration regulations adopt a concentration of 0.04 g/100 mL for commercial motor vehicle drivers. In many states, the concentration is 0.02 g/100 mL or less for drivers who are under the age of 21.

[7] National Highway Traffic Safety Administration (NHTSA) (2020). Traffic Safety Facts, Alcohol-Impaired Driving. DOT HS 813 294. Washington, D.C.: U.S. Department of Transportation.

[8] National Highway Traffic Safety Administration (NHTSA) (2021). Traffic Safety Facts, Research Note, Update to Special Reports on Traffic Safety During the COVID-19 Public Health Emergency: Fourth Quarter Data. DOT HS 813 135. Washington, D.C.: U.S. Department of Transportation.

While much research has been conducted on a variety of drugs and their effects on human performance, drug impairment is not "one size fits all." Each individual will have their own unique reaction to any given drug, or combination of drugs. A toxicology report on its own does not prove impairment. Each case must be examined separately, and the results of the toxicology testing must be used in conjunction with the observations of the law enforcement officer and any other information pertinent to the case.

Several states in which cannabis is decriminalized, as well as others, have created per se limits for the drug.[9] Much debate has occurred between various policy makers and scientists regarding the relevance of a per se limit in any law prohibiting drug consumption while operating a motor vehicle. There is no current scientific evidence which supports a clear dose or concentration which then leads to impairment from any drug,[10] let alone cannabis.

Several considerations must be made when analyzing a drug-impaired driving case. When looking specifically at cannabis, dose, route of administration, timing from consumption to sample collection, and individual tolerance must all be considered. As with all DUID cases, information from law enforcement (e.g., any observed impairment, driving performance, etc.) is needed alongside the toxicology result in order to interpret a cannabis case. While cannabis per se limits provide a threshold for a legal standard, they do not provide any information regarding the individual's effects or impairment from the drug nor do they correlate automatically to impairment.

Prescription and OTC drug cases pose another unique challenge when interpreting toxicology results. As of 2022, per se limits for prescription and OTC medications do not exist in any state, with good reason. As previously mentioned with cannabis casework, it is impossible to determine any individual's exact dose, and subsequent concentration in blood, of a medication that could cause impairment. It is also important to keep in mind that not all medications will cause an impairing effect. The therapeutic range of a drug may be used when interpreting results, however, this

[9] *See*, for example, the National Alliance to Stop Impaired Driving's website for a map of State Laws, allowing the user to click on a state to view statistics about and laws relating to impaired driving or visit NASID's website directly at https://nasid.org/.

[10] Blandino A, Cotroneo R, Tambuzzi S, Di Candia D, Genovese U, Zoja R. "Driving under the influence of drugs: Correlation between blood psychoactive drug concentrations and cognitive impairment. A narrative review taking into account forensic issues." Forensic Sci. Int. Synerg. 2022 Mar 21; 4:100224.

range is meant to determine if the concentration is within an appropriate dosing range. The therapeutic range is not an indication or range of impairment. Observations of impairment are instrumental in this type of case. The concentration listed on a toxicology report alone will not provide any background information or insight into the individual's response to the drug's effects.

Another important consideration in DUID casework is polysubstance use. Many DUID cases involve a driver who has used more than one impairing substance. Co-administration of several substances has the potential to increase the impairment threshold and change the effects of any of the drugs consumed. Even drugs which may not be considered impairing can cause a change in the metabolism of any co-administered substance. Interpretation of any toxicology result must be made in conjunction with information collected by law enforcement.

Novel psychoactive substances (NPS) present yet another challenge in DUID casework. While there are therapeutic and toxic ranges established for prescription and OTC medications, nothing of the sort exists for NPS. The NPS trends change quite frequently; this is what makes them difficult for toxicology laboratories to detect. If a laboratory possesses the instrumentation required to detect NPS, many will only provide the identification of the NPS, not the concentration. This is largely due to the lack of resources to develop and validate quantitative methods, and the challenges and costs associated with obtaining reference standards. Since there is a lack of established "therapeutic" or toxic ranges for NPS, the number is not always particularly useful.

Drug-impaired driving cases are challenging for prosecutors and law enforcement, but through communication and education, those challenges can be overcome. It is important for a prosecutor to know their laboratory, understand its scope of testing, and know the capabilities of the expert witness. Conversely, it is important for the toxicologist to know the case circumstances and any challenges or limitations to the interpretation.

Pharmacology

Pharmacology can be divided into two main components; *pharmacokinetics*, meaning what the body does to the drug, and *pharmacodynamics*, meaning what the drug does to the body.

Pharmacokinetics deals with how the drug gets into, around, and out of the body. The key steps are absorption, distribution, metabolism, and elimination (ADME). This is a dynamic process in which multiple steps can occur at the same time or overlap.

Absorption is the process of getting the drug into the bloodstream. The rate of absorption depends on numerous factors including the route of administration, drug concentration, chemical properties of the drug, and blood flow. The most common routes of administration for drugs are:

- Oral—swallowed
- Inhalation—smoked, huffed
- Injection—intravenous, intramuscular, subcutaneous
- Transdermal (skin) absorption—patch
- Mucosal (nose, mouth) absorption—snorted, nasal spray, sublingual (tongue), candy
- Rectal—suppository

The intravenous route is typically the fastest way to administer a drug, because the full dose of the drug goes directly into the bloodstream. Inhaling drugs is also a very effective route of administration. Due to the large blood flow around the lungs, drugs are absorbed into the bloodstream quickly. Conversely, taking a drug as a pill is one of the slowest routes of administration. The drug must travel through the entire gastrointestinal tract before being absorbed into the bloodstream primarily through the small intestines, and some of the drug will be lost during the process (*i.e.*, first pass metabolism).

Distribution is the process of transporting the drug throughout the body; it involves the movement of the drug from the blood into the tissues. The volume of distribution of a drug is the extent to which the drug is distributed in the body. Highly water-soluble drugs, like alcohol (ethanol), have a low volume of distribution because they remain mostly in the body water. Highly lipophilic (fat-soluble) drugs, like THC, have a relatively high volume of distribution and quickly distribute into fatty tissues like the

brain. An individual's volume of distribution for a drug can vary depending on factors such as age, gender, disease state, and body composition.

Metabolism is the process of changing the drug to help the body eliminate it. A metabolite is a compound that is formed in the body during this breakdown process. Metabolites can be active (*i.e.*, exert a pharmacological effect) or inactive. To complicate matters, some metabolites can also be classified independently as a drug. For example, methamphetamine is metabolized to amphetamine, but amphetamine is also a drug that may be prescribed on its own.

Elimination is the process of removing the drug from the body, either in its original form or as metabolites. The most common routes of elimination are through the liver and kidneys. Most drugs exhibit first order kinetics for their elimination, meaning a fraction of the drug is eliminated per unit time. This is often characterized by the drug's half-life, or the amount of time it takes for half of the drug to be eliminated. Alcohol is unique in that it exhibits zero order kinetics for elimination. This means that a constant amount of the drug is eliminated over time. Because there is a linear relationship between concentration and time, experts can perform calculations to estimate alcohol concentrations at an earlier time (*i.e.*, retrograde extrapolation). These types of calculations are not reliable for other drugs.

While pharmacokinetics is the study of the bodily absorption, distribution, metabolism and elimination of drugs, ***pharmacodynamics*** is the study of the effects of the drugs on the body. Every drug has both intended and unintended effects. Intended effects may include analgesia (*i.e.*, pain relief), euphoria, mood stabilization, lessening of anxiety, sleep, and other effects specific to the drug. Some intended effects may negatively impact an individual's driving ability. Unintended side effects are typically the impairment observations that law enforcement records. For example, the unintended side effects of a drug in the benzodiazepine category that may affect driving ability are drowsiness, confusion, disorientation, dizziness, and difficulty concentrating. The dose of the drug, and its subsequent response, are what causes the impairment seen in DUID casework. A drug's duration of effect may be known and documented; however, this will be different for each individual.

Therapeutic ranges are established for prescription and OTC medications. These can be useful when determining if a concentration of a drug is generally considered therapeutic or toxic. It is important to remember that therapeutic ranges have no direct correlation to impairment. A drug may be impairing even if the concentration in the blood is within the therapeutic range. Illicit drugs and NPS do not have established clinical therapeutic ranges. As an individual develops a tolerance to a drug over time, this will allow them to consume a higher dose of the drug in order to obtain the intended effect. In response to the drug tolerance, the individual may be able to withstand concentrations that would typically be considered toxic or even fatal to a less experienced user.

Hysteresis is the relationship between the concentration of a drug and its effect over time, but it is neither simple nor direct. As blood concentrations decrease, the effects of the drug are often in opposition from when the drug was first consumed. There is a lag time before the observed effects of a drug follow the changes in the blood concentration, which is another reason why DUID cases can be difficult to interpret. As discussed in the pharmacokinetics section, most drugs exhibit first order kinetics, while alcohol exhibits zero order kinetics. The differences in the kinetic process between alcohol and drugs lends to the complexity of DUID interpretation. The Mellanby effect[11] is a phenomenon where an individual's perceived effects of alcohol at the same BAC differ whether they are in the rising and declining BAC phases. In examining drug hysteresis, the central nervous system (CNS) stimulant category provides an example of this cycle. During the initial phase, an individual may experience stimulation, euphoria, and restlessness. As time progresses and the drug concentration is declining, the same drug level may cause the person to exhibit agitation, anxiety, confusion, and exhaustion. This is referred to as clockwise hysteresis. For example, a user of cocaine, which is a CNS stimulant, will often feel euphoric and highly stimulated when they first consume the drug. However, as the drug is eliminated, the person may exhibit quite opposite effects in that they might feel sluggish and slow.

While clockwise hysteresis is the decrease of a drug's effect in relation to its concentration over time, counterclockwise hysteresis is the process in which the effect of the drug will increase over time as the drug concentration decreases. THC, for example, exhibits counterclockwise hysteresis. The effects from the consumption of THC will

11 For additional information on the Mellanby effect, see Norman, Miriam, "The Mellanby Effect, Why Impaired Individuals Should Not Be Allowed to Be Behind the Wheel," National Traffic Law Center, *Between the Lines*, Vol. 27, Issue 1, January 2019.

often occur after the peak blood concentration is reached. The user will continue to experience effects as the THC concentration decreases.

All of this leads to difficulties in DUID case interpretation. When considering factors such as tolerance and individual pharmacokinetics and pharmacodynamics, there is no direct relationship between a dose of a drug and the expected effects for any one individual. A toxicologist will not be able to determine where an individual may be in a hysteresis loop using a blood concentration. When interpreting an impaired driving case, many factors must be considered, including the observations of law enforcement.

The selection of the specimen to be collected in a DUID case may be dictated by local and/or state laws. Blood and urine are the most frequent specimens collected for testing for drugs. Oral fluid is quickly becoming a promising matrix; however, many laboratories do not currently have validated methods to perform the testing. The detection of parent drug versus metabolites will vary based on the matrix selected.

Table 1—Advantages and Disadvantages of Specimen Type

Blood	
Advantages	**Disadvantages**
Indication of the drug that is circulating in the brain at the time of collection	Detection time is limited and the parent drug may dissipate prior to sample collection
Drug concentration (quantitation) may assist in the interpretation of the DUID case	Drug stability in blood is not the same for all drugs, some loss of certain drugs may occur between collection and testing
Detection time of drugs is relatively short providing information regarding recency of use	Only specific individuals are allowed to collect blood, this is driven by statutory regulations
	If consent is not provided by suspect, blood typically requires a search warrant

Urine	
Advantages	**Disadvantages**
Collection is easy, medical training not required	Limited interpretation of testing results, drugs detected merely indicate a history of use and not recency
Many drugs and their metabolites have a longer detection time	Adulteration is possible
	Same gender observed collection required
	Excessive fluid intake may cause greater elimination and the pH of the matrix may affect drug elimination

Oral Fluid	
Advantages	**Disadvantages**
Collection is easy, and may be done roadside (*e.g.*, proximate to the time of driving or crash)	Limited interpretation of quantitative testing results, more research is required in this area
Roadside devices are available for non-evidential testing	Not all drugs partition easily into oral fluid (*e.g.*, benzodiazepines)
Detection times similar to blood, provides recency of drug use	Possibility of the contribution of drug to the resulting concentration from oral/inhaled drug use

Impairment and the concentration of any drug in the human body are fleeting. Observations of impairment and sample collection must be done as quickly as possible proximate to the traffic stop or crash. As time progresses, the body will continue to metabolize any drug on board (*i.e.*, in a person's body), causing the potential loss of the toxicology drug evidence. While the body metabolizes the drug, the impairment will begin to lessen or change, making it difficult to make any observations that will provide the impairment evidence. One example of this is cannabis. THC has a very short half-life, resulting in rapid metabolism and excretion of the drug. The time from

the traffic stop or crash to the time of the blood draw can be significant and may be enough to eliminate the majority of the THC in the body.[12] The concentration of THC at the time of the blood draw is not reflective of the concentration in the blood at the time of the traffic stop or crash, and toxicologists cannot back calculate to estimate what that concentration might have been at the time of driving.

The toxicologist will not be able to determine in any case whether an individual was impaired by the drugs detected. Using the drug concentration in the blood will provide some information relevant to the therapeutic range and potential expected effects. The presence of a drug in blood or oral fluid indicates relatively recent use. The presence of any drug will allow for some interpretation by the toxicologist; however, the level of interpretation will vary depending on the specimen type.

[12] Desrosiers NA, Himes SK, Scheidweiler KB, Concheiro-Guisan M, Gorelick DA, Huestis MA. Phase I and II cannabinoid disposition in blood and plasma of occasional and frequent smokers following controlled smoked cannabis. Clin. Chem. 2014 Apr;60(4):631-43.

Drugs and Driving

Driving is a very complex task. Drivers are continuously and simultaneously receiving information from a variety of sources, processing that information, deciding what actions to take, and then executing those actions. Drugs can affect all of these important factors in a variety of ways.

- Driving requires *divided attention*, and drugs can impair a person's ability to multitask. An impaired driver may be so focused on trying to stay within his lane that he does not notice the light has turned red and he was supposed to stop.
- *Vision* is one of the primary sources of information for drivers. Some drugs can cause blurred vision, halos of light, or flashes of light. They can also cause pupil dilation or constriction, which affect a driver's reaction to light and visual information.
- Drugs can impact one's *perception of time and distance*. This can make it challenging to assess how long it takes to stop or the ability to maintain an appropriate following distance.
- Drugs may negatively impact *judgement*; this can impact a driver's ability to react appropriately. They may cause a person to exhibit increased risk-taking behaviors, or to not properly recognize a danger.
- *Psychomotor control* is critical to driving; braking, accelerating, steering, and other routine driving tasks require physical control. Poor coordination and control can lead to unsafe actions such as the inability to maintain proper speed and distance, not braking hard enough or braking too hard, weaving, and overcorrecting.

The table on the next page provides a summary of some of the general effects—and potential driving-specific effects—of various drug classes most commonly found in drug-impaired driving cases.[13] Note that this is not an all-inclusive list, and not all individuals will experience all the potential effects.

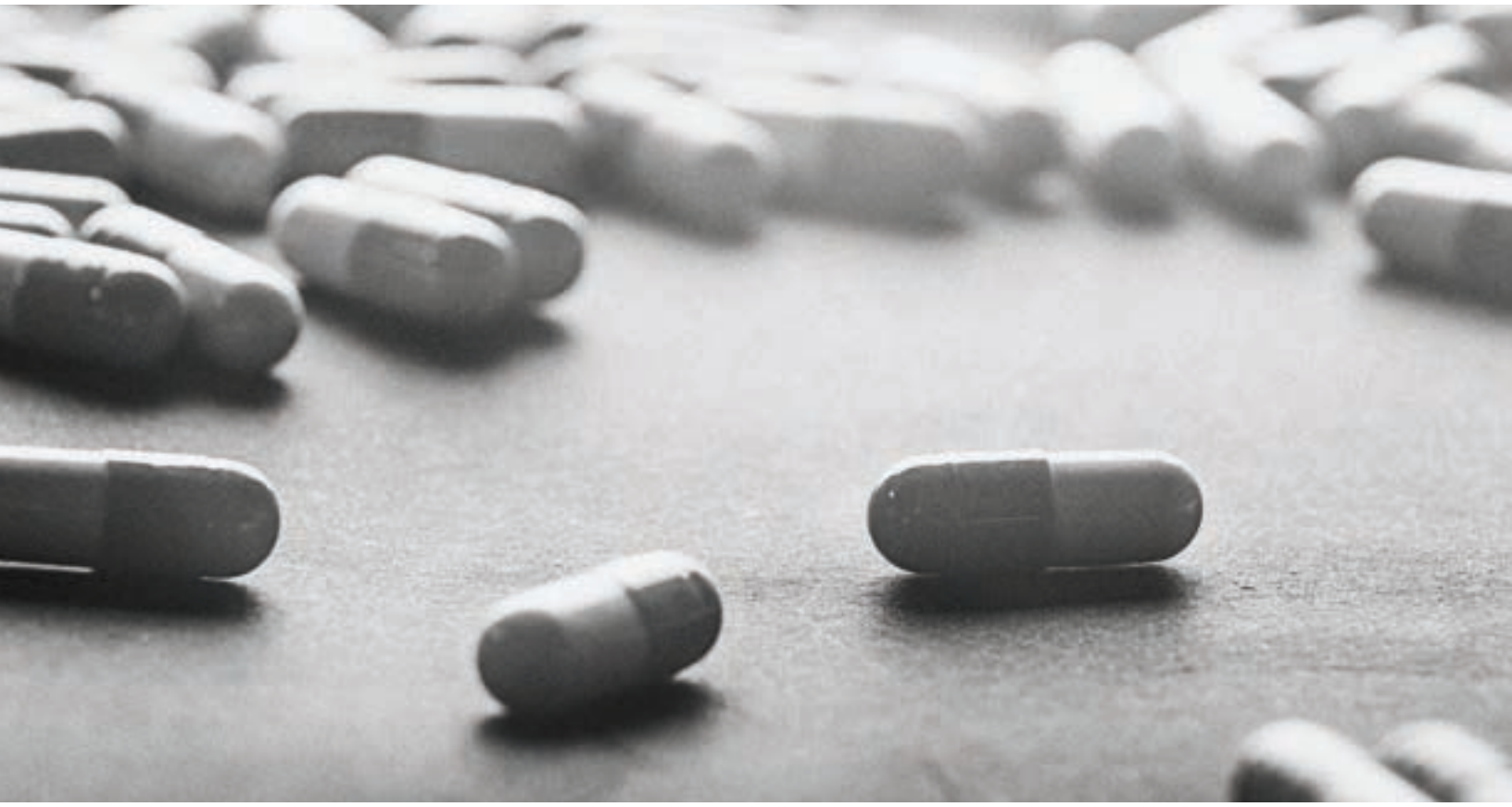
13 All categories of drugs cause impairment that is dangerous for driving activity. This monograph is covering only the most common drug categories found in DUID cases.

Table 2—Drug Classes, General Effects, and Driving Effects

Drug Class	Examples	General Effects	Driving Effects
CNS Depressants	Alprazolam Clonazepam Diazepam Lorazepam Carisoprodol Zolpidem Diphenhydramine Alcohol	Reduced anxiety Sedation Memory impairment Lower blood pressure HGN (and VGN) Blurred vision Incoordination Respiratory depression	Impaired divided attention Poor coordination Delayed reaction time Inability to maintain lane position Slow driving Reduced vigilance Confusion, disorientation Drowsiness
Narcotic Analgesics	Heroin Morphine Codeine Hydrocodone/ Hydromorphone Oxycodone/ Oxymorphone Fentanyl Tramadol Methadone Buprenorphine	Pain relief Nausea, constipation Lower BP, pulse, temperature Droopy eyelids Pupil constriction Dry mouth Sedation, dizziness Euphoria or dysphoria Slow reflexes Mental clouding	Slow driving Poor vehicle control, weaving Poor coordination Slow response to stimuli Delayed reactions Difficulty following instructions Falling asleep
CNS Stimulants	Cocaine Methamphetamine Amphetamine MDMA MDA	“Rush” Phase Euphoria Increased heart rate, BP, temperature Dry mouth Dilated pupils Twitching Rapid speech Insomnia “Crash” Phase Dysphoria Normal heart rate Normal to small pupils Restlessness, agitation, paranoia, delusions	“Rush” Phase Impaired divided attention Increased risk taking Speeding, aggressive driving Erratic, inattentive driving Inability to maintain lane Disorientation “Crash” Phase Impaired divided attention Fatigue Falling asleep at the wheel Lane drifting

Table 2—Drug Classes, General Effects, and Driving Effects

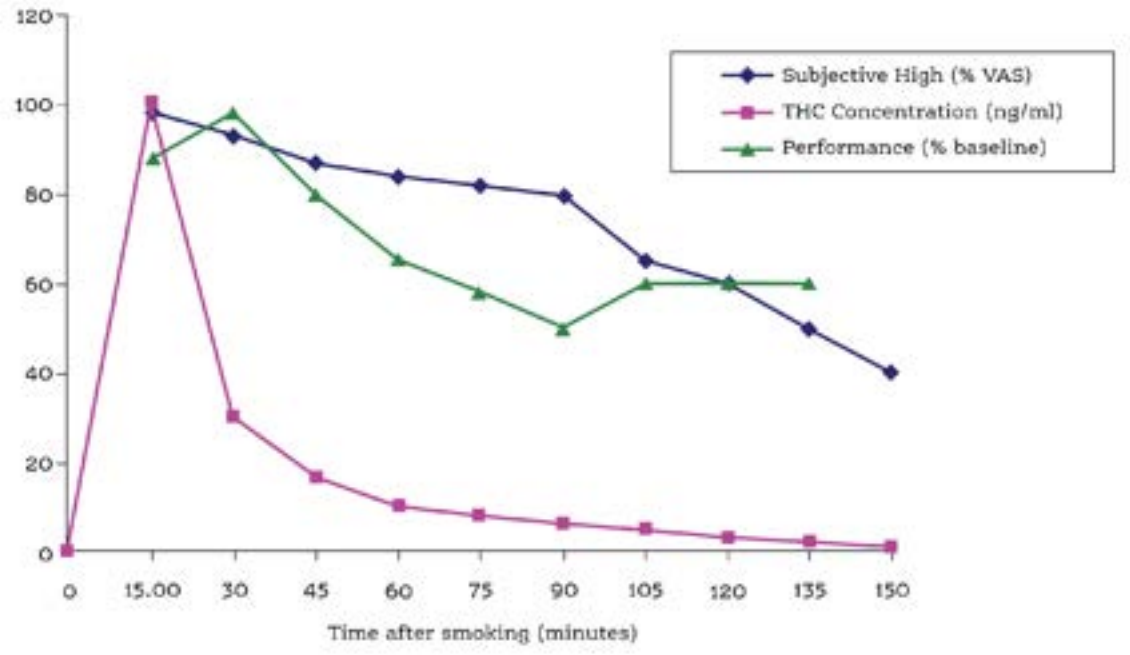
Drug Class	Examples	General Effects	Driving Effects
CNS Stimulants (cont'd.)		Aggression, violence Itching, picking, scratching Sleepiness with sudden starts	
Cannabis	Delta-9-tetrahydo-cannabinol (THC)	Euphoria Relaxation Confusion, sedation Altered perception Lack of concentration Memory impairment Reddening of the eyes Increased appetite Dry mouth Dizziness Increased heart rate	Increased reaction time Poor coordination Impaired time/distance estimation Weaving Reduced vigilance Short term memory and attention deficits Delayed decision making Increased risk taking



Cannabis and Driving[14]

Cannabis is one of the most common drugs found in impaired drivers,[15] but it can be very challenging to understand and interpret. Delta-9-tetrahydocannabinol (THC) is the primary psychoactive component in cannabis. When smoked, THC is rapidly absorbed into the bloodstream, then rapidly distributed to the tissues, including the brain. Peak THC levels in blood are reached within minutes, and can even occur before the end of smoking.[16] As the THC is absorbed into the tissues, the levels in the blood rapidly decline, and can go below detection limits within minutes to hours. Because of this, the peak effects of THC do not correlate well to the peak concentration in blood. The subjective feeling of drug effects, as well as performance decrements, last long after the THC levels in the blood have declined. This is evidenced by the figure below.

Figure 1 - Time Course of Standardized THC Concentration in Plasma, Performance Deficit and Subjective High after Smoking Marijuana (Adapted from Berghaus et al. 1998, Sticht and Käferstein 1998 and Robbe 1994)



NHTSA Marijuana Impaired Driving Report to Congress DOT HS 812440 July 2017

[14] For additional information on cannabis-impaired driving, see NTLC's Investigation and Prosecution of Cannabis-Impaired Driving Cases, July 2020.

[15] National Institute on Drug Abuse. 2019, December 31. Drugged Driving DrugFacts. Retrieved from https://nida.nih.gov/publications/drugfacts/drugged-driving on August 5, 2022. See also D'Orazio AL, Mohr ALA, Chan-Hosokawa A, Harper C, Huestis MA, Limoges JF, Miles AK, Scarneo CE, Kerrigan S, Liddicoat LJ, Scott KS, Logan BK. Recommendations for Toxicological Investigation of Drug-Impaired Driving and Motor Vehicle Fatalities-2021 Update. J. Anal. Toxicol. 2021 Jul 10;45(6):529-536.

[16] Huestis MA, Sampson AH, Holicky BJ, Henningfield JE, Cone EJ. Characterization of the absorption phase of marijuana smoking. Clin. Pharmacol. Ther. 1992 Jul;52(1):31-41.

When cannabis is consumed orally, such as in edible products like brownies or gummies, the pharmacokinetics are significantly different than from when it is smoked. The time it takes to reach the peak concentration is longer for oral administration, and the peak concentration obtained is lower.[17] In addition, there is usually more of the active metabolite 11-nor-9-hydroxy-THC formed. With orally consumed cannabis, the effects of the THC occur later. This delayed effect sometimes leads to users taking additional servings of an edible product, which then unintentionally results in much stronger effects than desired and potentially negative outcomes.

Frequent, chronic cannabis users can develop some tolerance to the drug. They need to attain higher THC levels to achieve the same effects compared to occasional users. Studies showed that performance decrements at similar THC levels were more significant in occasional users than heavy users. However, the chronic users still performed worse than baseline.[18]

Cannabis is often consumed in conjunction with alcohol. It has been reported with this combination that subjects experienced the cannabis effects more quickly, reported more episodes of euphoria, and reached higher THC levels.[19] Weaving, lane departure, maintaining following distance, and reaction time were more significantly impacted with the combination, as compared to alcohol or THC alone.[20]

[17] Vandrey R, Herrmann ES, Mitchell JM, Bigelow GE, Flegel R, LoDico C, Cone EJ. Pharmacokinetic Profile of Oral Cannabis in Humans: Blood and Oral Fluid Disposition and Relation to Pharmacodynamic Outcomes. J. Anal. Toxicol. 2017 Mar 1;41(2):83-99.
[18] Desrosiers NA, Ramaekers JG, Chauchard E, Gorelick DA, Huestis MA. Smoked cannabis' psychomotor and neurocognitive effects in occasional and frequent smokers. J. Anal. Toxicol. 2015 May;39(4):251-61.
[19] Lukas, Scott & Orozco, Sara. (2001). Ethanol increases plasma Δ9-tetrahydrocannabinol (THC) levels and subjective effects after marihuana smoking in human volunteers. Drug and alcohol dependence. 64. 143-9.
[20] Ramaekers JG, Robbe HW, O'Hanlon JF. Marijuana, alcohol and actual driving performance. Hum. Psychopharmacol. 2000 Oct;15(7):551-558.

Common Drugs in DUID

The effects of a drug will vary based on its category or classification (as reflected in the Table 2—Drug Classes, General Effects, and Driving Effects). Drugs are commonly divided into the following categories: cannabis, depressants, stimulants, narcotic analgesics, hallucinogens, inhalants, and dissociative anesthetics.[21] How a drug is classified generally depends on its chemical composition and its effects on certain receptors in the brain.

For example, narcotic analgesics tend to be opioid drugs such as fentanyl, morphine, oxycodone, and heroin. These drugs agonize (*i.e.*, activate) specific receptors in the brain, the mu, kappa, and delta. The binding affinity to the receptors will vary between the opioids within this classification. Due to the variance in binding affinity, the effects of each drug within this class will remain similar; however, the extent of the effects will be different for each drug. Common effects produced by a narcotic analgesic are sedation, euphoria, and respiratory depression. Observations may also include constricted pupils and the individual being "on the nod," meaning a back-and-forth state between consciousness and semi-consciousness. Drugs within this classification are known to cause physical dependence. During the withdrawal phase, the narcotic analgesic users will exhibit signs of impairment in opposition to those observed during the active phase. Agitation, restlessness and paranoia are all common signs of narcotic analgesic withdrawal.

Cannabis is typically the most common drug detected in DUID casework.[22] The two main endocannabinoid receptors are called CB1 and CB2. These endocannabinoid receptors play a role in functions such as mood, sleep, memory, and appetite. The active component of cannabis, THC, will bind to the CB1 and CB2 receptors and produce a variety of effects such as hallucinations and CNS depression. Route of administration (*e.g.*, vaping, edibles, smoking, etc.) will have an effect on an individual's reaction to THC. When considering the hysteresis loop of THC, the route of administration, and the time gap that often occurs between consumption and the

[21] These are the categories of drugs identified in the Drug Evaluation and Classification Program. All categories of drugs cause impairment that is dangerous for driving activity. This monograph is covering only the most common drug categories found in drug-impaired driving cases.

[22] National Institute on Drug Abuse. 2019, December 31. Drugged Driving DrugFacts. Retrieved from https://nida.nih.gov/publications/drugfacts/drugged-driving on August 5, 2022. *See also* D'Orazio AL, Mohr ALA, Chan-Hosokawa A, Harper C, Huestis MA, Limoges JF, Miles AK, Scarneo CE, Kerrigan S, Liddicoat LJ, Scott KS, Logan BK. Recommendations for Toxicological Investigation of Drug-Impaired Driving and Motor Vehicle Fatalities-2021 Update. *J Anal Toxicol.* 2021 Jul 10;45(6):529-536.

traffic stop (or crash), the outward effects of THC will vary. THC may cause delayed cognition and memory, anxiety, increased appetite, and an overall lack of coordination and balance. Physical observations include lack of convergence, eyelid tremors, pupil dilation and increased pulse and blood pressure.

Central Nervous System (CNS) depressants are quite common in DUID cases and are often drugs found in the benzodiazepine classification.[23] Other drugs within the CNS depressant category are sedatives, hypnotics, and tranquilizers. Much like narcotic analgesics, CNS depressants cause a reaction in the brain in a very specific way. Neurotransmitter levels are reduced which causes depression in arousal and stimulation in various areas of the brain. Common drugs within the benzodiazepine classification include alprazolam, lorazepam, clonazepam and diazepam. While those drugs listed are the common parent compound, some may also have metabolites which are pharmacologically active and can cause impairing effects. Sleep aids, such as zolpidem, are problematic in the context of DUID. The therapeutic use for these drugs is sleep and sedation. Consuming any sleep aid prior to operation of a motor vehicle will result in impairment of an individual's driving ability. Over-the-counter medications such as diphenhydramine and doxylamine are also in the CNS depressant category. Common effects of CNS depressants include slurred speech, poor coordination, confusion, and difficulty remembering simple instructions. Observations may include horizontal gaze nystagmus, overall poor performance on the Standardized Field Sobriety Tests (SFSTs), lack of convergence, and low pulse and blood pressure. Often the effects of a CNS depressant are compared to those of alcohol, as it is also in the depressant category.

CNS stimulants are also common in DUID cases.[24] Drugs in the stimulant category may be used to treat attention-deficit/hyperactivity disorder, migraines, narcolepsy, or excessive fatigue and sleepiness. Examples of prescription drugs in this category are amphetamine, methylphenidate, atomoxetine, and modafinil. Common illicit CNS stimulants include methamphetamine and its active metabolite, amphetamine, as well as cocaine.[25] Also included in this category are the less common synthetic cathinones such as methylone, butylone, and mephedrone. Stimulants achieve their effect by

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23 *See* D'Orazio AL, Mohr ALA, Chan-Hosokawa A, Harper C, Huestis MA, Limoges JF, Miles AK, Scarneo CE, Kerrigan S, Liddicoat LJ, Scott KS, Logan BK. Recommendations for Toxicological Investigation of Drug-Impaired Driving and Motor Vehicle Fatalities-2021 Update. *J. Anal. Toxicol.* 2021 Jul 10;45(6):529-536.
24 *Id.*
25 *Id.*

increasing the levels of dopamine, serotonin, and norepinephrine in the brain. The clockwise hysteresis loop of the CNS stimulants means an individual will appear and feel stimulated during the active phase of the drug; however, during the declining phase the effects will be similar to a CNS depressant. Common effects of CNS stimulants during the active phase are increased pulse and blood pressure, aggression, agitation, mood swings, and dilated pupils. When the drug concentration is in the declining phase, the effects may change to sleepiness, headache, and nausea.

Novel Psychoactive Substances (NPS) and drug analogs are constantly evolving, and while these types of drugs are not seen as often as cannabis, CNS depressants, and narcotic analgesics, they play a distinct role in DUID casework. Using the drug's chemical composition and binding affinity to particular receptors, one can predict the expected effects of these drugs. The fentanyl analogs, for example, may not be controlled, prescribed, or well researched. However, the substances in this group have a chemical structure that is similar to fentanyl. This means they will have similar effects on the common opioid receptors. The same conclusion may be made with novel benzodiazepines, which may not be scheduled or controlled. The structure of the compound will reveal the commonality to already known benzodiazepines and provide information on the drug's potential effects on the brain. Since the NPSs are constantly changing, they are difficult for laboratories to detect and not all are able to do so.

It is important to remember that many individuals consume more than one drug in DUID casework. The complexity of not only a single drug but polysubstance use is one of the many reasons why toxicology results are difficult to interpret. A prosecutor's early consultation with the toxicologist will provide valuable information regarding the scope of testing performed and any limitations of results interpretation.

Toxicology Testing & Laboratory Practices

Testing Methodology

A forensic toxicology laboratory applies common analytical chemistry techniques to a specimen taken from a suspected drug-impaired driver. The types of testing include screening methods and confirmation/quantitation methods. Screening tests are considered presumptive and are used to further direct testing activities; the most common are immunoassay and chromatographic techniques. Common immunoassay screening methods include enzyme linked immunosorbent assay (ELISA), enzyme multiplied immunoassay technique (EMIT), and fluorescence polarization immunoassay (FPIA). The technique is based on antigen-antibody reactions. If a drug (antigen) is present in the sample, it will bind to the corresponding antibody in the test, and the amount of binding can be measured. The binding is not specific to just one drug; compounds with similar chemical structures can all have some degree of binding. This concept is referred to as cross reactivity. For example, an immunoassay kit designed for opiates may be targeted to react with morphine, but it will also react with codeine and hydrocodone. It is important for a laboratory to properly validate immunoassay screening methods to ensure they adequately cover the scope of drugs they need to detect. Chromatographic screening involves using either gas chromatography (GC) or liquid chromatography (LC) with various detectors. A laboratory may use targeted screening methods that specifically look for a set number of drugs, or it may use a comprehensive screen that is designed to detect a wider variety of potential compounds.

Regardless of the screening technique, those results will direct further testing toward various confirmation methods. These tests typically use GC or LC, combined with mass spectrometry (MS). The drugs of interest need to be extracted, or isolated, from the biological sample (i.*e*., matrix) first. Then that extract is tested on the analytical instrument. The chromatography portion of the analysis separates the different drugs, metabolites, and other chemicals so that each can be individually identified. The sample travels through a column with a chemical coating and the compounds will interact with that coating based on their size and chemical properties. If a drug has a lot of interaction with the column, it will take a long time to come out the other end and reach the detector; if a drug has little interaction with the column, it will travel

faster. The amount of time it takes a compound to travel through the column is referred to as the retention time, and this is very reproducible under set conditions. GC and LC work similarly to separate the components: GC does this in the gaseous phase, and LC does it in the liquid phase. Once the compounds are separated, they enter the detector, which is the mass spectrometer. There are a variety of mass spectral techniques that can be applied, but they all provide information about the chemical structure of the drug. The retention time and the mass spectral information are compared to certified, known standards and used to definitively identify the drug or metabolite.

Quantitation, or quantification, refers to measuring the amount of drug in the sample. This is often combined with the confirmation testing method. A set of known concentration samples (*i.e.*, calibrators) are analyzed and used to establish a calibration curve. The response of unknown samples is then compared to that calibration curve to provide the amount of compound detected. Drug concentrations in impaired driving cases are often reported in nanograms per milliliter, or ng/mL units.

Quantitative results may be reported with measurement uncertainty. This refers to the expected dispersion around a measurement; it is not the same as an error rate. Any measurement is simply an estimate of the true value and will have an associated uncertainty, depending on the sensitivity of the measurement process. In forensic toxicology, it is important to provide this information so that results can be appropriately compared to other testing results or to per se limits.

Checks and Balances

A toxicology laboratory performs a wide variety of activities to ensure the accuracy and reliability of the reported results. The methods used for testing must be properly validated. *Validation* provides objective evidence that a method is fit for its intended use, and it identifies the method's limitations. Before using any method for testing casework samples, the laboratory must conduct experiments related to bias, precision, interference, limits of detection, and limits of quantitation, among other criteria.

Each time a test method is used, the laboratory will include *quality control* (QC) practices. These are essential to demonstrating that the validated method continues to be fit for its intended purpose. QC provides concurrent objective evidence to support the reliability of an individual test result, as well as to monitor a test method's performance over time. Tests will typically include *negative controls* to demonstrate that the method can properly identify negative samples and to establish that there is no contamination or interference. There will also be a variety of *positive controls* that contain drugs of interest to ensure that positive samples can be accurately identified. In a quantitation method, these controls will be prepared independently of the calibrators to ensure there is agreement in the concentrations measured. For certain types of analyses, there is even an *internal standard* added to each sample to ensure that each individual sample performs properly throughout the testing process.

A laboratory should also have established measurement *traceability* for its methods. This is typically accomplished through the use of certified reference materials and calibrated equipment.

Additional quality assurance program components include accreditation, proficiency testing, and certification. *Accreditation* requires a laboratory to adhere to industry standards and be regularly inspected to check conformance to those requirements. It also ensures a process of continuous improvement. *Proficiency testing* provides an external check on the laboratory's testing capabilities. This can provide confidence in the results being provided, as well as identify areas for improvement. *Certification* of personnel provides an independent recognition of a person's specialized knowledge, skills, and abilities related to a particular area of expertise. This typically involves passing an initial examination to become certified and is then maintained by providing evidence of continued professional development.

Testing Protocols

Toxicology laboratories have different capabilities and testing protocols. It is important for the users of toxicology services to understand this. The scope of testing relates to what drugs the laboratory can test for; the sensitivity refers to how low of a concentration of a drug the laboratory can detect. There are published standards and recommendations for a laboratory to follow to ensure its testing is appropriate for impaired driving investigations. Some may employ stop testing protocols, meaning if the alcohol result is above a certain level, further drug testing is not conducted. There are also a small number of laboratories that may only do screening tests and report those results, even though this practice is discouraged.[26] A law enforcement officer or a prosecutor may need to make a special request for the laboratory to test for specific drugs, or to have presumptive results confirmed. The prosecutor's communication with the toxicologist is key to ensuring they get the services needed, and understand the reports received.

Sources of Information on Drug Effects

Toxicologists must rely on a variety of sources of information to assess the potential for a drug to cause impairment.

- *Empirical data* are extensively published and provide information on the pharmacology, effects, and duration of action for many drugs. However, they are not specific to driving, the individual, or the situation.
- *Epidemiological studies* investigate drug use and driving behaviors in a given population. They can be useful to identify trends, and often have a large data set.
- *Case reports* are published reports of impaired driver cases. These involve real-world doses of drugs but have no controls.
- *Laboratory studies* involve drug administration and performance of psychophysical tests, *e.g.*, reaction time or divided attention tests. These allow researchers to isolate the task in a safe and controlled environment. The limitations are that real-world levels of most drugs cannot be used, and the tasks may not directly relate to driving performance.

[26] *See* National Safety Council, Position/Policy Statement, Confirmation of Positive Drug Screen Results in Transportation Safety Cases, September 2008.

- *Simulator studies* build off other laboratory-based studies but can relate the tasks more directly to driving, but still be performed in a safe and controlled environment. There are limitations with drug dose, and they do not truly mirror driving since there are no consequences or real dangers.
- *Driving studies* evaluate actual driving performance after drug administration. These studies are limited by the dose of drug administered and are not common due to the complexities and risks associated.

There are strengths and limitations to each type of data but, taken in combination, they can provide important information related to drug use and performance. The effects of drugs are dependent on dose, route of administration, time since dosing, acute versus chronic use, poly-drug use, experience level of the user, and tolerance. No single study will provide the full picture. For example, in one study, single low doses of amphetamine relieved some symptoms of fatigue in healthy sleep-deprived individuals.[27] The results of that study do not reflect the potential impacts of amphetamine abuse on driving.

[27] Caldwell JA, Caldwell JL. An in-flight investigation of the efficacy of dextroamphetamine for sustaining helicopter pilot performance. Aviat. Space Environ. Med. 1997 Dec;68(12):1073-80.

Toxicology Expert Testimony

Regardless of whether alcohol, drugs, or both are involved, there are three phases of detection for an impaired driving case. Law enforcement observations of the vehicle in motion, personal contact with the driver, and pre-arrest screening (*i.e.*, performance of SFSTs and, possibly, a DRE evaluation) all provide important pieces of information in a drug-impaired driving case. In cases involving a crash, law enforcement observations may be fewer or non-existent, particularly if medical intervention occurs quickly. All information gathered during the impaired driving investigation, including statements made by the driver, observable signs of impairment, and evidence of drug use, will aid in building the DUID case. The complete picture of a DUID case involves all the pieces of the puzzle. The toxicology report adds to the strength of a case, but it cannot stand on its own to prove a drug-impaired driving case.

Still, toxicology testing and expert testimony are key elements in an impaired driving investigation and prosecution. The testing performed must be relevant, reliable, and based on sound scientific principles. The subsequent expert opinion and testimony must be unbiased and supported by the scientific literature.

It is extremely important for a prosecutor handling a drug-impaired driving case to meet with the toxicologist pre-trial. The prosecutor needs to understand how the laboratory work is done, and who (*e.g.*, which lab personnel) is needed if expert witness testimony is required. Most toxicology laboratories employ a workflow that involves multiple scientists being involved in each case. Different people may receive the evidence, perform the screening tests, perform the confirmatory tests, interpret the data, and write the reports. A toxicologist typically handles hundreds of samples a year and, consequently, does not have an independent recollection of analyzing a particular subject's blood sample. A toxicologist relies on standard operating procedures, contemporaneous notes, quality control, and other data to discuss the testing that was conducted. A common practice in forensic laboratories is to have a Certifying Scientist (or similarly named individual) who reviews all the individual testing results and data and makes the reporting decisions. This person is the one who signs the report and can provide the associated expert testimony.

Since most toxicology laboratories have multiple people involved in the testing process, this can sometimes lead to Confrontation Clause challenges. The Confrontation Clause of the Sixth Amendment to the United States Constitution provides that "in all criminal prosecutions, the accused shall enjoy the right...to be confronted with the witnesses against him." In *Melendez-Diaz v. Massachusetts*,[28] the United States Supreme Court stated "...we do not hold, and it is not the case, that anyone whose testimony may be relevant in establishing the chain of custody, authenticity of the sample, or accuracy of the testing device, must appear in person as part of the prosecution's case. While...[i]t is the obligation of the prosecution to establish the chain of custody,...this does not mean that everyone who laid hands on the evidence must be called." Many states have additional case law addressing Confrontation Clause matters.[29]

Pretrial discussions are also essential for the prosecutor to understand the level of testimony the toxicologist may offer at trial, as well as any limitations or potential challenges to the toxicology result. The prosecutor needs to understand the specific limitations in the toxicologist's testimony and together they should review any questions or challenges to the toxicology. It is critical for a prosecutor to understand the types of testimony a toxicologist may offer at trial and what is outside of their scope. A toxicologist's testimony may be necessary to establish basic facts such as the work performed in the laboratory, scientific principles for the testing performed, information regarding the laboratory's quality assurance program, and chain of custody. They can provide the court with the test results, including the accuracy and reliability of the testing and any limitations. Any toxicologist will be able to provide this basic level of testimony.

The next level would be for the toxicologist to provide broader expert testimony to educate the court on the effects of the drug or drugs involved in the case, including how they relate to driving, based on the scientific literature. This testimony, in combination with other evidence such as driving behavior, SFSTs, the drug recognition

[28] *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 311, n. 1, 129 S.Ct. 2527 (2009) (internal quotation omitted).
[29] For additional information on this and other constitutional law issues in impaired driving cases, see the National Traffic Law Center's monograph, Constitutional Law Issues in Impaired Driving Cases (January 2021).

expert's (DRE) drug influence evaluation,[30] and witness statements can help establish the case for drug-impaired driving prosecutions. In some circumstances, it may be necessary to identify a forensic toxicology expert to review all the specifics of the case, including witness statements, video, and DRE evaluation, and who is qualified to render an opinion as to whether the individual was impaired. This level of testimony is time consuming and expensive and is, therefore, much less common in public forensic laboratories. It is important for the prosecutor to understand the level of expert testimony necessary and available for their case.

ANSI/ASB Best Practice Recommendation 037, Guidelines for Opinions and Testimony in Forensic Toxicology, provides guidance for the toxicologist's written and oral expert opinions and testimony.[31] It provides examples of what would generally be considered appropriate within the field, some of which are summarized in the table on the next page. It also discusses areas that may not have sufficient scientific consensus, or may be beyond a forensic toxicologist's expertise, and are therefore generally considered to be inappropriate opinions and testimony to offer. These guidelines can help a prosecutor develop direct examination questions that are consistent with what is considered appropriate expert opinion and testimony. It can also help a prosecutor to cross-examine a defense witness whose testimony may be inconsistent with the best practice recommendations.

[30] For additional information about drug recognition experts and/or the drug influence examination, see the National Traffic Law Center's monograph, Saving Lives and Preventing Crashes, The Drug Evaluation and Classification (DEC) Program (2018).
[31] The information in this table includes excerpts from the American Academy of Forensic Sciences' Guidelines for Opinions and Testimony in Forensic Toxicology, ANSI/ASB Best Practice Recommendation 037, First Edition, 2019.

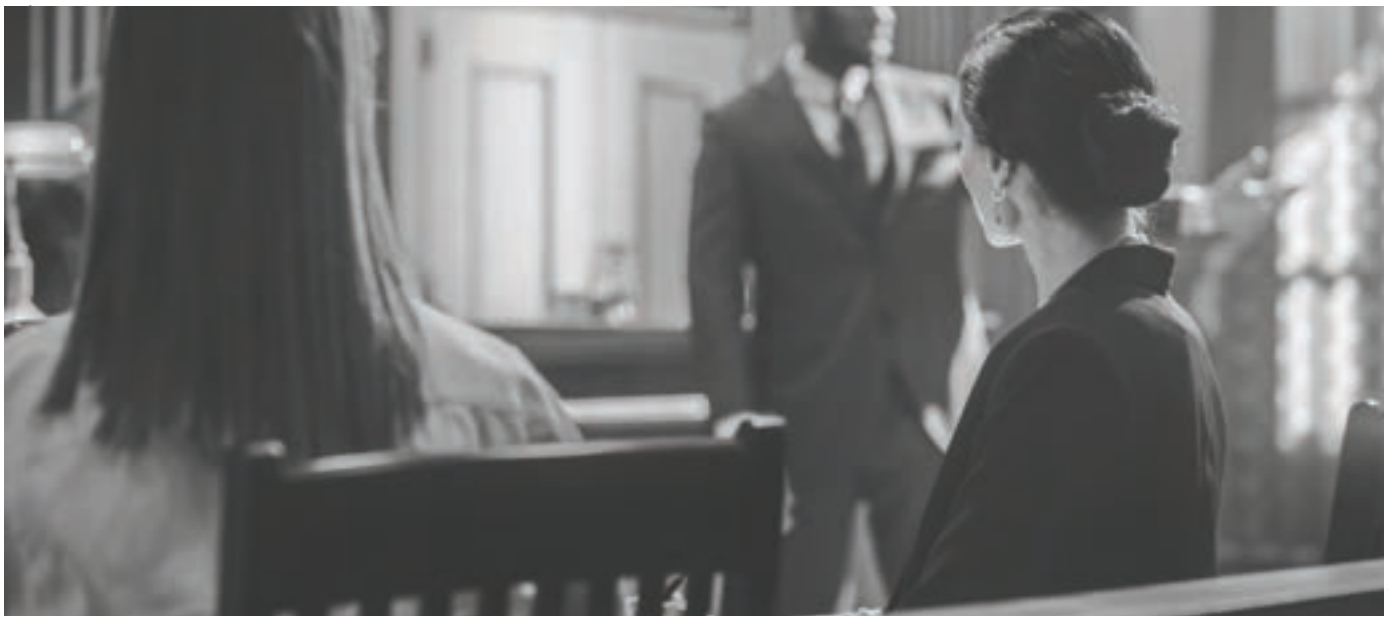
Table 3—Guidelines for Opinions and Testimony in Forensic Toxicology

Appropriate Opinion / Testimony	Inappropriate Opinion / Testimony
Lab report, analytical work, limitations in testing (*e.g.*, cutoffs, scope, etc.)	Should not address behavioral intent based solely on a drug concentration
Qualify a reported concentration in the context of a case as relevant to a therapeutic range, supported by references, databases and/or other pertinent information	Should not opine as to a specific individual's degree of impairment based solely on a quantitative result
Pharmacodynamics and pharmacokinetics of drugs and other chemicals	Should not imply impairment of an individual based on analytical findings from a biological sample unless supported by the literature
Toxicological impact of the presence, absence and stability of drugs	Should not perform extrapolation calculations for drugs other than ethanol
Impairment for the average individual, including effects consistent with the observations provided in hypotheticals and/or evidence	Should not opine as to the effects of a drug or combination of drugs on a specific individual without context of a given case

The ANSI/ASB Best Practice Recommendation 037 guidance recommends that unless it is supported by the literature, the analyst should never testify to a person's impairment based only on the test result. In a drug-impaired driving trial, the toxicologist's role is not to identify whether an individual was impaired. The toxicologist serves as a witness to provide background information on the laboratory, support the accuracy and reliability of the test results, and educate the court (or jury) regarding the effects of the drug or drugs detected, including their effects on driving. If another witness testifies about observations of impairment, a toxicologist may be able to use those in conjunction with the toxicology results to provide insight into how the effects of the drugs detected relate to the specifics of the case at trial. The toxicology report and interpretation, officer observations, DRE evaluation, evidence of recent drug use, driving observations, and other reports from civilians and hospital staff are all important components (when available) of the comprehensive DUID case.

Lastly, the phrase "reasonable degree of scientific certainty" is commonly used by attorneys when offering or challenging scientific evidence, including toxicology results and opinions. This phrase should be avoided. There is no definition or standard defining what a "reasonable" level of certainty is. In 2016, the National Commission on Forensic Science issued a Recommendation to the Attorney General about the use of the term "reasonable scientific certainty,"[32] and the U.S. Attorney General issued a memorandum in September 2016 instructing federal forensic examiners and federal prosecutors not to use the expression.[33]

It is important for a drug-impaired driving prosecutor to elicit the necessary testimony from other witnesses regarding their observations of a defendant's impairment. The toxicology testimony should support this other evidence and strengthen the overall case. It should not be the practice of the prosecutor to expect the toxicologist to have the time and resources to review all the other evidence in every case and be able to provide an opinion on a person's impairment. Testimony as to the observations of impairment along with the toxicological evidence, taken together present the best case for the fact-finder.



[32] *See* National Commission on Forensic Science, Recommendation to the Attorney General, Use of the Term "Reasonable Scientific Certainty," March, 22, 2016.

[33] *See* U.S. Department of Justice, Office of the Attorney General, Memorandum for Heads of Department Components (Recommendations of the National Commission on Forensic Science), September 6, 2016, https://www.justice.gov/opa/file/891366/download. *See also* Danielle Weiss and Gerald LaPorte, "Uncertainty Ahead: A Shift in How Federal Scientific Experts Can Testify," National Institute of Justice Journal, 279, 1-8, April 2018.

CONCLUSION

Impaired driving cases are among the most difficult criminal cases a prosecutor can handle and are further complicated when the impairment is due to drugs. These cases usually involve technical evidence and scientific testimony. A drug-impaired driving prosecutor must understand not only the law enforcement detection training and terminology related to drugs, and the abilities and limitations of each potential witness, but also the scientific principles supporting toxicological evidence. Hopefully, the guidance offered in this monograph will enable prosecutors to present the evidence in these complex cases more skillfully and professionally.

Appendix 1—Available Resources

American Academy of Forensic Sciences (AAFS) Academy Standards Board (ASB) has published standards related to topics discussed in this monograph. They can be accessed for free at https://www.aafs.org/academy-standards-board.

- ANSI/ASB Standard 120, Standard for the Analytical Scope and Sensitivity of Forensic Toxicological Testing of Blood in Impaired Driving Investigations
- ANSI/ASB Standard 036, Standard Practices for Method Validation in Forensic Toxicology
- ANSI/ASB Standard 054, Standard for a Quality Control Program in Forensic Toxicology Laboratories
- ANSI/ASB Standard 017, Standard Practices for Measurement Traceability in Forensic Toxicology
- ANSI/ASB Standard 037, Guidelines for Opinions and Testimony in Forensic Toxicology
- ANSI/ASB Standard 053, Standard for Report Content in Forensic Toxicology

National Alliance to Stop Impaired Driving (NASID) https://nasid.org/

- Map of State Laws with statistics about and laws relating to impaired driving

The **National Traffic Law Center** has published many monographs relating to impaired driving and has developed online training for prosecutors. These resources are free and can be accessed at https://ndaa.org/programs/ntlc/.
Resources relating specifically to drug-impaired driving include:

- *Admissibility of Horizontal Gaze Nystagmus Evidence*
- *Cannabis Impairment Detection Workshop Guide*
- *Investigation and Prosecuting of Cannabis-Impaired Driving Cases*
- *Saving Lives and Preventing Crashes, The Drug Evaluation and Classification (DEC) Program*
- *Horizontal Gaze Nystagmus—The Science and The Law*
- *Constitutional Law Issues in Impaired Driving Cases*
- *Investigating & Prosecuting Drug-Impaired Driving Cases* online training (CLE available)

Other helpful resources and training from the National Traffic Law Center are available at https://ndaa.org/programs/ntlc/monographs. These include:

- *Alcohol Toxicology for Prosecutors*
- *Basic Trial Techniques for Prosecutors in Impaired Driving Cases*
- *Breath Testing for Prosecutors*
- *Challenges and Defenses II: Claims and Responses to Common Challenges and Defenses in Driving While Impaired Cases*
- *Challenges and Defenses III: Responses to Common Challenges and Defenses in Impaired Driving Cases*
- *CDL Quick Reference Guide*
- *Commercial Drivers' Licenses: A Prosecutor's Guide to the Basics of Commercial Motor Vehicle Licensing and Violations, Second Edition*
- *Crash Reconstruction Basics for Prosecutors*
- *Cross-Examination for Prosecutors*
- *Distracted Driving CDL Enforcement for Prosecutors and Law Enforcement*
- *Hardcore Drunk Driving Prosecutorial Guide: A Resource Outlining Prosecutorial Challenges, Effective Strategies and Model Programs*
- *Investigation and Prosecution of Distracted Driving Cases*
- *Large Truck Crash Reconstruction for Prosecutors*
- *Masking Quick Reference Guide*
- *Overcoming Impaired Driving Defenses*
- *Prior Convictions in Impaired Driving Prosecutions*
- *DWI Prosecutor's Handbook*

The National Traffic Law Center also offers free, online training for prosecutors (and frequently qualify for CLE credit). The training courses are available at https://ndaa.org/training-courses/national-traffic-law-center-trainings/. These include:

- Mastering Masking
- Human Trafficking and the Impact on Commercial Driver's Licenses
- Prosecuting DUI Cases
- Investigation and Prosecution of Drug-Impaired Driving Cases

The International Association of Chiefs of Police offers additional information about Drug Recognition Expert training, the drug influence evaluation process, and the Drug Evaluation and Classification Program. This information may be accessed at www.decp.org.

Appendix 2—Predicate Questions for the Toxicologist Witness

Questions regarding drug testimony may vary based on case circumstances, the level of expertise of the toxicologist witness, and jurisdictional requirements. A prosecutor should consult with laboratory personnel to understand the extent of expert testimony available. These questions are meant to be a starting point for prosecutors.

Qualifications:

What is your name, occupation?
Where are you employed?
What is your current position?
What are your responsibilities/duties at the laboratory?
How long have you worked at the laboratory?
Previous employment, if applicable
What is your academic background?
Are you a member of any professional organizations? (*if applicable*)
Do you hold any professional certifications? (*if applicable*)
Have you received specialized training specific to testing <blood/urine> for the presence or absence of drugs?
Have you received specialized training specific to the effects of drugs?
Does that include effects specific to driving?
Is your lab accredited?
    What does it mean to be accredited?

Evidence:

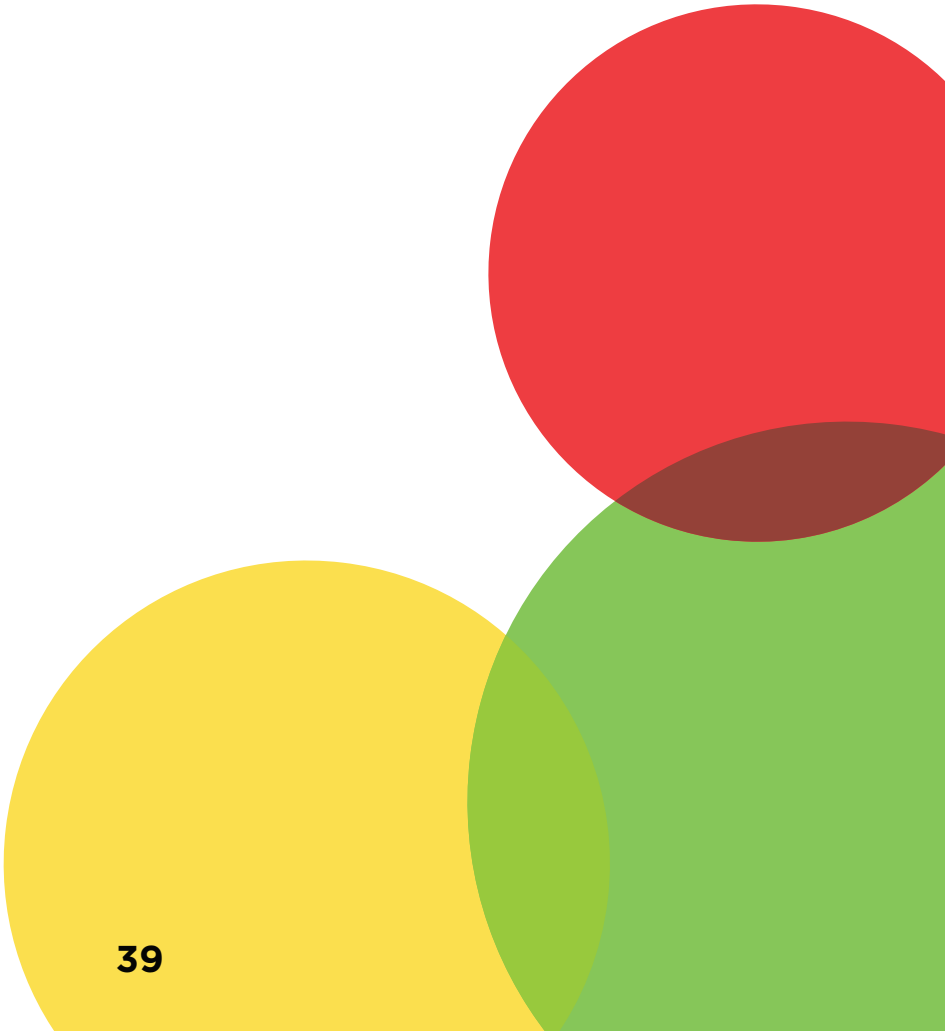
Work with your expert and office for proper admission of evidence and associated records to establish evidence integrity and chain of custody.

Testing:

Did your laboratory test evidence related to <person in question>?
What testing was performed?
    What was your role in that process?
Please describe the testing methods used for this sample.

Are these methods generally accepted by the scientific community?
Were the tests performed in accordance with standard operating procedures?
How can you be sure?
Did the test method and equipment perform properly? How can you tell?
What procedures were followed to ensure the result is accurate?
(QA plan, QC used, peer review)

Results:
Were the results properly recorded, reviewed, and was a laboratory report issued?
What were the reported results?
What is <drug>?
What are the general effects of <drug>?
Is it possible for <drug> to affect driving? How?

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