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Alcohol, Other Drug, and Multiple Drug Use Among Drivers

Abstract: This safety research report examines the crash risk associated with different drugs, including alcohol, and the prevalence of their use among drivers; it also discusses countermeasures to reduce impairment-related crashes. To do this, the National Transportation Safety Board (NTSB) conducted a literature review of impaired driving research, examined drug reporting in the National Highway Traffic Safety Administration's Fatality Analysis Reporting System, and performed an independent analysis of the presence of potentially impairing drugs in driver specimens submitted to four US laboratories that met strict standards for collecting high-quality toxicology data.

The NTSB identified the following safety issues: (1) the need to implement proven countermeasures for alcohol-impaired driving; (2) the need to address the growing problems of cannabis-, other drug-, and multiple-drug-impaired driving; (3) the need to improve drug-impaired driving laws and enforcement; (4) the need to ensure that driving safety is considered in the evaluation of prescription and over-the-counter drugs; and (5) the need to enhance systems for documenting and tracking the incidence of drug use and driving.

As a result of this safety research, the NTSB makes new recommendations to the National Highway Traffic Safety Administration; the US Food and Drug Administration; and the 50 states, the District of Columbia, and the Commonwealth of Puerto Rico. The NTSB also classified two previous recommendations.

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Acronyms and Abbreviations

ANSI/ASB Standard 120	American National Standards Institute/American Academy of Forensic Sciences Standards Academy Board *Standard for the Analytical Scope and Sensitivity of Forensic Toxicological Testing of Blood in Impaired Driving Investigations*, ANSI/ASB Standard 120
ARIDE	Advanced Roadside Impaired Driving Enforcement
BAC	blood alcohol concentration
CFR	*Code of Federal Regulations*
DNA	deoxyribonucleic acid
DOT	US Department of Transportation
DRE	drug recognition expert
DRUID	Driving Under the Influence of Drugs, Alcohol and Medicines
DUI	driving under the influence
FARS	Fatality Analysis Reporting System
FBI	Federal Bureau of Investigation
FDA	US Food and Drug Administration
g/dL	grams per deciliter
GHSA	Governors Highway Safety Association
ICADTS	International Council on Alcohol, Drugs, and Traffic Safety
IIJA	Infrastructure Investment and Jobs Act
MDA	3,4-methylenedioxyamphetamine
MDMA	3,4-methylenedioxymethamphetamine
ng/mL	nanograms per milliliter
NHTSA	National Highway Traffic Safety Administration

NRS	National Roadside Survey
NSC ADID	National Safety Council Alcohol Drugs, and Impairment Division
NTSB	National Transportation Safety Board
OTC	over-the-counter
SFST	standardized field sobriety test
THC	tetrahydrocannabinol
VMT	vehicle miles traveled

Executive Summary

Safety Research Topic

Alcohol-impaired driving is involved in nearly one in three traffic fatalities, and the problem of driving while impaired by other drugs alone or combined together continues to create harm on our roadways. Alcohol and other drugs, including illicit, prescription, and over-the-counter drugs, can negatively affect driving performance and increase crash risk. Taking multiple drugs at the same time, sometimes referred to as polydrug or polysubstance use, can have similar effects on drivers and is an emergent concern for roadway safety. Over the past 5 decades, the National Transportation Safety Board (NTSB) has documented drug impairment from alcohol, other drugs, or a combination of drugs as a cause of numerous highway crashes and has issued more than 150 safety recommendations to address impaired driving. This NTSB safety research report examines the crash risk associated with different drugs, including alcohol, and the prevalence of their use among drivers; it also discusses countermeasures to reduce impairment-related crashes.

To conduct this research, the NTSB reviewed scientific literature about impaired driving, examined drug reporting in the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System, and performed an independent analysis of the presence of potentially impairing drugs in driver specimens submitted to four US laboratories that met strict standards for collecting high-quality toxicology data. These specimens were from fatally injured drivers and drivers arrested for or suspected of impaired driving.

What We Found

A literature review found that multiple drugs and drug categories are associated with impaired performance and increased crash risk. (A drug category refers to a group of drugs that have similar effects, such as stimulants or sedatives.) We confirmed that drug data in national-level databases continue to be unreliable and cannot be used to estimate drug prevalence among drivers. Consequently, we analyzed the best available toxicological data from five populations of drivers, including drivers arrested for impaired driving and fatally injured drivers, from the Orange County, California, Crime Laboratory; the Wisconsin State Laboratory of Hygiene, which provided data for two populations of drivers; the New York State Police Forensic Investigation Center; and the San Francisco Office of the Chief Medical Examiner.

Between 71% and 99% of drivers in the five populations studied tested positive for one or more potentially impairing drugs, and about half of drivers tested positive for more than one category of drug. Alcohol and cannabis were the two most

commonly detected drugs across all populations studied. We must address those. Alcohol was most often detected alone, whereas cannabis was most often detected in combination with alcohol or other drugs. Alcohol continues to be the drug with the most detrimental impact on traffic safety; however, cannabis and other potentially impairing drugs contribute to the problem of impaired driving crashes.

The research also found that reducing the time between an impaired driving event and biological specimen collection increases the likelihood that toxicological test results will reflect drug presence at the time of an event. Also, because there is no common standard of practice for the collection, testing, and reporting of driver drug toxicology data in the United States, critical information that could improve understanding of drug trends and prevalence, assist with the evaluation of countermeasures, and better guide treatment options for impaired driving offenders is not being captured or analyzed. For this reason, widespread adoption of standardized drug testing and reporting is needed to improve our understanding of the prevalence of drug use among crash-involved drivers and drivers arrested for impaired driving. Efforts are also needed to increase the reporting of blood alcohol concentrations among drivers involved in fatal crashes.

Currently, some policies halt further drug testing when a blood alcohol concentration over a certain threshold is detected. However, if we limit further testing for drivers whose blood alcohol concentrations exceed a certain threshold, we miss important information about what else may be impairing them and ways to intervene, including, but not limited to, improving the safety of prescription and over-the-counter drugs and treatment interventions for drug addictions. A standard toxicology testing approach will allow us to implement appropriate countermeasures widely and to identify developing problems with impairment. However, testing is only a part of the solution. We must also work on laws, enforcement, education, and treatment interventions.

Our research indicated several areas where improvements could be made to reduce the incidence of drug-impaired driving, including the following:

- Implementing proven countermeasures for alcohol-impaired driving.
- Addressing the growing problems of cannabis-, other drug-, and multiple-drug-impaired driving, for example, by including driving-related warnings on cannabis products, improving prescription and over-the-counter drug labeling, and continuing efforts to increase drivers' awareness of the risks of drug-impaired driving.
- Improving drug-impaired driving laws and enforcement by authorizing the use of electronic warrants and oral fluid testing to expedite the collection of biological specimens and by using the NHTSA-developed Drug-Impaired Driving Criminal Justice Evaluation Tool to guide improvements to

addressing drug-impaired driving. Additionally, specifying a prescribed set of drugs that are impairing can limit enforcement efforts.

- Ensuring that driving safety is considered in the evaluation of prescription and over-the-counter drugs both during new drug development and after drugs have gone to market.
- Enhancing systems for documenting and tracking the incidence of drug use and driving both to better our understanding of the problem and to customize early intervention and post-conviction intervention treatments, which can be effective for reducing impaired driving recidivism.

What We Recommended

As a result of this research, the NTSB issued 12 new recommendations and classified 2 previously issued recommendations. Six recommendations were issued to various states, the District of Columbia, and the Commonwealth of Puerto Rico. Those recommendations call on them to do the following:

- Require a warning label on cannabis products advising users to not drive after cannabis use due to its impairing effects.
- Modify laws to allow for oral fluid collection, screening, and testing for the detection of drug use by drivers.
- Allow the use of electronic warrants to obtain biological specimens during impaired driving arrests.
- Enact laws specifying that drivers under the influence of a drug or multiple drugs that may impair driving are considered to be impaired under the definition of drug-impaired driving.
- Assess drug-impaired driving efforts using a tool developed by NHTSA and, based on the results, apply for NHTSA funds to establish programs to reduce drug-impaired driving.
- Require government-funded toxicology laboratories to adopt and routinely apply (regardless of driver blood alcohol concentration) standard practices for the toxicological testing of biological specimens and provide funding for equipment, personnel, and training to facilitate that testing. *(This new recommendation supersedes Safety Recommendation H-22-23, which was classified Closed—Superseded.)*

The NTSB issued three recommendations to NHTSA to do the following:

- Disseminate a common standard of practice to state officials for drug toxicology testing. *(This new recommendation supersedes Safety Recommendation H-12-33, which was classified Closed—Acceptable Action/Superseded.)*
- Establish a program to support toxicology laboratories' compliance with a standard practice for the toxicological testing of biological specimens.
- Establish a trauma center-based sentinel surveillance system; that is, a collection of reporting sites that provide timely and high-quality data to measure trends in the prevalence of drug use among crash-involved drivers.

Lastly, the NTSB issued three recommendations to the US Food and Drug Administration (FDA) to do the following:

- Conduct a study to understand how drug labels could be modified to increase user understanding and compliance with driving-related warnings and publish the study findings.
- Develop a system to audit drugmaker compliance with FDA guidance to evaluate drug effects on the user's ability to operate a motor vehicle.
- Incorporate additional data and research concerning drug use and driving to improve FDA drug safety surveillance systems.

1. Introduction

Drug-impaired driving, including impairment from alcohol, other drugs, or multiple drugs, is not a new problem.[1] The National Transportation Safety Board (NTSB) has investigated numerous crashes involving drug-impaired driving, conducted safety research on the topic, and held public forums to discuss varying dimensions of the issue. As a result, over the past 5 decades, the NTSB has issued more than 150 related safety recommendations.[2] "Prevent Alcohol- and Other Drug-Impaired Driving" is an issue area on the NTSB's 2021–2023 Most Wanted List of Transportation Safety Improvements, and impaired driving has been an area of concern on most of the NTSB's Most Wanted Lists since its inception in 1990.[3]

Between 2012 and 2013, the NTSB held two Board meetings and a public forum addressing impaired driving, subsequently issuing a total of 19 recommendations with the goal of eliminating impaired driving crashes (NTSB 2012a, 2012b, 2012c, 2013a). In its 2013 report, *Reaching Zero: Actions to Eliminate Alcohol-Impaired Driving*, the NTSB focused primarily on alcohol-impaired driving because its association with crash risk and the countermeasures to address it were well understood. Other drugs were also recognized as a potential problem for road safety; however, because less was known about the scope of their use by drivers, the NTSB called for improvements in identifying other drug use among crash-involved drivers.

Since that time, the NTSB has continued to document drug impairment from alcohol, other drugs, or a combination of drugs—sometimes referred to as polydrug or polysubstance use—as a cause of highway crashes.[4] This safety research report examines the crash risk associated with different drugs, including alcohol, and the prevalence of their use among drivers; it also discusses countermeasures to reduce

[1] *Alcohol* is a drug. However, it is sometimes considered as distinct from other drugs. In this report, the terms *drug*, *drug-impaired driving*, and *drug prevalence* will include alcohol unless clearly stated otherwise.

[2] Appendix A lists all NTSB impairment-related recommendations related to the highway mode. Additional information about safety recommendations referenced in this report is also available via the CAROL Query.

[3] Impaired driving has been highlighted on the NTSB's Most Wanted List for 28 of 34 years.

[4] See appendix B for a list of recent NTSB-investigated highway crashes in which drug use was cited as the probable cause or a contributing factor.

impairment-related crashes.[5] To do this, the NTSB conducted a literature review of impaired driving research, examined drug reporting in the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System (FARS), and performed an independent analysis of the presence of potentially impairing drugs in driver specimens submitted to four US laboratories that met strict standards for collecting high-quality toxicology data.[6]

This research focused specifically on identifying drugs that may impair driving and determining their prevalence of use among drivers. Although a primary focus was given to alcohol and cannabis due to their documented prevalence and negative impacts on traffic safety, numerous other drugs, including illicit, prescription, and over-the-counter (OTC) drugs, were examined.[7] Any drug that may impair driving performance may result in traffic harm and adverse legal consequences for the driver, such as an arrest for driving under the influence (DUI). Yet, many drivers may be unaware of the risks certain drugs present to the safe operation of a motor vehicle. This includes drugs that are prescribed by a doctor or used according to the drug labeling. This should not discourage the proper medical use of drugs or stigmatize the underlying medical conditions they are intended to treat. However, a better understanding of driving risk and prevalence of all drugs is critical to promoting traffic safety and providing all drivers with necessary information regarding potential risks to their safety and the safety of all road users.

1.1 Drug Impairment and Use Among Drivers

The best available national-level drug-impaired driving data are limited to alcohol use by drivers in fatal crashes. NHTSA reports driver blood alcohol concentration (BAC) in fatal crashes for FARS.[8] Figure 1 depicts the number of fatalities in alcohol-impaired driving crashes per year and fatalities per 100 million vehicle miles traveled (VMT) based on FARS estimates. Beginning in the 1980s, there

[5] Visit ntsb.gov to find additional information in the public docket for this NTSB safety research (case number DCA21SS003). Use the CAROL Query to search safety recommendations and other safety research.

[6] See section 2.3 for a description of the standards for inclusion in this safety research.

[7] *Cannabis* is a plant commonly referred to as "marijuana." This report uses the term "cannabis" except in instances where the term "marijuana" is used by the author or organization being cited.

[8] NHTSA uses a statistical technique known as *multiple imputation*, which refers to the practice of "filling in" missing data with plausible values. Between 2018 and 2020, more than one-third of drivers in fatal crashes did not have BAC reported. Multiple imputation in FARS involves estimating 10 simulated BAC values for each missing value, then using statistical averages for subsequent analyses (Subramanian 2002).

was a substantial reduction in both the number of impaired driving fatalities and the fatality rate. However, since 2010 there has been little change, except in 2020, when there was a notable increase, which coincided with the COVID-19 pandemic.[9] NHTSA estimated that 11,654 people died in crashes involving an alcohol-impaired driver in 2020, accounting for nearly 1 in 3 traffic fatalities (NCSA 2022a; NCSA 2022b).[10]

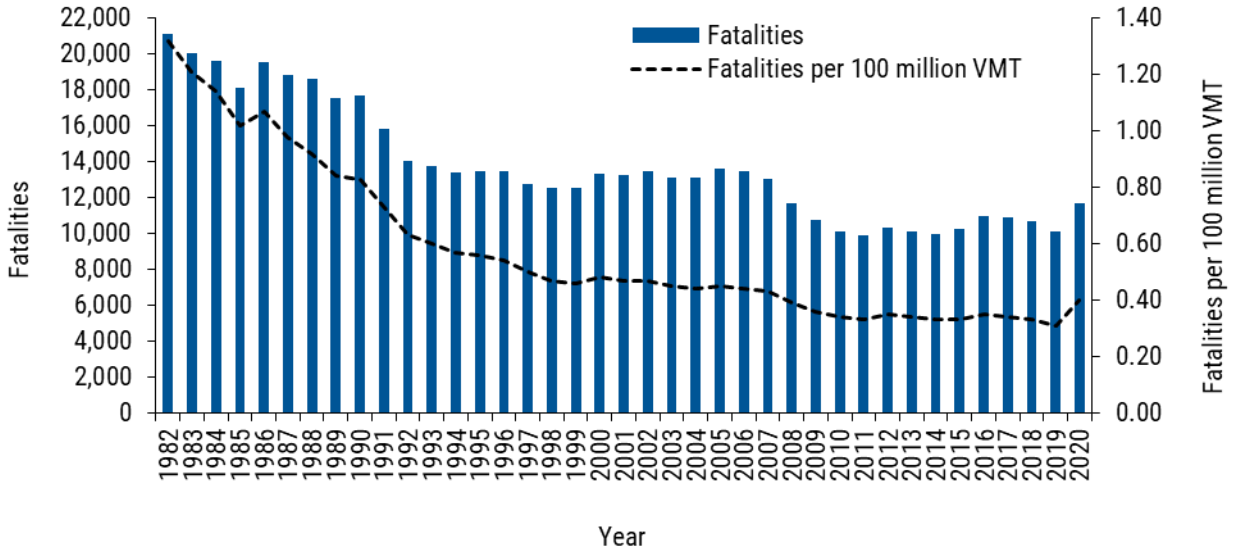

Figure 1. Number and rate of fatalities involving an alcohol-impaired driver, per 100 million VMT, 1982–2020.

FARS also contains information about other drug use; however, because of inconsistencies in the collection, testing, coding, and reporting of these data across and within jurisdictions, NHTSA has issued broad cautions against the use of its data about other drug use, including to examine trends over time or to make comparisons with alcohol use (Berning and Smither 2014; Berning and others 2022). Despite the limitations of national fatal crash data concerning other drug use and driving, there is evidence of major societal trends in drug prescribing and drug use over the past 2 decades that may have affected the prevalence of drug use among drivers and drug-related crashes. This includes a significant increase in prescription drug use—including potentially impairing benzodiazepines, muscle relaxants, and opioid analgesics—among adults of all ages in the United States (Kantor and others 2015;

[9] The COVID-19 pandemic began in late 2019. See the Centers for Disease Control and Prevention's "CDC Museum COVID-19 Timeline" and "Basics of COVID-19" sites for further information.

[10] NHTSA defines an alcohol-impaired driver as one with a BAC of 0.08 grams per deciliter (g/dL) or higher, which is consistent with the per se impairment threshold in 49 states. In 2018, Utah became the first state to lower its per se BAC limit to 0.05 g/dL.

Schepis and McCabe 2016; Hirschfeld 2017). Also, there has been a proliferation of novel psychoactive substances, which are chemicals designed to mimic the effects of illicit drugs.[11] Common examples include "spice" and "bath salts," which are designed to mimic cannabis and illicit stimulants, respectively.[12] Research has shown increases in novel psychoactive substance use in the United States and may not capture the full extent of its use because such drugs are difficult to detect using conventional methods (Neicun and others 2020).

Additionally, there has been a general movement to decriminalize or legalize cannabis use over the past decade.[13] Since 2012, 21 states, the District of Columbia, and two US territories have legalized recreational cannabis use.[14] Other states have made cannabis legal for medical use or have decriminalized it by reducing the penalties associated with its possession. Research about the effects of such measures on the prevalence of cannabis use among the driving population and traffic safety have shown mixed results (Ramirez and others 2016a; Tefft and Arnold 2020; Farmer, Monfort, and Woods 2022; Aydelotte and others 2019; Monfort 2018; Eichelberger 2019; Highway Loss Data Institute 2020).

In addition to increases in potentially impairing drug use overall, there is also evidence that people are using impairing substances while driving. For example, the 2013–2014 National Roadside Survey (NRS), a nationally representative study in which biological specimens were collected from volunteer drivers and tested for alcohol and 98 other drugs or drug metabolites, estimated that 22.3% of daytime drivers and 22.5% of nighttime drivers tested positive for potentially impairing drugs (Ramirez and others 2016b; Kelley-Baker and others 2017).[15] Their results also showed a significant increase in drug use by nighttime drivers compared to 2007, the first year in which the NRS tested for drugs other than alcohol. The prevalence of both

[11] *Novel psychoactive substances* are also referred to as "synthetic drugs" or "designer drugs."

[12] See the US Drug Enforcement Administration's "Designer Drugs" webpage for more information.

[13] *Cannabis* is a plant commonly referred to as "marijuana." This report uses the term "cannabis" except in instances where the term marijuana is used by the author or organization being cited. Also, since 2019, two states (Oregon and Colorado) and several cities have legalized or decriminalized psilocybin, commonly known as "magic mushrooms."

[14] (a) See the National Conference of State Legislatures' "State Medical Cannabis Laws" webpage for more information. (b) Additionally, the Agriculture Improvement Act of 2018, Public Law 115–334, 132 Stat. 4490 (2018), contained language that ended federal control over cannabis plants and derivatives containing no more than 0.3% tetrahydrocannabinol (THC) on a dry weight basis.

[15] A *drug metabolite* is a compound formed by the body processing, or metabolizing, a drug.

cannabis alone and cannabis in combination with other drugs increased significantly between the 2007 and the 2013–2014 NRS periods (Kelley-Baker and others 2017).

The National Survey on Drug Use and Health, an annual survey conducted by the Substance Abuse and Mental Health Services Administration, found that, in 2020, more than 1 in 10 respondents reported driving under the influence of alcohol and/or an illicit drug or illicit drugs in the past year (SAMHSA 2021). The two most commonly reported drugs were alcohol at 7.2% and cannabis at 4.5%. About 1% of respondents reported driving under the influence of other selected illicit drugs, including cocaine, heroin, hallucinogens, inhalants, and methamphetamine. A nationally representative survey of drivers conducted by the AAA Foundation for Traffic Safety in 2020 found that 5.9% admitted to driving when they were over the alcohol limit in the past month, 4.4% admitted to driving within an hour of using marijuana, and 3.4% admitted to driving when using potentially impairing prescription drugs (AAA FTS 2021).

Tracking the prevalence of potentially impairing drug use among crash-involved drivers is a necessary component of determining crash risk, understanding trends, and evaluating the effectiveness of countermeasures. A recent NHTSA-sponsored study examined drug prevalence among seriously and fatally injured road users who were taken to certain trauma centers beginning in September 2019. The COVID-19 pandemic occurred during the study period, so the study reported findings for the periods before and after the March 16, 2020, declaration of a public health emergency (Thomas and others 2020).[16]

Before the COVID-19 public health emergency declaration, 50.8% of seriously or fatally injured drivers tested positive for at least one potentially impairing drug category, and 17.6% tested positive for two or more.[17] For the 4 months studied after the declaration, the proportions increased significantly to 64.7% and 25.3%, respectively. Alcohol and cannabis were the most common drugs detected (Thomas and others 2020). Two subsequent publications noted that drug prevalence in the third and fourth quarters of 2020, while still higher than prepandemic levels, had begun to recede (Office of Behavioral Safety Research 2021a, 2021b). The NHTSA study provides important insights but cannot be considered representative of all crash-involved drivers in the United States because it only included seriously or fatally injured drivers and its data collection varied somewhat over time and locations.

[16] The researchers reported that they were able to modify testing protocols to continue collecting data during the pandemic.

[17] (a) A drug category refers to a group of drugs that have similar effects, such as stimulants or sedatives. (b) The drug categories were alcohol, cannabis, stimulants, sedatives, opioids/narcotic analgesics, antidepressants, OTC, and other drugs.

Because alcohol-impaired driving is involved in nearly one in three traffic fatalities and because of the growing problem of driving while impaired by other drugs or multiple drug use, the NTSB has undertaken this research effort. The NTSB is not alone in its efforts to understand and address issues relating to drug-impaired driving. For example, the Infrastructure Investment and Jobs Act (IIJA) included several sections on multiple substance-impaired driving prevention.[18] Also, in recent years, many groups have undertaken efforts to address this issue, including NHTSA, the Centers for Disease Control and Prevention, the Transportation Research Board, the National Safety Council, the Governors Highway Safety Association (GHSA), the National Governors Association, the Foundation for Advancing Alcohol Responsibility, the Society of Forensic Toxicologists, and many others. This safety research aims to add to the current literature and other work that has been done or is currently underway to understand and address the problem of drug and multiple drug use among drivers.

1.2 Scope

This research focuses on drug and multiple drug use among drivers; however, there are no reliable national-level data available on the topic. Therefore, to conduct this research, the NTSB relied on an extensive review of relevant scientific literature to inform its analytical approach and used the best data available from four US laboratories that met strict standards for collecting high-quality toxicology data. Analyzing these data allowed the NTSB to gain current, detailed, and comprehensive results about the types of drugs and drug combinations drivers are using when they are fatally injured or arrested for impaired driving.

This research does not assess the effects of all potentially impairing drugs or all possible drug combinations. The laboratory data used are not representative of all impaired drivers and could not be aggregated due to differences among laboratories. Still, the data selection process was criteria based, and the sample driver populations are examined in parallel to determine drug prevalence.

Although the documented prevalence and traffic harm from alcohol and cannabis created a special focus on these two substances, other potentially impairing drugs were included in this research. Much less is known about the prevalence of other potentially impairing drugs, including many illicit, prescription, and OTC drugs. The unique toxicology data and methodology used in this research allowed for an

[18] IIJA, Public Law 117–58, 135 Stat. 429 (2021). See the following sections: 24105, "National Priority Safety Programs"; 24106, "Multiple Substance-Impaired Driving Prevention"; 24107, "Minimum Penalties for Repeat Offenders for Driving While Intoxicated or Driving Under the Influence"; 24220, "Advanced Impaired Driving Technology"; and 25025, "Drug-Impaired Driving Data Collection."

innovative assessment of the prevalence of many of these potentially impairing drugs and drug combinations.

Therefore, it is important to note that the following points informed and guided the scope of this research:

- Alcohol and cannabis were key focus areas, but other potentially impairing drugs were examined to better understand the prevalence of drug use and drug combinations among drivers. This included the combinations of other potentially impairing drugs with alcohol and cannabis.
- Only potentially impairing drugs were included in the analysis. Many drugs may improve driving performance, including by treating potentially impairing medical conditions.

1.3 Goals

The goals of this research are to (1) better understand the prevalence of potentially impairing drug use among drivers; (2) summarize what is known about how different drugs, including alcohol, and drug combinations may affect driving safety; and (3) recommend measures to reduce the likelihood of drug-impaired driving and to improve our ability to track its prevalence.

1.4 Challenges in Researching Drugs and Drug-Impaired Driving

Understanding the problem of drug-impaired driving is challenging and complex for a variety of reasons. There are hundreds of potentially impairing drugs and thousands of potential drug combinations. For most drugs, with the notable exception of alcohol, there is no clear correlation between measurable drug concentrations from biological specimens and the level of impairment experienced by a driver. Also, different drugs may affect people differently depending on the characteristics of the drug, the characteristics of the user, and the circumstances in which the drug is used. This section is designed to provide readers a basic overview of some of the many factors that need to be considered to fully understand and address the problem of drug-impaired driving and to interpret the results of the present research.

1.4.1 Characteristics of Drugs

This research focuses on alcohol and other drugs with psychoactive effects that could potentially impair driving.[19] Alcohol's negative effects on driving performance and crash risk are well understood and have been described in detail in other reports (NTSB 2013a; NASEM 2018). Illicit drugs generally refer to drugs that are illegal to possess and have no medical use; they are considered impairing with a high propensity for abuse.[20] Additionally, some drugs that are prescribed for medical conditions or sold OTC have the potential to be impairing by, for example, increasing drowsiness, affecting judgment, slowing reaction time, or blurring vision. Such drugs may carry labels that warn users to avoid driving or using heavy machinery while taking the drug or that caution them not to drive until they know how the drug affects them. In these cases, a drug may impair driving even if prescribed by a doctor and taken as recommended.[21]

Characteristics of a drug's chemistry can also lead to different effects on users. For example, a stimulant drug will have a very different effect than a depressant drug. Additionally, when drugs are taken in combination, their impairing effects may increase, or new effects may develop. For example, many drugs with depressive effects, such as opioids and benzodiazepines, contain warnings that users should not consume alcohol while taking those drugs because of the potential for combined effects. The US Food and Drug Administration (FDA) has cautioned that drug interactions can make certain drugs less effective, increase the action of a drug, or lead to unexpected side effects that may be harmful to health.[22] Further, in some cases, drug users may not be aware that they are consuming more than one drug; for example, if an illicit drug contains a contaminant or cutting agent that also has psychoactive properties.[23]

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[19] Psychoactive drugs affect the brain or nervous system functioning in ways that can alter perception, behaviors, or performance.

[20] The US Drug Enforcement Administration categorizes a subset of drugs in five "Schedules" based on their potential for abuse. Schedule I drugs are considered to have no medical use and are generally not available legally. Although cannabis is classified as a Schedule I drug, several states have laws that allow its medical or recreational use.

[21] Many OTC and prescription drugs are medically necessary. The objective is not to discourage the consumption of drugs used as a part of medical treatment or to cast a negative light on individuals taking these drugs or any underlying medical condition. Rather, the potentially impairing effects of these drugs must be understood and communicated to drivers to mitigate traffic harm.

[22] See the FDA's "Drug Interactions: What You Should Know" webpage for more information.

[23] A *cutting agent* refers to a less expensive substance added to dilute or adulterate a drug.

1.4.2 Characteristics of the User

Drugs may affect people differently depending on genetic or physical characteristics or medical conditions. For example, the drug zolpidem, commonly marketed as Ambien and prescribed as a sleep aid to treat insomnia, is metabolized slower by females than by males. For drivers with certain medical conditions, drugs may reduce crash risk. Drugs used to treat epilepsy or narcolepsy are examples of drugs that have the potential to reduce crash risk for individuals who have those diseases (Devlin and others 2012; Donjacour and others 2016).

1.4.3 Circumstances of Drug Use

Some drugs may be relatively non-impairing at low doses but may have significant effects on performance at higher doses. For example, dextromethorphan, commonly marketed as Robitussin, is commonly used as a cough suppressant. At recommended doses, it has little to no effect on performance for most people, but at high doses, it can result in dissociative effects and hallucinations, increasing crash risk (Couper and Logan 2004).[24]

The route of administration, such as eating, inhaling, or injecting, can affect the way a drug is absorbed into the body. For example, cannabis that is inhaled via vaporization, or "vaping," results in stronger drug effects and higher peak blood tetrahydrocannabinol (THC) concentrations compared to an equivalent amount of smoked cannabis (Spindle and others 2018). Compared to vaping or smoking, in which psychoactive effects are reported almost immediately after inhalation, when cannabis products are eaten, the psychoactive effects may not begin until 30 to 60 minutes later (Borodovsky and others 2016).

Some drugs may cause impairment immediately following use, but for others the onset may be delayed. Additionally, the duration of a drug's effects can vary greatly depending on the rate at which a drug is metabolized. Further, although many drugs are impairing while the drug is actively circulating in the user's system, some drugs may affect users in different ways over the course of their metabolism and elimination. For example, after certain stimulants are metabolized, there is a withdrawal phase, which involves extreme fatigue, depression, and drug craving, even when drug levels are low (Couper and Logan 2004).

[24] *Dissociative effects* refer to a sense of disconnection from the self or the surrounding environment.

Some prescription drugs can cause severe impairment in new users, but after a period of use, tolerance develops, and driving performance may return to baseline.[25] For example, experimental studies examining the antidepressant mirtazapine, commonly marketed as Remeron, found that users in a driving simulator showed some evidence of performance impairment (variability in lane position) after 2 days of use but that performance returned to normal after about 2 weeks of use (Theunissen and others 2013). For other drugs, such as benzodiazepines, which are central nervous system depressants commonly prescribed for anxiety, tolerance may take much longer (Hansen and others 2015; van der Sluiszen and others 2019).

For some drugs, long-term habitual use has been linked to performance decrements even after a period of abstinence. For example, one study found that psychomotor performance of chronic daily cannabis smokers improved over a 3-week period of abstinence but did not recover to the point that it was equivalent to the performance of a control group comprised of occasional users (Bosker and others 2013).[26]

1.4.4 Documenting Drug Use and Drug-Related Driving Impairment

The ability to detect whether a driver has used specific drugs can support research, crash investigation, enforcement of impaired driving laws, and more effective education and intervention, all of which have the potential to reduce the incidence of impairment-related crashes and improve roadway safety.

On an individual level, identifying potentially impairing drugs can facilitate impaired driving arrests and prosecution. However, it may also help to develop customized interventions to reduce the likelihood of recidivism. Better understanding the drugs in a driver's system can help shape the most effective treatment options. For example, for a driver impaired only by alcohol, an alcohol ignition interlock may be a successful tool for preventing recidivism, whereas identifying the use of other drugs or multiple drug use could lead to changes in a driver's prescriptions or treatment for a substance use disorder. A number of education and treatment tools also exist, including pretrial services, early intervention services, monitoring, supervision, and treatment.

From a community perspective, understanding which drugs are being used by drivers and their prevalence can enhance understanding of the association of drugs

[25] Use of a certain drug may also produce tolerance to other drugs, a phenomenon known as *cross-tolerance*.

[26] *Psychomotor performance* refers to physical movement in coordination with the cognitive processing of information, such as a driver's speed of reaction when steering a vehicle.

and crash risk and can be used to direct resources toward systemic countermeasures, such as awareness campaigns and training for law enforcement or medical professionals.

Most law enforcement officers learn about detecting signs of alcohol use and impairment during their initial training, but fewer have detailed training on detecting and identifying impairment from other drugs. The current tools used by law enforcement officers rely largely on interviews, behavioral observations, and physiological assessments. Law enforcement assessments seek to evaluate and document both whether a driver is demonstrating signs of impairment and whether the driver has consumed drugs that are consistent with the observed signs of impairment; these assessments include the following:

- The standardized field sobriety tests (SFSTs) are designed to detect drivers with BACs at or above 0.08 grams per deciliter (g/dL). There are three SFSTs: one-leg stand, walk and turn, and horizontal gaze nystagmus.[27] Most law enforcement officers learn to conduct the SFSTs during basic academy training. There is some evidence that some SFSTs could be used to screen for certain drugs or drug categories, including stimulants, depressants, cannabis, and narcotic analgesics (Porath-Waller and Beirness 2014). However, the SFSTs are likely not sufficient to identify drivers impaired by all potentially impairing drugs, and NHTSA has not validated the SFSTs for any drugs other than alcohol.
- The Advanced Roadside Impaired Driving Enforcement (ARIDE) program is a 16-hour training program that educates law enforcement officers about how to observe, identify, and articulate the signs of impairment related to both alcohol and other drugs. Since the program's inception in 2009, more than 141,000 law enforcement officers, prosecutors, and toxicologists have received this training (IACP 2021).
- The Drug Evaluation and Classification program, developed by the International Association of Chiefs of Police and NHTSA, trains law enforcement officers to become experts in identifying the signs and symptoms of impairment by various categories of drugs. In 2021, 8,115 drug recognition experts (DREs) were in the United States, representing about 1.2% of law enforcement officers (IACP 2021).[28] This program includes 72 hours of classroom training and 40 to 60 hours of field training. Law enforcement officers who complete the Drug Evaluation and

[27] *Horizontal gaze nystagmus* refers to a rapid side-to-side motion of the eye.

[28] According to the US Bureau of Labor Statistics' "Occupational Employment and Wage Statistics" webpage, there were 665,380 police and sheriff's patrol officers in the United States in 2021.

Classification program are certified to perform a 12-step evaluation protocol to assess subjects for drug impairment, which includes psychophysical tests and physical examinations. DREs are required to regularly perform and document their evaluations under specific conditions to maintain certification.

In some cases, a law enforcement officer who has arrested a driver for impaired driving will request or, depending on the circumstances, compel a driver to submit a biological specimen to screen or test for the presence of alcohol and other drugs. Biological specimens may include breath, urine, blood, or oral fluid. Toxicological analyses of biological specimens may also be conducted as a part of a postmortem investigation for drivers who are fatally injured in motor vehicle crashes or in support of research.

1.4.4.1 Breath

Breath specimens are routinely collected during impaired driving arrests when alcohol impairment is suspected because they can provide reliable estimates of BAC. Portable breath-testing devices are commonly used at the roadside as part of the SFSTs. Evidential breath testing devices, that is, those that meet NHTSA-established model specifications, are typically used in police departments after an arrest has occurred.[29] Breath testing is not currently used to reliably test for drugs other than alcohol, although some research has been conducted to explore its future feasibility (Beck, Ullah, and Kronstrand 2019; Johnson, Miskelly, and Rindelaub 2022).[30]

1.4.4.2 Urine

Urine is a commonly used biological specimen for drug testing. Title 49 *Code of Federal Regulations* (*CFR*) Part 40 requires employers to conduct urine drug testing for commercial motor vehicle drivers under several circumstances, including fatal crashes or serious crashes in which citations are issued. In some states, urine specimens are used for impaired driving investigations in which drugs other than alcohol are suspected.[31] Urine can provide information about historical use of or exposure to drugs. However, urine can be challenging to collect, it can also be

[29] See NHTSA's "Alcohol Measurement Devices" webpage for more information.

[30] See also the National Institute of Standards and Technology's "Chemical Foundations for a Cannabis Breathalyzer" webpage for more information.

[31] For example, in Florida, urine is commonly collected during arrests for driving under the influence of drugs because Florida statute does not allow for the collection of blood except in cases when using breath or urine is impossible or impractical and serious bodily injury or death is involved. See the Florida Senate's 2017 Florida Statutes, Title XXIII, chapter 316, section 1932, for more information.

susceptible to substitution or tampering, and it may not provide evidence of recent drug use (Niedbala and others 2001). In general, urine tests cannot identify the specific concentration of a drug acting on the body or the timing of its use relative to the timing of a crash or driving violation. In its 2021 recommendations for toxicological investigation for drug-impaired driving and motor vehicle fatalities, the National Safety Council's Alcohol, Drugs, and Impairment Division (NSC ADID) noted these limitations and concluded that it would sunset its guidance concerning urine as an appropriate testing specimen for impaired driving investigations (D'Orazio and others 2021).

1.4.4.3 Blood

Blood is generally considered to be an optimal biological specimen for toxicological analyses to determine the presence of drugs that were psychoactive at the time of collection. Blood is very useful, but its collection requires transport to a facility for a blood draw, during which time drugs in a driver's system continue to be metabolized.[32] As a result, the toxicological analysis may not reflect the drug levels present in a driver's blood at the time of an event or a drug may even completely metabolize out of a driver's system by the time of collection.

1.4.4.4 Oral Fluid

Oral fluid, which is comprised of saliva and other substances found in the mouth, such as cell debris and particles of ingested materials, may be collected with relative ease and swiftness compared to blood and urine (White and Moore 2018). Oral fluid drug testing has long been used in clinical and workplace settings, but its use for drug-impaired driving enforcement is relatively new. Some law enforcement agencies have begun using oral fluid screening devices at the roadside during impaired driving arrests to provide rapid qualitative (positive or negative) information about a predetermined panel of drugs or drug categories. Oral fluid specimens can also be used for confirmatory testing by toxicology laboratories, which typically includes a larger panel of drugs and provides information about the quantity of drugs detected in the specimen. However, currently only one state, Alabama, routinely conducts confirmatory testing on oral fluid specimens.[33]

[32] In some communities, law enforcement personnel or contractors with phlebotomy training—that is, training in drawing blood samples—are used to expedite blood collection. For example, police departments in Arizona, Idaho, Minnesota, and Washington have such phlebotomy programs (NHTSA 2019).

[33] The Alabama Department of Forensic Sciences also encourages law enforcement to collect blood specimens to provide a more complete picture of recent drug use. See its "Toxicology Oral Fluid Drug Testing Program" webpage for more information.

1.4.4.5 Challenges in Using Biological Specimens to Document Impairment

Toxicological testing can provide information about whether a drug was consumed, but for most drugs, a measured concentration alone cannot indicate whether a driver was impaired by that drug at the time of a crash or a traffic stop. In the case of alcohol, as a driver's BAC increases, their performance degrades and their crash risk increases, and this has provided the rationale for illegal per se BAC limits.[34] However, for many drugs, this is not the case. For example, as shown in figure 2, when a person smokes cannabis, their blood THC levels rise with the peak occurring shortly after smoking ends. The THC levels in blood drop rapidly thereafter, but the subjective high and performance decrements remain after THC levels have receded (Compton 2017).

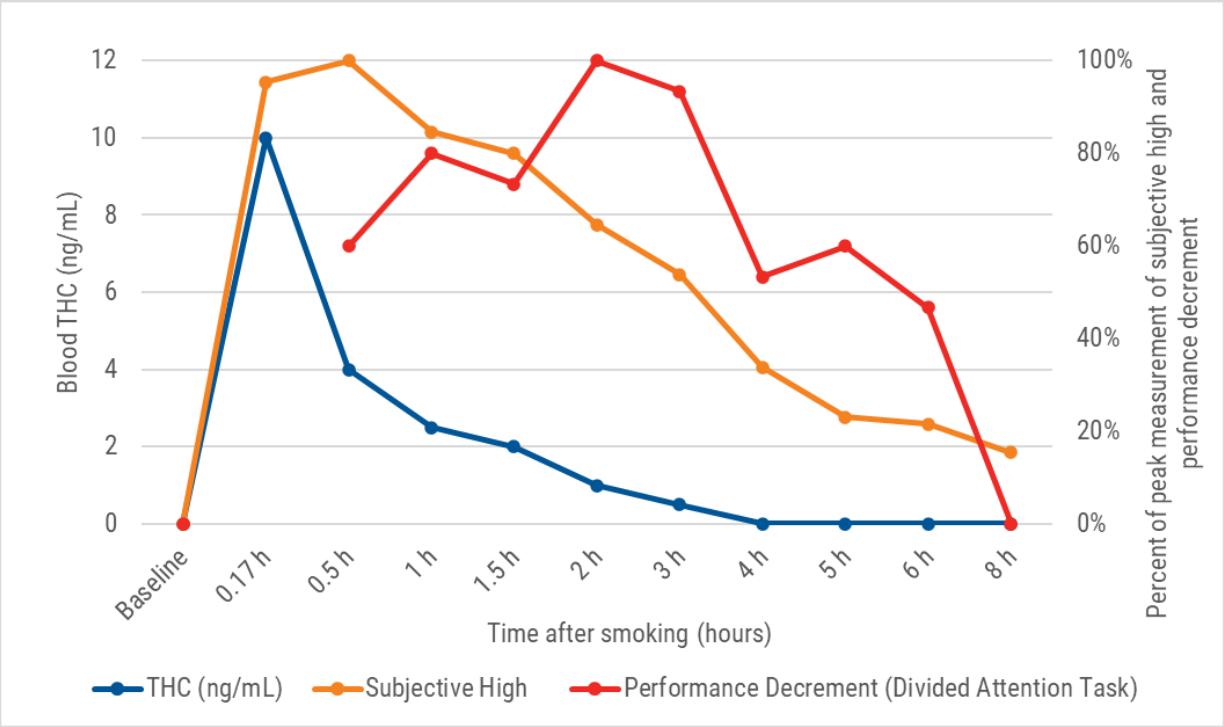

Figure 2. Time course of standardized THC concentration in blood, subjective high, and negative performance on a divided attention task after smoking cannabis (Source data: Spindle and others 2018; Spindle and others 2019).

Note: In the figure, ng/mL refers to nanograms per milliliter.

[34] *Per se BAC laws* establish the BAC level at which it is illegal per se (in itself) for a driver to operate a vehicle, regardless of the driver's apparent condition or actions.

2. Methodology

This section discusses the methods the NTSB used to conduct this research: (1) a literature review of impaired driving research, (2) an examination of drug reporting in NHTSA's FARS, and (3) an independent analysis of high-quality toxicology data of fatally injured drivers and drivers arrested for or suspected of impaired driving from four laboratories that met strict data standards for inclusion. These methods worked together to improve our understanding of the effects drugs have on drivers, the current state of national data on drug use and driving, and the prevalence of drugs and drug combinations in fatally injured drivers or drivers arrested for or suspected of impaired driving on US roadways.

2.1 Literature Review

The literature review focused on meta-analyses of epidemiological and experimental studies that have been conducted over several decades to assess the performance effects and crash risk of various drugs and drug combinations.[35] When meta-analyses were not available, the report describes the findings from individual studies.

2.2 FARS Analysis

As a census of all fatal crashes on US roadways, FARS is a prominent source of traffic safety data.[36] FARS collects data on both alcohol and other drugs. However, in 2014, NHTSA issued a report cautioning that the drug data in FARS had significant limitations and were insufficient to answer many important questions about the prevalence and risk of drug-impaired driving (Berning and Smither 2014). Since that time, NHTSA has put out a renewed call for caution using drug data in FARS while also highlighting steps taken to improve drug data in FARS (Berning and others 2022). For example, beginning in 2018, the agency expanded FARS to allow for the entry of all available drug tests and results, thereby allowing for the documentation of more than three drugs per driver, which had been the previous FARS limit.

Because of its well-documented shortcomings, the NTSB did not use FARS to characterize drug prevalence among drivers in fatal crashes. However, the NTSB did conduct analyses of FARS drug data to determine the following:

[35] A *meta-analysis* is a statistical study design used to systemically summarize and combine the results of multiple previous independent studies relevant to an issue.

[36] FARS includes motor vehicle crashes on public roadways that involve the death of a vehicle occupant or nonoccupant within 30 days of the crash.

- whether alcohol and other drug testing/reporting, for both fatally injured and surviving drivers, has increased in recent years
- reporting rates for drug testing by state in which the crash occurred
- whether the 2018 FARS change from a limit of three nonalcohol drugs per driver to unlimited drug reporting increased reporting of drivers positive for more than three drugs

2.3 Prevalence Data from Jurisdictions with Advanced Testing Programs

There are severe limitations with existing national data on drug-involved driving (Berning and others 2022; NTSB 2012c). These limitations often stem from inconsistencies in drug testing procedures and reporting in both state databases and at toxicology laboratories. For example, in many jurisdictions, laboratories first determine BAC in their toxicology testing programs, and, if that level is above the state's per se limit, additional testing for other drugs is not performed.[37] This type of "stop-testing" protocol provides information on alcohol-impaired driving but little to no information on circumstances where alcohol is combined with other drugs.[38] There are also large amounts of missing data due to the lack of toxicology testing and major inconsistencies in drug testing protocols, including which drugs are tested for and under what circumstances. Because of missing data and inconsistent testing protocols, it is difficult to assess the prevalence of drug use and to assess crash risk associated with different drugs.

Thus, to address the severe limitations of current national drug data, the NTSB took a targeted approach to soliciting high-quality data from leading laboratories across the country. Specifically, we sought out laboratories that performed consistent and comprehensive drug testing of all driver specimens received. These laboratories provided data that exceeded the known limitations of most impaired driving databases and provided unique and previously unexplored insights into the drug use of drivers in those communities.

[37] The process of first testing for BAC levels may be based on the costs associated with a comprehensive drug panel or because of complexities in the legal system when positive BAC levels are reported with the presence of other drugs.

[38] *Stop-testing* generally refers to canceling further drug tests when a driver's BAC is above a certain threshold.

Acknowledging the common limitations of toxicology data, the NTSB developed data-inclusion standards to guide the selection of these laboratories and data. For example, the selected laboratories had to do the following:

- consistently test all driver specimens for drugs regardless of circumstances; that is, they did not use "stop-testing" protocols for drivers above a certain BAC
- use a comprehensive drug panel that included compounds from the American National Standards Institute/American Academy of Forensic Sciences Standards Board *Standard for the Analytical Scope and Sensitivity of Forensic Toxicological Testing of Blood in Impaired Driving Investigations*, ANSI/ASB Standard 120 (ANSI/ASB 2021)[39]
- use blood as a testing specimen to reflect a closer association to time of drug usage
- maintain data management systems that allow for the electronic transfer of deidentified toxicology data

The NTSB conducted outreach to identify and contact toxicology experts for this data collection effort. The purpose of this outreach was twofold. First, the NTSB sought to identify data from jurisdictions with laboratories that met the above criteria. Second, the NTSB elicited subject matter expert input from the toxicology community to understand the steps laboratories or jurisdictions took to expand and improve their testing programs and the obstacles they faced or continue to face when conducting and reporting on comprehensive testing.

The NTSB spoke with subject matter experts from the following organizations:

- Alabama Department of Forensic Sciences
- California Department of Justice Bureau of Forensic Services
- Colorado Department of Public Safety

[39] (a) A *drug compound* refers to drugs or drug metabolites. (b) The ANSI/ASB Standard 120 compounds include THC, carboxy-THC, 11-hydroxy-THC, methamphetamine, amphetamine, 3,4-methylenedioxyethylamphetamine (MDMA), 3,4-methylenedioxyamphetamine (MDA), cocaine, benzoylecgonine, cocaethylene, carisoprodol, meprobamate, zolpidem, alprazolam, clonazepam, 7-aminoclonazepam, lorazepam, diazepam, nordiazepam, oxazepam, temazepam, codeine, 6-acetylmorphine, buprenorphine, norbuprenorphine, fentanyl, hydrocodone, methadone, morphine, oxycodone, tramadol, and O-desmethyltramadol (ANSI/ASB 2021).

- Florida (multiple organizations represented)[40]
- Houston Forensic Science Center
- NSC ADID
- New York State Police
- North Louisiana Criminalistics Laboratory
- NMS Labs[41]
- Orange County, California, Crime Laboratory
- San Francisco Office of the Chief Medical Examiner
- San Diego County, California, Sheriff's Department
- Wisconsin State Laboratory of Hygiene

The subject matter experts provided valuable input about their experiences concerning driver toxicology testing. Four organizations identified by these subject matter experts had laboratory protocols and data that met the inclusion criteria and agreed to share data with the NTSB:

- Orange County, California, Crime Laboratory
- Wisconsin State Laboratory of Hygiene
- New York State Police Forensic Investigation Center
- San Francisco Office of the Chief Medical Examiner[42]

[40] Forensic Toxicology Laboratory at the University of Florida, Palm Beach County Sheriff's Office, Forensic and Clinical Toxicology Laboratory of the University of Miami School of Medicine, Florida Department of Law Enforcement Orlando Regional Laboratory and Tallahassee Regional Laboratory, Pinellas County Forensic Laboratory, Hillsborough County Medical Examiner's Office, Florida Department of Transportation, Florida Traffic Safety Resource Prosecutor, and Florida Impaired Driving Coalition.

[41] NMS Labs was formerly known as National Medical Services.

[42] For simplicity, throughout the remainder of this report, the Orange County Crime Laboratory will be referred to as the Orange County laboratory, the Wisconsin State Laboratory of Hygiene will be referred to as the Wisconsin laboratory, New York State Police Forensic Investigation Center will be referred to as the New York laboratory, and the San Francisco Office of the Chief Medical Examiner will be referred to as the San Francisco laboratory.

Many of the other organizations NTSB spoke with shared summaries or published data from their laboratories that provided insight into the procedures and findings of those laboratories (Harper 2020; Lee and Stout 2020; Lee, Stout, and Egdorf 2021; Rosenthal and Reed 2022).

2.4 Data Analysis Approach

The amount of data NTSB acquired for this research was substantial; specimens from many drivers were tested at each of these laboratories and those specimens were tested for a large number of drugs for each driver. A structured approach to coding and analyzing the toxicology data was necessary to guide the analysis and interpretation. This approach was developed through discussions with the NTSB medical officers and review of the drug toxicology literature; the toxicologists who provided data for this research also provided a technical review of the approach.

2.4.1 Development of Drug Categories and Subcategories

Drugs are complex, and many toxicology laboratories test for hundreds, if not more than a thousand, different drug compounds. The development of a drug classification scheme that comprehensively and accurately classifies drugs and their metabolites is helpful for interpretation of results and discussion. There is no universal method for classifying drugs, and numerous varying approaches exist in the traffic safety literature and field.[43] Based upon review of the existing drug classification schemes, and in close coordination with NTSB medical officers, the NTSB developed a novel method for drug classification and analysis.

[43] See the following for a few examples of these approaches: NHTSA's *2013–2014 National Roadside Study of Alcohol and Drug Use by Drivers: Drug Results* (Kelley-Baker and others 2017); the International Association of Chiefs of Police's "7 Drug Categories" webpage; the NTSB's *2013–2017 Update to Drug Use Trends in Aviation* (NTSB 2020a); the FDA's "Pharmacologic Class" webpage.

A full list of individual drugs and metabolites that were assessed within each category and subcategory is available in the NTSB public docket.[44] The drug categories and, when appropriate, subcategories resulting from the classification are listed in table 1. (Appendix C provides descriptions of the NTSB's drug categories and subcategories.) It should be noted that ethanol was differentiated from other non-ethanol alcohols in this categorization scheme and analysis. In the remainder of the report, ethanol will simply be referred to as alcohol.[45] Furthermore, this classification approach was designed to only categorize potentially impairing drugs. "Potentially impairing" was added before the "neuropsychiatric medications" and the "other" categories for extra clarity because many of these types of medications would not generally be impairing. However, all categories should be understood to only include examples of impairing drugs for this report.

[44] See the NTSB public docket, case number DCA21SS003.

[45] (a) Ethanol is the alcohol present in alcoholic beverages such as beer, wine, and spirits. (b) *Non-ethanol alcohols* tested for by the four laboratories included acetone, isopropanol, and methanol.

Table 1. NTSB potentially impairing drug categories and subcategories used for drug classification and analysis.

Drug Category	Drug Subcategory
Alcohol (Ethanol)	—
Non-Ethanol Alcohols	—
Cannabis	THC Other Cannabinoids
Potentially Impairing Neuropsychiatric Medications	Antidepressants Antiepileptics Antipsychotics Other Anxiolytics Other Potentially Impairing Neuropsychiatric Medications
Hallucinogens	—
Inhalants	—
Dissociative Anesthetics	—
Sedatives	Barbiturates Benzodiazepines Muscle Relaxants Sedating Antihistamines Sleep Aids Other Sedatives
Stimulants	Amphetamines Cocaine Methamphetamines Piperazines Other Stimulants
Narcotic Analgesics	Non-Fentanyl Opioids Fentanyls
Novel Psychoactive Substances	Synthetic Cannabinoids Synthetic Cathinones
Other Potentially Impairing Drugs	Anticholinergics Antiemetics Blood Pressure Medications Methorphan Migraine Medications Mitragynine Other Alkaloids Other (for example, butane)

Note: The em dash means not applicable.

2.4.2 Metabolite Coding

As drugs are metabolized by the human body, they break down into new compounds (that is, metabolites). The original drug taken by the user can often be identified by the detection of the parent drug, that is, the original drug taken, or its metabolites. For example, cannabis usage is often detected by the identification of the parent drug delta-9-THC or one of its common metabolites, such as 11-hydroxy-delta–9-THC or 11-nor-delta-9-carboxy-THC. In this case, testing positive for any of these compounds is evidence of cannabis usage, but the presence of all three of them should not be treated as multiple drug usage because they are the result of taking a single drug. This is critical because many parent drugs, such as cocaine, are rapidly metabolized below detectable levels and are often best detected through their metabolites. Further complicating analyses is that some parent drugs metabolize into active compounds that may also be taken as a parent drug; for example, codeine metabolizes into morphine.

As a part of this research, a comprehensive examination of drug metabolite pathways was conducted to capture the complexity of drug metabolism.[46] Specifically, the following coding and analysis rules were developed for the treatment of drugs and metabolites:

- The detection of a parent drug's metabolite(s) was coded as testing positive for use of the parent drug, even if the parent drug was not detected.
- The presence of multiple metabolites of a drug was not treated as multiple drug usage.
- Metabolites were generally coded as the highest detected parent drug. For example, if both diazepam and nordiazepam were detected, then they were solely coded as diazepam for analysis and reporting.

[46] See the NTSB public docket, case number DCA21SS003, for more information.

2.4.3 Identification of Potentially Impairing Drugs

The purpose of this research was to identify drugs that may potentially be impairing an individual's performance at the time of driving. There are numerous drugs that may be tested for by toxicology laboratories and included in common datasets, but many of those drugs are unlikely to actually influence or degrade an individual's driving performance. For example, many toxicology laboratories test for non-impairing drugs, such as nicotine, caffeine, and acetaminophen (commonly marketed as Tylenol). These and many other likely non-impairing drugs are included in FARS, and, without proper care, analyses of such data could lead to a significant overreporting of the prevalence of drug or multiple drug use that may impair driving.

Another key consideration, especially in a crash context, is that potentially impairing drugs may be given as a part of standard medical treatment following a crash. Although such drivers would clearly not have been influenced by these drugs at the time of driving, specimens drawn for drug testing after the administration of these drugs, as is often the case, would show the driver testing positive for these potentially impairing drugs. To address this concern, the NTSB identified drugs that were likely to be administered as a part of postcrash treatment. Both drugs that are likely non-impairing and likely administered as a part of postcrash medical treatment were removed from analysis for the present research. A full list of these drugs is available in the NTSB public docket.[47]

2.4.4 Analysis Approach

The laboratories that provided data for this research conduct drug testing that is more extensive than tests conducted for crash-involved drivers or impaired driving investigations in most US toxicology laboratories. The populations tested and the toxicology test protocols followed in the four laboratories were similar, but not identical. Therefore, the data could not be accurately combined for analysis. Each laboratory's dataset provides a meaningful snapshot of its particular population, but key differences in populations, drug panels, and testing protocols do not facilitate accurate aggregation of these data for combined analyses. Instead, each laboratory's data were analyzed and reported separately, and common themes across the results are discussed.

[47] See the NTSB public docket, case number DCA21SS003.

2.4.5 Interpretation

Several keys to interpretation and research limitations must be understood when discussing the toxicology results. The detection of a drug in these populations of drivers is evidence of recent usage of that drug but does not definitively demonstrate the driver was impaired at the time of driving or that other drugs not detected were not influencing the driver. Many drugs remain at detectable levels even after their influence on a driver's performance has dissipated. Alternately, many drugs that may have been influencing an individual at the time of driving may have metabolized out a driver's system by the time a specimen was taken for testing. That is, it is important to understand that long delays can occur between when a driver is arrested or involved in a crash and when a biological specimen is collected for toxicology testing. Every feasible step was taken to minimize these challenges, for example, using appropriate testing specimens, considering metabolites, and removing drugs that were likely administered postcrash.

The actual population of drivers tested must also be considered. For example, a set of drivers that were tested for impaired driving cases may not represent the entire population of impaired drivers in a locality because not all impaired drivers are arrested and not all arrested drivers are tested. Possible effects from these factors were not explored in the present research. Additionally, many law enforcement officers may not be as familiar with impaired driving that does not involve alcohol. It is possible that drivers impaired by other drugs are not arrested if they do not test at or above the legal limit on a breath testing device. Some individuals originally arrested for impaired driving may also have been suffering from a medical condition rather than drug impairment. These are important considerations for future research, but they are beyond the scope of the present research.

3. Results

This section discusses the results of the methods described in the previous section.

3.1 Literature Review

The literature review conducted in support of this research concentrated on two key areas: (1) the ways that certain drugs affect driving performance and (2) crash risk associated with drug and multiple drug use among drivers. The review focused on large-scale meta-analyses that combined the results from multiple high-quality peer-reviewed studies. Information gathered from the literature review provided context for many of the discussions throughout this report.

3.1.1 Estimates of How Various Drugs Affect Driving Performance

Driving is complex and requires attention and the simultaneous performance of several tasks. Researchers interested in how drugs may impair driving performance have measured different variables, such as lane weaving or lane departures, vehicle speed or speed variation, reaction times to environmental stimuli, and performance on divided-attention tasks. A given drug may affect some but not all driving-performance-related variables. Also, a drug may affect a driver in indirect ways that can affect performance. For example, if a drug increases risk-taking behaviors, such as speeding, a driver may lose control of the vehicle. Or if a drug causes drowsiness, a driver's reaction time may be slower.

Research in this area generally involves dosing participants and then assessing driving- or driving-related performance in controlled environments. For example, researchers may measure visual acuity or divided attention in laboratory settings or measure lane keeping, speed variability, or reaction time to hazards in simulated or actual driving environments. A strength of this type of research is that by using controlled doses and performance testing, a study may provide a detailed understanding of the ways a given drug may affect various types of driving-related performance. However, there are also limitations because researchers may be unable to test illicit drugs due to legal or ethical restrictions. Also, the controlled dosing and testing environments may not be reflective of real-world drug use or real-world driving conditions.

Significant work has been done to document which drugs may impair driving performance. For example, in 2004, NHTSA published a set of "Drugs and Human Performance Fact Sheets" for 16 different drugs or drug groups that were commonly

used at the time (Couper and Logan 2004).[48] The fact sheets were developed by a panel of international experts on drug-impaired driving and included information about each drug's chemistry, how it affects the body, its usage and dosage, and its performance effects. The fact sheets also included scientific references and recommended reading. In 2018, NHTSA began a project to update the 2004 fact sheets and to expand the number of drugs described.[49]

The Driving Under the Influence of Drugs, Alcohol and Medicines (DRUID) project, a 5-year effort involving 18 European countries, comprised numerous studies to assess the prevalence of use and risk of various drugs (Hels and others 2011). The project also conducted meta-analyses on data from 450 published papers on alcohol and 605 publications concerning medicines and illicit drugs to estimate the overall effects of different drugs and drug categories on performance. The DRUID project found that alcohol and several other drugs, including cannabis, and several benzodiazepines, sleep aids, antidepressants, and antihistamines, significantly and negatively affected fitness to drive.[50] Using these analyses, the project estimated the degree of impairment for different drugs and drug doses. However, the resulting report acknowledged that there was not enough information to fully assess all drugs or drug combinations (EMCDDA 2012).

More recent meta-analyses have confirmed and expanded the findings from the DRUID project. One meta-analysis demonstrated impairment in several driving-related tasks after cannabis use and that the impairment was greater for occasional users compared to regular users (McCartney and others 2021). Another found that alcohol, cannabis, and the combination of both drugs had a significant impairing effect on certain driving performance measures, and that the combination of the two drugs was more detrimental than either drug alone (Simmons and others 2022). Two meta-analyses that examined the effects of sleep aids on driving performance found that certain sleep aids, including zopiclone and zolpidem, were associated with impaired driving performance the morning after use (Roth and others 2014; McElroy and others 2021).

[48] The drugs were carisoprodol, cocaine, dextromethorphan, diazepam, diphenhydramine, gamma-hydroxybutyrate (GHB), ketamine, lysergic acid diethylamide (LSD), marijuana (cannabis), methadone, methamphetamine, MDMA, morphine, phencyclidine (PCP), toluene, and zolpidem.

[49] For more information, see the US Department of Transportation's (DOT) webpage "Update NHTSA's Drugs and Human Performance Fact Sheets."

[50] See appendix D for a summary of the DRUID meta-analysis results.

3.1.2 Crash Risk Associated with Individual Drugs or Drug Categories

In general, epidemiological studies that aim to assess the crash risk for different drugs compare the presence of drugs in populations of drivers involved in crashes of varying severity to a control group of comparable drivers who were not involved in crashes. These are referred to as case-control studies. By contrast, in responsibility studies, researchers compare drug presence in drivers deemed responsible for a multivehicle crash to drug presence in those drivers deemed not responsible. Drug presence is typically measured using toxicological analysis or driver self-report. Many studies also account for factors that may be related to both drug use and crash risk, such as driver age, sex, or other drug use.

Because of challenges in conducting this type of research, most studies have only assessed the crash risk associated with the presence of a drug, as opposed to concentrations of a drug or actual impairment from that drug. By contrast, research on alcohol has been able to quantify the crash risk associated with different BACs compared to drivers with a BAC of 0.00 g/dL. One case-control study used data from more than 10,000 crash- and non-crash-involved drivers in California and Florida; it found that a statistically significant elevated crash risk began at a BAC of 0.04 g/dL and rose steeply at higher BACs (Blomberg and others 2005). As shown in figure 3, at a BAC of 0.08 g/dL, the per se impairment level in most states, the crash risk was more than 2.5 times higher, and at a BAC of 0.10 g/dL, the crash risk was nearly 5 times higher. A separate meta-analysis, which combined data from eight studies of alcohol and crash risk, found a similar dose-risk curve (Taylor and others 2010).

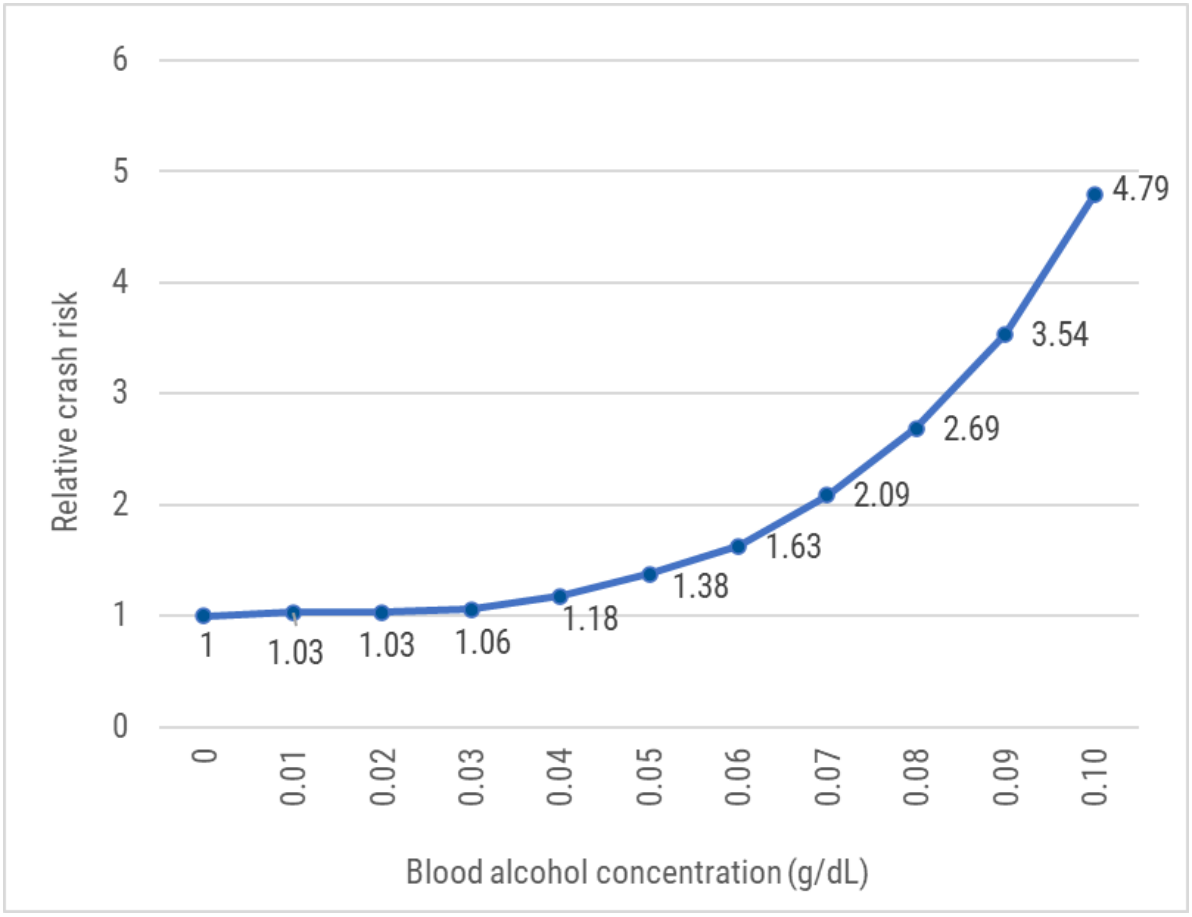

Figure 3. Relative crash risk associated with different BACs (Source: Blomberg and others 2005).

For other drugs besides alcohol, table 2 documents findings from several meta-analyses.[51] Most of the findings come from a meta-analysis conducted by Elvik (2013) that included 264 risk estimates from 66 studies published between 1976 and 2011. In this table, relative risk indicates the likelihood of a crash or the likelihood that a driver was deemed responsible for a crash with a drug present compared to drivers without a drug present.

[51] The meta-analyses referenced in table 2 combined multiple studies that may have defined drugs or drug categories differently.

Table 2. Meta-analysis findings from Elvik 2013, unless otherwise indicated; statistically significant crash risk findings are indicated with an asterisk.

Drug or Drug Category	Crash Severity or Responsibility	Odds Ratio[f]	95% Confidence Interval[g]
Amphetamine	Fatal crashes	5.17*	2.56–10.42
	Injury crashes	6.19*	3.46–11.06
	Property damage crashes	8.67*	3.23–23.32
Analgesics	Injury crashes	1.02	0.89–1.16
Antiasthmatics	Injury crashes	1.31*	1.07–1.59
Antidepressants	Injury crashes	1.35*	1.11–1.65
	Property damage crashes	1.28	0.90–1.80
Antihistamines	Injury crashes	1.12*	1.02–1.22
Benzodiazepines	Fatal crashes	2.30*	1.59–3.32
	Injury crashes	1.17*	1.08–1.28
	Property damage crashes	1.35*	1.04–1.76
	All crashes[a]	1.59*	1.10–2.31
	All crashes[a]	1.81*	1.35–2.43
	Crash responsibility[a]	1.41*	1.03–1.94
Cannabis	Fatal crashes	1.26	0.88–1.81
	Injury crashes	1.10	0.88–1.39
	Property damage crashes	1.26*	1.04–1.76
	All crashes[b]	2.66*	2.07–3.41
	All crashes[c]	1.32*	1.09–1.59
	All crashes[d]	1.92*	1.35–2.73
Cocaine	Fatal crashes	2.96*	1.18–7.38
	Injury crashes	1.66	0.91–3.02
	Property damage crashes	1.44	0.93–2.23
Opiates	Fatal crashes	1.68*	1.01–2.81
	Injury crashes	1.91*	1.48–2.45
	Property damage crashes	4.76*	2.10–10.80
Opioids (prescription)	All crashes[e]	2.29*	1.51–3.48
	Crash responsibility[e]	1.47*	1.01–2.13
Penicillin	Injury crashes	1.12	0.91–1.39
Zopiclone	Fatal crashes	2.60	0.89–7.56
	Injury crashes	1.42	0.87–2.31
	Property damage crashes	4.00*	1.31–12.21

a. The source for this information is Dassanayake and others 2011.

b. The source for this information is Li and others 2012.

c. The source for this information is Rogeberg, Elvik, and White 2018.

d. The source for this information is Asbridge, Hayden, and Cartwright 2012.

e. The source for this information is Chihuri and Li 2017.

f. The odds ratio estimates the odds of crash involvement or crash responsibility when a drug is present compared to when it is not present. An estimate greater than 1 indicated that a drug increased risk, and an estimate less than 1 would indicate that a drug reduced risk.

g. A 95% confidence interval is a range of values above and below an estimate used to interpret the estimate's accuracy and precision. The estimates with 95% confidence intervals that did not include 1 were considered significant and predictive in terms of changes in risk.

The results from the studies described above suggest that several drugs or drug categories are associated with significantly increased crash risk or increased likelihood of responsibility in a multivehicle crash. There was a clear pattern of significantly increased risk associated with alcohol, amphetamine, benzodiazepines, and opioids. For several other drugs and drug categories, one or more meta-analyses indicated increased risk for certain types of crashes. However, an association between a drug category and crash risk does not mean that every drug within that category necessarily increases crash risk. For example, tricyclic antidepressants are generally considered to be more impairing than selective serotonin reuptake inhibitors, which are also used as antidepressants. Further, many antidepressants may not only improve an individual's overall health but may indeed help with potentially impairing medical conditions, such as depression (Aduen and others 2018).

3.1.3 Crash Risk Associated with Multiple Drug Use

The research challenges for understanding the effects of a single drug are greatly multiplied when examining drug combinations. There are nearly unlimited combinations of drugs that may each affect a given driver differently. This may limit the availability of meta-analyses that rely on multiple studies addressing the same research question. Yet, one such meta-analysis found that the drug combination of alcohol and benzodiazepines was associated with a greater than 7-fold increased crash risk compared to drivers who tested negative for all drugs (Dassanayake and others 2011).[52]

For drug combinations not assessed through meta-analysis, findings can be derived from epidemiological studies. For example, the DRUID project compared drug presence from crash-involved drivers (cases) to non-crash-involved drivers (controls) to assess the crash risks of individual drugs as well as the risks associated with combining alcohol with other drugs and multiple drug use that did not include

[52] (a) The odds ratio was 7.69, and the 95% confidence interval was 4.33–13.65.
(b) Benzodiazepines and alcohol are known to have additive effects due to both drugs acting on gamma-aminobutyric acid (GABA) receptors. This means taking benzodiazepines will increase the impairing effects of alcohol. Other drugs interact differently with alcohol, which will impact both the quantity of alcohol required for impairment as well as the strength of the impairing effects of a given quantity of alcohol.

alcohol (Hels and others 2011).[53] The aggregated results showed that the odds of drivers being seriously injured in a crash, compared to drivers who tested negative for drugs, were more than 28 times higher for drivers who tested positive for alcohol combined with other drugs and 8 times higher for drivers who tested positive for more than one nonalcohol drug.[54] The aggregated results from fatally injured drivers showed similar results. Drivers who tested positive for alcohol combined with other drugs had a crash risk more than 31 times higher than drivers who tested negative for the presence of drugs or alcohol.[55] For drivers who tested positive for more than one nonalcohol drug, the risk was more than 18 times higher.[56] A separate analysis of a subset of the DRUID project data collected in Belgium examined drug category combinations, including alcohol and sedatives, alcohol and stimulants, multiple sedatives, and stimulants and sedatives (Kuypers and others 2012). The crash risk associated with each of the combinations was found to be significant and ranged from 13 to 210 times greater for drivers who tested positive for these drug combinations than for drivers with negative drug tests.[57] However, the authors noted that a study limitation was the small sample sizes of drivers who tested positive for certain drugs and drug combinations. Additionally, a limitation of both studies was the fact that some individuals in the control group population refused to participate. If those who refused were more likely to have used alcohol or other drugs, the risk estimates could be inflated.

[53] The drugs studied in the DRUID project included alcohol, 6-acetylmorphine (6-AM), alprazolam, amphetamine, benzoylecgonine, cannabis, clonazepam, cocaine, codeine, diazepam, flunitrazepam, lorazepam, MDA, 3,4-methylenedioxy-N-ethylamphetamine (MDEA), MDMA, methadone, methamphetamine, morphine, nordiazepam, oxazepam, zolpidem, and zopiclone. Tramadol, 7-amino-clonazepam, and 7-amino-flunitrazepam were tested for in most but not all countries (Hels and others 2011).

[54] For drivers who tested positive for alcohol combined with other drugs, the odds ratio was 28.82, and the 95% confidence interval was 18.41–45.11. For drivers who tested positive for more than one nonalcohol drug, the odds ratio was 8.01, and the 95% confidence interval was 5.34–12.01.

[55] The odds ratio was 31.52, and the 95% confidence interval was 16.83–59.05.

[56] The odds ratio was 18.51, and the 95% confidence interval was 10.84–31.63.

[57] For alcohol and sedatives, the odds ratio was 67.19, and the 95% confidence interval was 23.91–188.84. For alcohol and stimulants, the odds ratio was 20.34, and the 95% confidence interval was 4.93–83.82. For multiple sedatives, the odds ratio was 13.70, and the 95% confidence interval was 2.95–63.66. For stimulants and sedatives, the odds ratio was 210.97, and the 95% confidence interval was 4.90–9088.71.

A study using data from 3,398 fatally injured drivers from the Australian states of Victoria, New South Wales, and Western Australia found that drivers with both a BAC ≥0.05 g/dL and the presence of THC in their blood were nearly three times more likely to be deemed responsible for a crash than drivers with a BAC ≥0.05 g/dL alone (Drummer and others 2004).[58] A similar study using US data found that drivers with a combination of THC and a BAC >0.00 g/dL but <0.05 g/dL were 3.42 times more likely to be found responsible for a crash than drivers with no alcohol or other drugs detected in their system (Romano, Voas, and Camp 2017). The same study did not find a significant likelihood of crash responsibility for drivers with a BAC >0.00 g/dL but <0.05 g/dL and no other drugs present, suggesting that it was the combination of alcohol and cannabis that led to the elevated risk. However, it is important to interpret this US study with caution because it relied on FARS drug data, which has significant limitations. Further, it is important to note that not all case-control studies have identified significant risk associated with multiple drug use. For example, a NHTSA-sponsored study conducted in Virginia Beach, Virginia, involving more than 3,000 crash-involved drivers and 6,000 matched controls, found a significant crash risk for alcohol but not for other drugs or drug combinations when controlling for demographic variables (Lacey and others 2016).

Epidemiological studies, such as those described in this section, are valuable because they can provide insights about overall association between drug use and crash risk. However, an epidemiological link between a drug or class of drugs and crashing does not necessarily mean that a drug is dangerous to use while driving under all circumstances. For example, epidemiological studies do not generally look at the dose or whether a driver was using a drug as directed by their health care provider. Nonetheless, when findings from epidemiological research, and particularly meta-analyses of epidemiological studies, are considered alongside studies of how drugs or drug combinations affect driving-related performance, they can provide a more nuanced understanding of how different drugs affect driving safety.

[58] The odds ratio was 2.9, and the 95% confidence interval was 1.1–7.7.

3.1.4 Summary of Drugs that Impair Performance and Increase Crash Risk

In summary, many studies have been conducted to assess (1) how various drugs affect driving and driving-related performance and (2) the association between the use of various drugs and either crash risk or crash responsibility. Both of these factors are important to consider when evaluating how a given drug or drug combination may affect driving safety. A review of these studies as well as several meta-analyses, which systemically combine the results of multiple previous independent studies relevant to an issue, allowed for the identification of some of the drugs and drug categories that can affect driving safety. The NTSB concludes that multiple drugs and drug categories—including alcohol, cannabis, and numerous illicit, prescription, and OTC drugs—can impair driving performance and are associated with increased crash risk. As shown in table 2, some of these drugs are riskier and affect performance more than others. It is also important to recall that some drugs are medically necessary and may make drivers safer than not taking the drugs, and in some cases, an underlying condition a drug is treating may also increase crash risk independent from the drug effects.

3.2 FARS Analyses

In 2012, the NTSB issued recommendations to states to increase collection, documentation, and reporting of BAC results using NHTSA best practice guidance, with a goal of achieving BAC reporting rates of at least 80% of fatally injured drivers and at least 60% of surviving drivers in fatal crashes (H-12-34, H-12-35).[59] At the time, the national BAC reporting rates were 69% for fatally injured drivers and 28% for surviving drivers in fatal crashes. For the present research, we compiled data from the 3 most recent years with available data: 2018, 2019, and 2020. As shown in table 3, the rates of BAC reporting were on average about 5 percentage points lower in the most recent 3 years than in 2012 for both fatally injured and surviving drivers (NCSA 2014, 2019, 2020, 2021, 2022a).

[59] Each individual state received a classification based on its response to Safety Recommendations H-12-34 and H-12-35. Both recommendations have an overall classification of Open—Acceptable Response. See appendix A for more information.

Table 3. Proportions of fatally injured and surviving drivers in fatal crashes in the United States with BACs reported in FARS.

Year	2012	2018	2019	2020[a]
Fatally Injured	69%	65%	65%	58%
Surviving	28%	23%	24%	22%

a. The COVID-19 public health emergency took place in 2020, which may have affected testing rates during this period.

Additional analyses were conducted to examine testing rates for drugs other than alcohol.[60] As shown in table 4, the proportions of drivers reported as drug tested were also lower, on average, over the most recent 3 years tested compared to 2012.

Table 4. Proportions of fatally injured and surviving drivers in fatal crashes in the United States that were reportedly drug tested based on FARS data.

Year	2012	2018	2019	2020[a]
Fatally Injured	61%	65%	60%	54%
Surviving	21%	19%	18%	17%

a. The COVID-19 public health emergency took place in 2020, which may have affected testing rates during this period.

The availability of drug test results varied greatly by state in 2020, as shown in figure 4. For example, for Montana, FARS reported drug testing for more than 80% of drivers in fatal crashes. By contrast, there were eight states with drug tests reported for less than 20% of drivers in fatal crashes, and for two states, the proportion was less than 5%. The availability of this information in FARS does not necessarily reflect the actual testing rates within each state; it may reflect the level of test reporting to FARS analysts.

[60] FARS maintains alcohol and other drug data in separate data files.

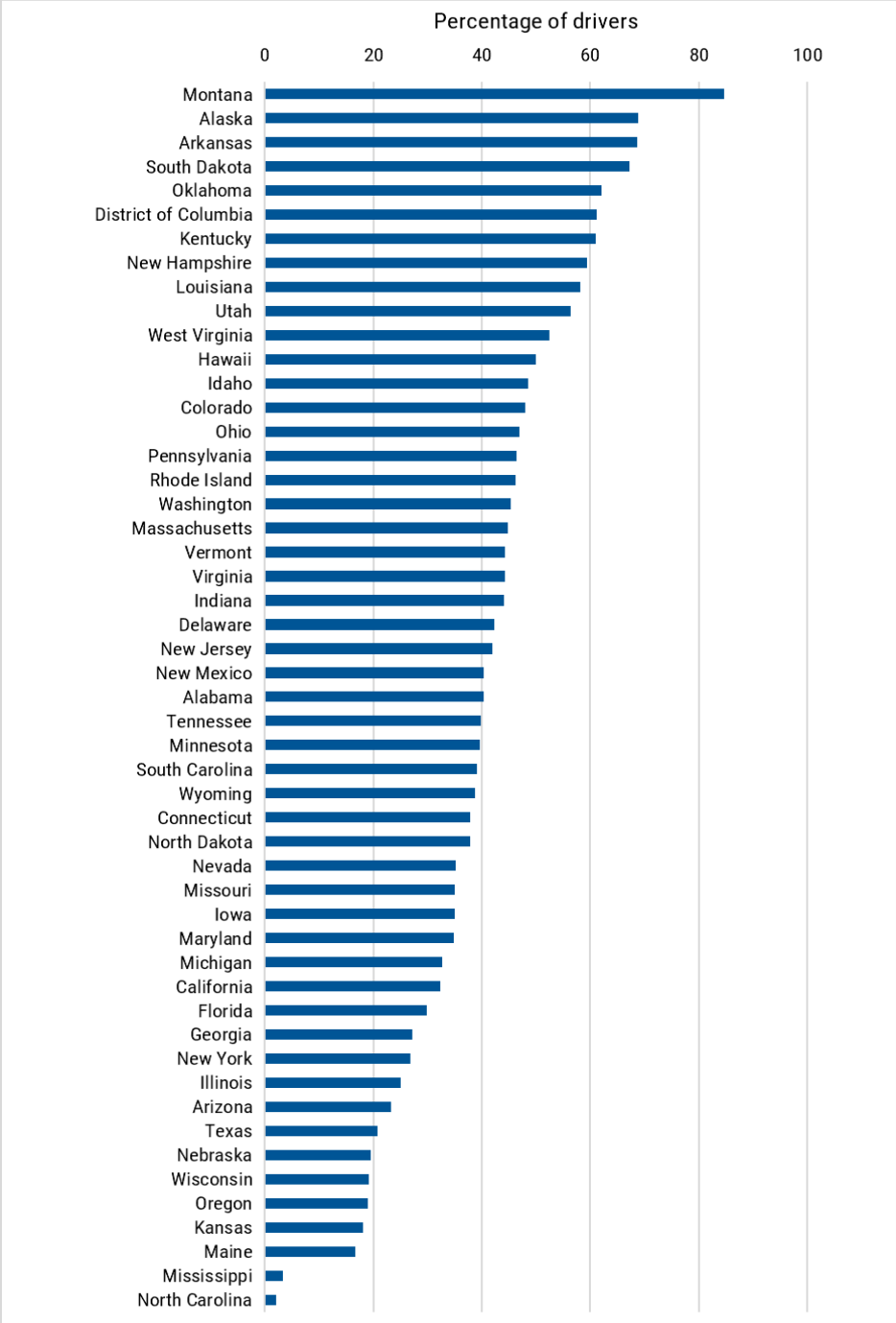

Figure 4. Percentage of drivers in fatal crashes tested for drugs by state, reported to FARS, 2020.

The review of FARS data showed that for the majority of drivers, there are no reported test results for drugs other than alcohol and that reporting rates vary greatly across states. Further, reports from NHTSA, the agency that maintains FARS, cautions against the usage of drug data in FARS for prevalence analyses (Berning and Smither

2014; Berning and others 2022). Therefore, the NTSB concludes that drug data in national-level databases continue to be unreliable and cannot be used to estimate drug prevalence among drivers.

3.3 Toxicology Analyses from Four Jurisdictions

As noted previously, four laboratories met the inclusion criteria for this research and agreed to share data with the NTSB for independent analysis. Separate analyses were conducted on each of these datasets. Data from each laboratory were unable to be reasonably aggregated into a single analysis due to key differences among laboratories. This included the population of drivers being tested, the number of drugs tested at each laboratory, and other differences in laboratory protocols. However, the results across laboratories may be examined in parallel to draw conclusions regarding drug prevalence.

The four laboratories and the type of data they provided are described below.

- The **Orange County laboratory** provided 2 years of data between August 1, 2018, and July 30, 2020, on 14,051 drivers arrested for impaired driving offenses.
- The **Wisconsin laboratory** provided a database that included two populations of drivers that were comprehensively and consistently tested for drugs. The first population was fatally injured drivers. The second population was crash-involved drivers arrested for impaired driving offenses. Data were provided from January 1, 2019, to March 31, 2021, for both populations. This resulted in 9,569 crash-involved arrested drivers and 406 fatally injured drivers.
- The **San Francisco laboratory** provided over 3 years of data between March 20, 2015, and December 31, 2018, from 2,075 drivers arrested for impaired driving. All 2,075 drivers were tested for alcohol locally by the San Francisco Office of the Chief Medical Examiner. Blood specimens of these drivers were analyzed by NMS Labs for all other drugs.
- The **New York laboratory** provided 11 months of data between May 7, 2020, to June 8, 2021, from drivers suspected of impaired driving in a crash that involved a fatal or serious physical injury. All drivers were tested for alcohol and other drugs. Due to the sample size (217 total drivers), both of these populations were analyzed together for this research.[61]

[61] (a) Throughout the remainder of this report, these will be referred to as arrest cases for comparison as these cases usually involve an arrest. (b) All cases received by the New York laboratory involving a crash with a fatality or a serious injury are comprehensively tested for all drugs.

Table 5 provides an overview of the data provided by each of the four laboratories. It shows the number of compounds tested, number of drivers tested, and key data characteristics. For a full list of compounds tested by each laboratory, see appendix E.

Table 5. Summary of characteristics of the laboratories and datasets included in this research.

Data Provided	Orange County Laboratory	Wisconsin Laboratory	Wisconsin Laboratory	San Francisco Laboratory	New York Laboratory
Driver Population	Impaired driving arrests	Crash-involved impaired driving arrests	Crash-involved fatally injured	Impaired driving arrests	Crash-involved suspected impaired driving cases involving fatality or serious injury
Potentially Impairing Compounds Tested	183	136	136	54	39
Data Start Date	8/1/2018	1/1/2019	1/1/2019	3/20/2015	5/7/2020
Data End Date	7/30/2020	3/31/2021	3/31/2021	12/31/2018	6/8/2021
Sample Size	14,051	9,569	406	2,075	217
Age	Yes	Yes	Yes	Yes	Yes
Sex	Yes	Yes	Yes	No	Yes
Incident Date	No	Yes	Yes	Yes	Yes
Time Between Arrest and Blood Collection	No	Yes	No	Yes	Yes

Analyzing substance usage across categories represents the most likely and prominent effects of mixing drugs, aids interpretations, and provides clear areas for potential countermeasure development. For this reason, the analyses in this section were primarily focused on drug categories and subcategories rather than individual compounds or drugs. To reduce redundant reporting of results across laboratories, such as detailed demographic breakdowns, results are reported using the best suited dataset(s) for the specific analysis.

3.3.1 Overall Drug Prevalence

Across all data from the four laboratories, the vast majority of drivers arrested for impaired driving tested positive for at least one potentially impairing drug, as detailed in table 6.

Table 6. Prevalence of potentially impairing drugs in the five driver populations studied.

	Orange County Laboratory	Wisconsin Laboratory Crash-Involved Impaired Driving Arrests	Wisconsin Laboratory Crash-Involved Fatally Injured	San Francisco Laboratory	New York Laboratory
Total Sample	14,051	9,569	406	2,075	217
Drivers Testing Positive	13,903	9,073	289	2,040	171
Percentage of Drivers Testing Positive	98.9%	94.8%	71.2%	98.3%	79.8%

It would be expected that drivers arrested for impaired driving offenses would be highly likely to test positive for at least one potentially impairing drug since suspected driver impairment led to the impaired driving arrest. By contrast, the fact that 71.2% of drivers in the fatally injured population tested positive for at least one potentially impairing drug could be considered high knowing that not all fatally injured drivers are responsible for crashes.

Figure 5 shows the percentages of drivers testing positive by drug category across all laboratories and populations. Note that the percentages in the figure sum to more than 100% because some drivers were positive for multiple drug categories.[62] Alcohol was by far the most commonly detected drug. It was detected in between 55% and 78% of the drivers in the impaired driving datasets. Alcohol was also the most commonly detected drug for the fatally injured drivers, with a positivity rate of about 44%. The second most commonly detected drug in all datasets was cannabis. Cannabis was detected in over 30% of drivers in the impaired driver arrest populations and in 20% of the fatally injured drivers. The next most common categories of detected drugs were stimulants, sedatives, and narcotic analgesics.

[62] See section 3.3.4 of this report for further discussion of the combinations of drug categories that drivers tested positive for in each population examined.

These categories varied slightly in the order in which they were most commonly detected by laboratory.[63]

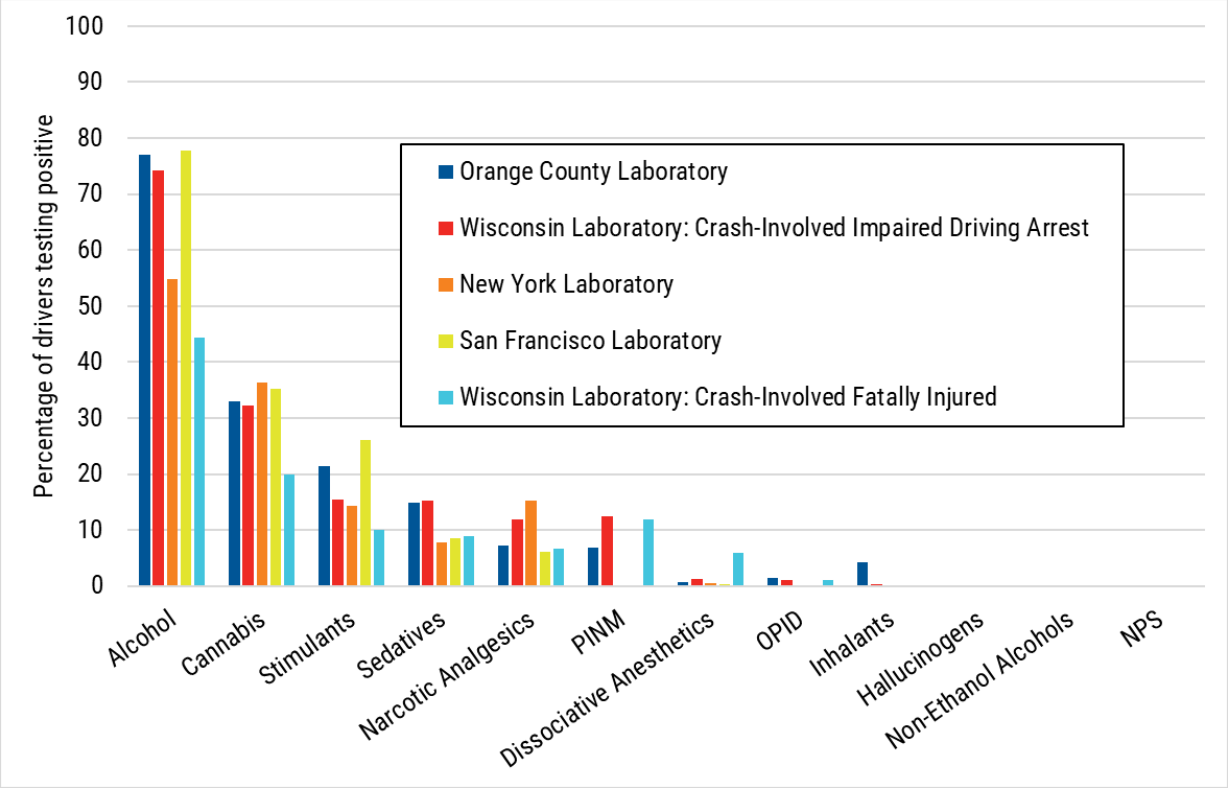

Figure 5. Percentage of drivers testing positive for each drug category by laboratory dataset.

Note: PINM refers to potentially impairing neuropsychiatric medications, OPID refers to other potentially impairing drugs, and NPS refers to novel psychoactive substances.

[63] Differences in the detection of drug categories across laboratories may reflect regional differences in drug prevalence or variance in laboratory testing procedures. Not all laboratories tested for the same number of drugs within each category and fewer drugs tested in a category would result in a lower prevalence for that category. For example, the New York laboratory did not test for any potentially impairing neuropsychiatric medications

3.3.2 Results by Subcategory

The prevalence of subcategories of drugs was also explored. This provides a more granular analysis of drugs that were detected in each of the driver populations. Table 7 shows the frequency and percentage of drivers testing positive for drug categories and subcategories for the impaired driving arrest population from the Orange County laboratory and the crash-involved impaired driving arrest population from the Wisconsin laboratory. These laboratories are highlighted due to their comparatively large sample sizes and extensive drug panels that best allow for examining subcategory prevalence. Looking at these two populations demonstrates some consistencies in drug subcategory prevalence, as well as variations that could be attributable to differences in drug use patterns by region or variance in overall testing protocols. For example, in both populations, benzodiazepines were the most commonly detected sedative. Similarly, methamphetamine and cocaine were consistently the most commonly detected stimulants. However, methamphetamine was more than 2.5 times more likely to be detected in the Orange County laboratory data (13.2%) than in the Wisconsin laboratory data (5.2%). It should be noted many of these similarities extended to all five laboratory populations. This includes benzodiazepines consistently emerging as the most common sedative subcategory and methamphetamine and cocaine emerging as the most common stimulant subcategories.

Table 7. Drug category and subcategory prevalence for drivers arrested for impaired driving from the Orange County laboratory and crash-involved impaired driving from the Wisconsin laboratory.

Drug Category and Subcategory	Orange County Laboratory Frequency	Orange County Laboratory Percent	Wisconsin Laboratory Frequency	Wisconsin Laboratory Percent
Alcohol (Ethanol)	10,827	77.1%	7,112	74.3%
Non-Ethanol Alcohols	13	0.1%	3	<0.1%
Cannabis	4,623	32.9%	3,090	32.3%
THC	4,613	32.8%	3,090	32.3%
Other Cannabinoids	10	0.1%	not tested	—
Potentially Impairing Neuropsychiatric Medications	975	6.9%	1,198	12.5%
Antidepressants	451	3.2%	347	3.6%
Antiepileptics	410	2.9%	795	8.3%
Antipsychotics	348	2.5%	310	3.2%
Anxiolytics	5	<0.1%	11	0.1%
Other Potentially Impairing Neuropsychiatric Medications	2	<0.1%	3	<0.1%
Narcotic Analgesics	1,030	7.3%	1,135	11.9%
Non-Fentanyl Opioids	860	6.1%	650	6.8%
Fentanyls	303	2.2%	737	7.7%
Hallucinogens	19	0.1%	7	0.1%
Inhalants	596	4.2%	33	0.3%
Dissociative Anesthetics	80	0.6%	127	1.3%
Sedatives	2,084	14.8%	1,461	15.3%
Barbiturates	33	0.2%	22	0.2%
Benzodiazepines	1,374	9.8%	1,172	12.3%
Muscle Relaxants	225	1.6%	47	0.5%
Sedating Antihistamines	813	5.8%	317	3.3%
Sleep Aids	96	0.7%	100	1.1%
Other Sedatives	—	—	4	<0.1%
Stimulants	3,000	21.4%	1,478	15.5%
Amphetamines	324	2.3%	229	2.4%
Cocaine	978	7.0%	840	8.8%
Methamphetamine	1,856	13.2%	501	5.2%
Piperazines	5	<0.1%	1	<0.1%
Other Stimulants	39	0.3%	11	0.1%
Novel Psychoactive Substances	not tested	—	2	<0.1%
Synthetic Cathinones	not tested	—	0	0.0%
Synthetic Cannabinoids	not tested	—	2	<0.1%
Other Potentially Impairing Drugs	207	1.5%	102	1.1%
Anticholinergics	23	0.2%	0	0.0%
Antiemetics	6	<0.1%	15	0.2%
Methorphan	121	0.9%	45	0.5%
Migraine Medications	6	<0.1%	not tested	—
Mitragynine	56	0.4%	43	0.5%

Note: (a) Subcategories do not sum to categories because a person who tested positive for multiple subcategories within one category would only be counted once at the category level. (b) The em dash means no data available.

3.3.3 Results by Sex

Information on the sex of the driver was provided to the NTSB by all of the laboratories except for the San Francisco laboratory. This allowed for the examination of differences in the prevalence of various drug categories by sex. Figure 6 displays the percentage of drivers testing positive for each drug category by sex in the Orange County laboratory dataset. This laboratory was chosen as an exemplar due to its large sample size and the representativeness of these results across other datasets. Out of the 13,942 drivers with a recorded sex in the Orange County laboratory dataset, 10,840 (77.8%) were male and 3,102 were female (22.2%).

Although alcohol and cannabis were the most commonly detected drugs for both sexes in all datasets, there were significant differences between sexes observed in which other drug categories were most prevalent. In the Orange County laboratory dataset, males were significantly more likely to test positive for cannabis and stimulants. Females were significantly more likely to test positive for alcohol, sedatives, potentially impairing neuropsychiatric medications, non-ethanol alcohols, and other potentially impairing drugs. Across all datasets, there was a tendency for males to test positive at a higher rate for drugs that are commonly used illicitly, and for females to test positive for drugs that are most commonly used legally and/or with a prescription.

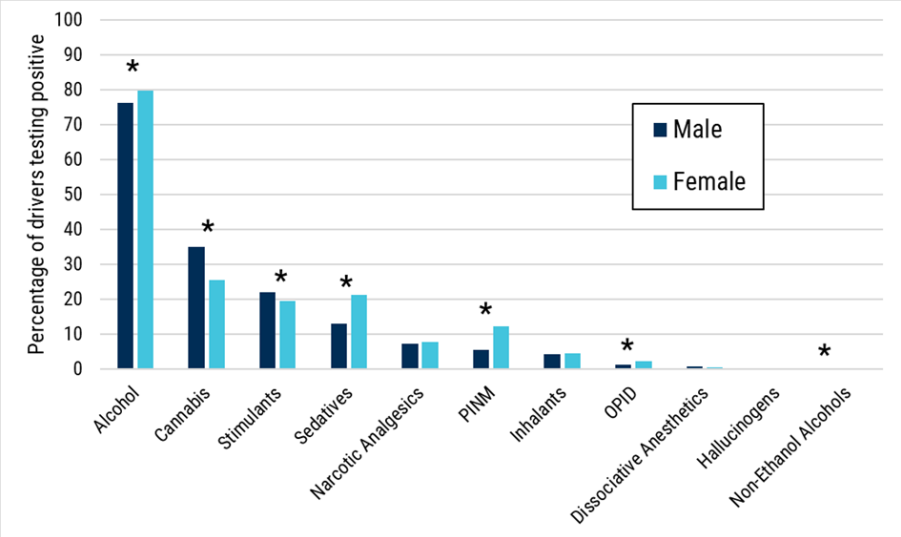

Figure 6. Percentage of drivers testing positive for each drug category by sex in the Orange County laboratory dataset.

Note: (a) The asterisk symbol indicates that the group difference between the sexes from the chi-square test was statistically significant at $p < 0.05$. (b) PINM refers to potentially impairing neuropsychiatric medications, and OPID refers to other potentially impairing drugs. (c) Females were significantly more likely to test positive for non-ethanol alcohols (0.23%) as compared to males (0.06%).

3.3.4 Driving with Multiple Categories of Drugs

Multiple drug presence was determined by examining the combinations of drug categories that drivers tested positive for in each population. Combinations of drug categories were examined rather than combinations of individual drugs or drug subcategories to assess the most common drug combinations and for easier interpretability of results.[64] For example, the Orange County laboratory alone had 266 distinct combinations of drug categories in its sample of 14,051 drivers. This number would have been exponentially greater for combinations of individual drugs and would have made meaningful interpretation of the results more difficult.

3.3.4.1 Overall Prevalence of Multiple Drug Categories

Figure 7 shows the percentage of drivers who tested positive for varying numbers of drug categories. For the impaired-driving arrest populations, about half tested positive for two or more drug categories. In the Wisconsin fatally injured driver population, about 28% tested positive for two or more drug categories.

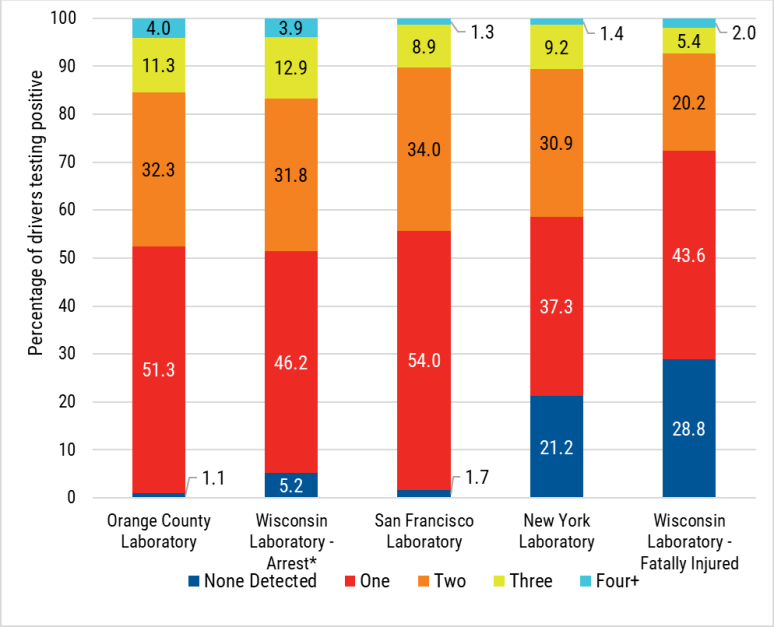

Figure 7. Percentage of drivers testing positive for multiple drug categories in each laboratory dataset.

Note: The asterisk on the category "Wisconsin Laboratory – Arrest" refers to crash-involved drivers arrested for impaired driving.

[64] As a result, if a driver tested positive for multiple drugs within one category, that driver was classified as using a single drug category.

3.3.4.2 Specific Combinations of Multiple Category Drug Presence

There were hundreds of combinations of drug categories within the drivers tested. Table 8 shows the most common drug categories (where only one category of drug was detected) and combinations of drug categories from the Orange County laboratory dataset. This dataset highlights the wide variety of drug combinations detected in drivers in this research. There was significant variance in the prevalence of these combinations across the datasets. However, the most frequently detected combination of multiple drug categories across all datasets was alcohol and cannabis. No other combination of drug categories had a prevalence greater than 10% across any of the datasets analyzed.

Table 8. Frequency of commonly observed drug categories and drug category combinations in the Orange County laboratory dataset.

Drug Categories and Combinations of Drug Categories	Frequency	Overall Percent
Alcohol Only	5,926	42.17
Alcohol and Cannabis	2,022	14.39
Alcohol and Stimulants	739	5.26
Cannabis Only	685	4.88
Stimulants Only	455	3.24
Alcohol, Cannabis, and Stimulants	376	2.68
Alcohol and Sedatives	356	2.53
Cannabis and Stimulants	264	1.88
Cannabis and Sedatives	175	1.25
Alcohol, Cannabis, and Sedatives	166	1.18
Narcotic Analgesics and Stimulants	157	1.12
No Alcohol or Other Drugs Detected	148	1.05
Alcohol and Inhalants	143	1.02
Alcohol and Potentially Impairing Neuropsychiatric Medications	143	1.02
All Other Single Drug Categories or Combinations of Drug Categories	2,296	16.34
Total	**14,051**	**100.00**

3.3.4.3 Alcohol and Cannabis

Alcohol and cannabis, as well as their combined use with each other and other drugs, were further examined because they were the most frequently observed combination of drug categories across all laboratories. Figure 8 shows the distribution of drivers from the Orange County laboratory and the Wisconsin laboratory datasets on impaired driver arrests relative to the presence of alcohol, cannabis, or both. These two datasets are highlighted for their relatively large sample sizes as well as the representativeness of the results across the other datasets. Strong similarities can be seen between these datasets. In both the Orange County laboratory and the Wisconsin laboratory datasets, the vast majority of drivers—89% in the Orange County data on impaired driving arrests and 84% in the Wisconsin data on crash-involved impaired driving arrests—tested positive for alcohol and/or cannabis. Over half of drivers tested positive for alcohol, but not cannabis. Over 20% had both alcohol and cannabis while about 10% tested positive for cannabis, but not alcohol. Although cannabis was the second most commonly detected drug behind alcohol, cannabis was often detected in combination with alcohol.

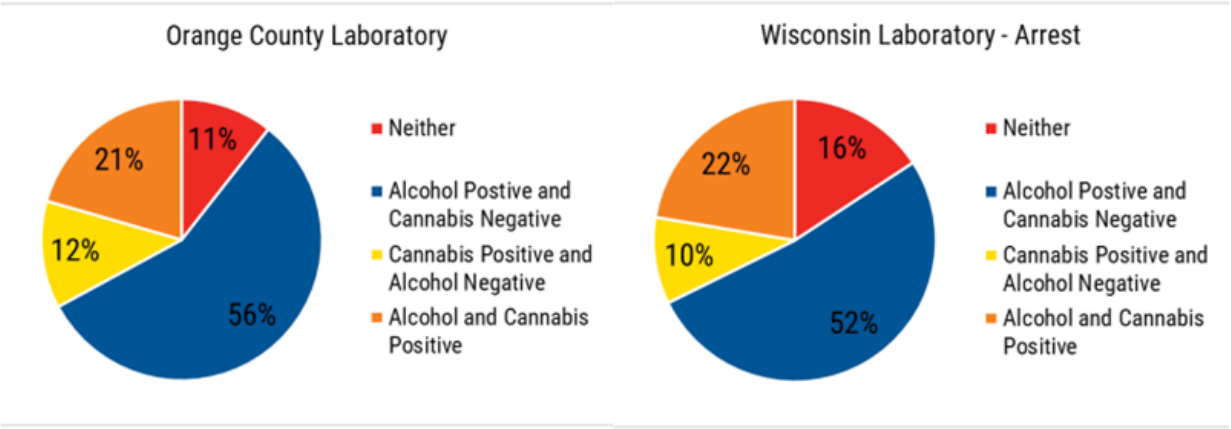

Figure 8. Distribution of alcohol and cannabis in the Orange County laboratory data on drivers arrested for impaired driving and the Wisconsin laboratory data on crash-involved drivers arrested for impaired driving.

Table 9 further examines the prevalence of alcohol and multiple drug combinations among all potentially impairing drugs included in the present research. Results show that these drivers were slightly more likely to only have alcohol in their system as compared to alcohol plus at least one other potentially impairing drug. This was observed in four of the five laboratory populations, with the New York laboratory as the exception.

Table 9. The prevalence of alcohol alone, in combination with other drugs, and overall for each driver population.

Alcohol	Orange County Laboratory	Wisconsin Laboratory (Crash-Involved Impaired Driving Arrests)	Wisconsin Laboratory (Crash-Involved Fatally Injured Drivers)	San Francisco Laboratory	New York Laboratory
Alcohol Only	42.2%	39.7%	26.9%	43.6%	22.6%
Alcohol and Other Drugs	34.9%	34.6%	17.4%	34.1%	32.3%
Alcohol Total	77.1%	74.3%	44.3%	77.7%	54.9%

Table 10 further explores the prevalence of cannabis detected alone, in combination with alcohol, and in combination with other drugs (excluding alcohol). Despite nearly one-third of drivers testing positive for cannabis across all populations, cannabis alone was infrequently detected in these populations, ranging from 2.9% to 8.8%. Cannabis was most frequently found in combination with alcohol, but it was also found in combination with additional drugs other than alcohol.

Table 10. The prevalence of cannabis alone, in combination with other drugs, and overall for each laboratory sample driver population.

Drug Category	Orange County Laboratory	Wisconsin Laboratory (Crash-Involved Impaired Driving Arrests)	Wisconsin Laboratory (Crash-Involved Fatally Injured Drivers)	San Francisco Laboratory	New York Laboratory
Cannabis Only	4.9%	2.9%	5.2%	5.5%	8.8%
Cannabis and Alcohol Only	14.4%	15.6%	6.7%	16.1%	17.1%
Cannabis, Alcohol, and Other Drugs	5.0%	6.8%	3.2%	6.6%	5.5%
Cannabis and Other Non-Alcohol Drugs	8.6%	7.0%	4.9%	7.0%	5.1%
Cannabis Total[a]	32.9%	32.3%	20.0%	35.2%	36.4%

a. The percentages in this row may not reflect the exact column totals due to rounding.

The consistency of quantification of alcohol and THC concentrations also allowed for an examination of these concentrations in these data. In particular, the Orange County laboratory provided a large sample size with consistent quantification of both BAC and THC. Figure 9 shows a histogram of BAC values from the 10,804 drivers that had positive BACs. The average BAC of these drivers was 0.17 g/dL. This is similar to data from other laboratories with consistent BAC reporting, such as the Wisconsin laboratory data on crash-involved drivers arrested for impaired driving, for which the average BAC of drivers with alcohol in their system was 0.19 g/dL.

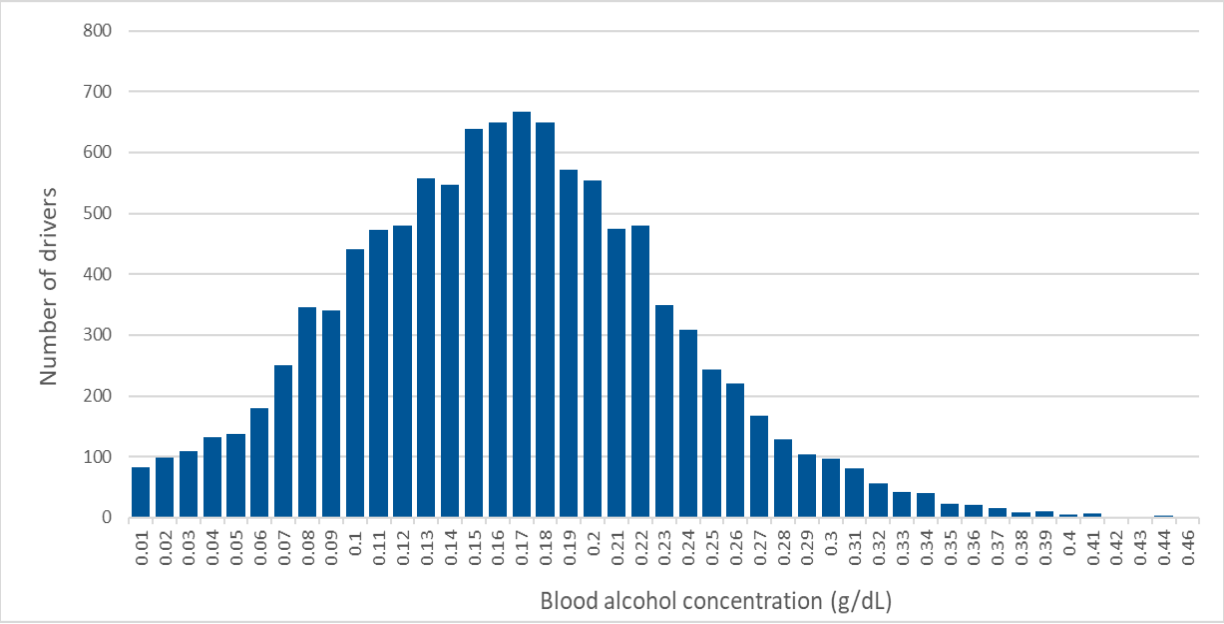

Figure 9. Distribution of drivers with different BACs from the Orange County laboratory dataset.

The average BAC of drivers who only tested positive for alcohol and no other drugs was further explored. In particular, BAC comparisons were made to determine the number of drivers arrested for impaired driving in the Orange County laboratory dataset that tested below the commonly established per se limits of 0.05 g/dL (Utah) and 0.08 g/dL (all other states and territories). There were 5,492 drivers who tested positive for alcohol and no other substances. The average BAC of these individuals was 0.17 g/dL. Out of these 5,492 drivers, there were 339 (6.2%) drivers with a BAC below 0.08 g/dL and 105 drivers (1.9%) with a BAC below 0.05 g/dL. This indicates that while a large majority of the drivers suspected of impaired driving in this sample had BACs above common per se legal limits in the United States, there were numerous drivers suspected of impaired driving with BACs below these levels.

Concentrations of THC were also explored due to the relative consistency of quantification and overall prevalence of cannabis in the drivers in the laboratory

datasets analyzed for this research. Again, the Orange County laboratory data provided an ideal set of drivers for analysis due to the large sample size and consistent reporting of THC values. Figure 10 shows the THC concentrations for drivers in the Orange County laboratory dataset. There were 4,015 (28.6%) drivers with detectable levels of THC. The average THC concentrations of these drivers was 6.9 nanograms per milliliter (ng/mL) with a median of 4.6 ng/mL.

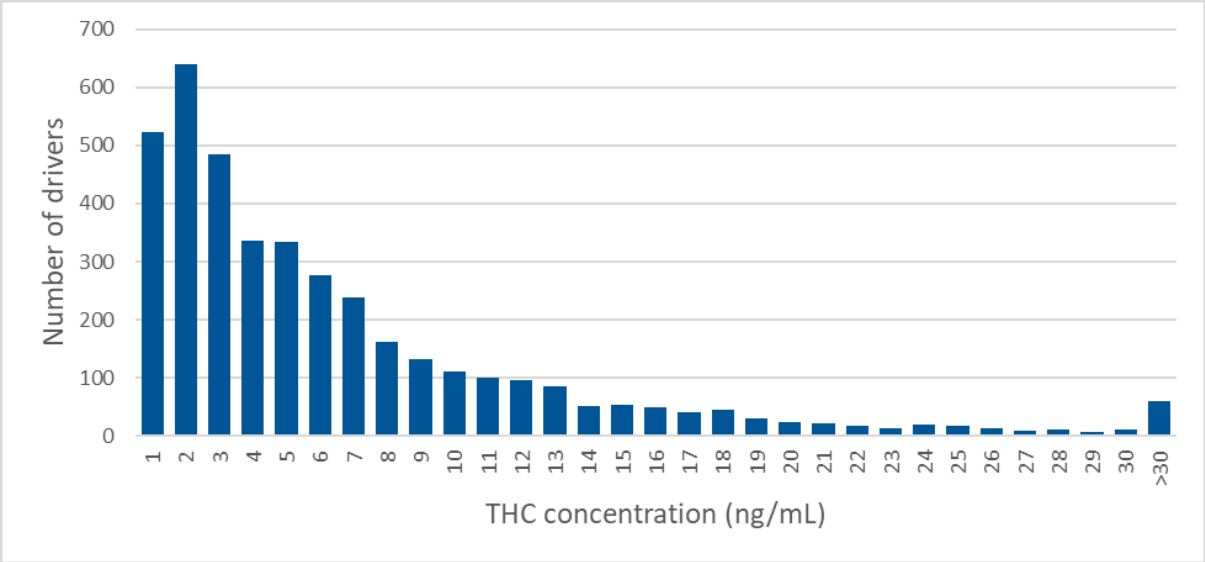

Figure 10. Distribution of drivers with different blood THC concentrations from the Orange County laboratory dataset.

Analyses were also conducted examining drivers who only tested positive for THC. This was done to further explore the effects of cannabis on the driver without the influence of other drugs or drug interactions. The Orange County laboratory had 666 drivers that only tested positive for THC. The average THC concentrations of these drivers was 10.2 ng/mL.

Several US states and Canada have per se values for THC ranging from 2 ng/mL to 5 ng/mL.[65] As shown in figure 10, many drivers arrested for impaired driving tested below these levels. The 666 drivers who tested positive for THC, and only THC, in the Orange County laboratory dataset were examined to determine how

[65] According to the National Conference of State Legislatures' "Drugged Driving: Marijuana-Impaired Driving" webpage, five states (Illinois, Montana, Nevada, Ohio, and Washington) have specific per se limits for THC in blood ranging from 2 ng/mL to 5 ng/mL. Colorado's law states that it is permissible to assume a driver was under the influence if their blood THC level is 5 ng/mL or higher. Twelve states (Arizona, Delaware, Georgia, Indiana, Iowa, Michigan, Oklahoma, Pennsylvania, Rhode Island, South Dakota, Utah, and Wisconsin) have zero tolerance laws for driving with THC, and the remaining states do not specify a threshold for impairment.

many of these drivers had toxicology results below 5 ng/mL.[66] Nearly one-third of these drivers (215 or 32%) had THC values below this value.

3.3.5 Likelihood of Testing Positive for Other Drugs Based on BAC

The size and quality of the Orange County laboratory dataset was ideal for further examining the prevalence of varying BACs in drivers and possible relationships between BAC and the prevalence of other drugs. This also shows the magnitude of drug data that is lost with stop-testing procedures. Out of the 14,051 drivers in the Orange County laboratory dataset who were arrested for impaired driving, 3,247 (23.1%) had a BAC of 0.00 g/dL, 994 (7.1%) had a BAC >0.00 g/dL but <0.08 g/dL, and 9,810 (69.8%) had a BAC ≥0.08 g/dL. Among drivers who tested positive for alcohol, the average BAC was 0.17 g/dL with a maximum BAC of 0.46 g/dL.

The relationship between BAC and the likelihood of testing positive for nonalcohol drugs was examined. Out of the 3,247 drivers with a BAC of 0.00 g/dL, 3,099 (95.4%) tested positive for at least one category of nonalcohol drug. Out of the 994 drivers with a BAC >0.00 g/dL but <0.08 g/dL, 65.0% (646) had at least one category of drug other than alcohol detected. Over 40% of the 9,810 drivers with a BAC ≥0.08 g/dL (4,232 or 43.1%) had at least one other category of drug detected in their system in addition to alcohol. This means that if stop-testing protocols for drugs were in place for drivers with BACs ≥0.08 g/dL, just over 30% (4,232 or 30.1%) of the 14,051 drivers in this sample who tested positive for at least one category of drug other than alcohol would have been recorded as only positive for alcohol.

3.3.6 Time to Test

Certain potentially impairing drugs can quickly metabolize below detectable levels in a driver's system. Therefore, collecting biological specimens as soon as possible after an impaired driving arrest increases the likelihood that the presence of potentially impairing drugs will be detected.[67] The delay between the time of an impaired driving event and the collection of a blood specimen for toxicology testing was available for both the Wisconsin laboratory and the San Francisco laboratory sample populations. The Wisconsin and San Francisco laboratory populations were chosen for analysis because of their collection and reporting of both time of event

[66] There were 666 drivers with quantified levels of THC. The 685 drivers testing positive for "cannabis only" in table 8 included drivers that tested positive for any cannabinoid, which could include testing positive for a metabolite of THC but not a quantified and positive value for THC.

[67] For example, as shown in figure 2, within 30 minutes of smoking cannabis, blood THC levels had decreased by more than half their peak level.

and time of sample collection as well as the similarity of both datasets not being limited to severe crashes, which would potentially bias the time it takes to collect a sample. Out of the 9,569 drivers in the Wisconsin laboratory impaired driving arrest sample, there were 9,046 drivers with complete data for elapsed time between the event and sample collection. To control for possible data entry errors and outliers, elapsed times less than 15 minutes or greater than 24 hours were excluded from this analysis. This left 8,969 cases for analysis.

The average time between the crash-involved impaired driving event and the blood draw was 1 hour 51 minutes in the Wisconsin laboratory sample population. Less than 20% of drivers had a time to test of less than 1 hour. Just over half of drivers were tested after 1 hour 40 minutes.

A similar protocol was used for the San Francisco laboratory sample population and any drivers with an elapsed time less than 15 minutes or greater than 24 hours were excluded from the analysis. There were 2,023 of the 2,075 drivers with time-to-test data that met these criteria.

The average time between a blood draw and the impaired driving event in the San Francisco laboratory sample population was 2 hours 4 minutes. Over half of drivers had a delay greater than 1 hour 40 minutes. Less than 15% of drivers had a time to test of less than 1 hour.

Many drugs can be metabolized completely out of an individual's system or below laboratory-detection thresholds in the average of about 2 hours that it took to conduct a blood draw after the traffic event in the Wisconsin and San Francisco laboratories. Ultimately, long delays between the time of the traffic event and specimen collection decreases the probability a drug will still be detected in a driver, which may impact the prosecution of the case. Thus, it is critical to identify and implement programs that reduce the delay in obtaining a specimen for drug testing.

3.4 Summary of Drug Prevalence Results

Because there is no reliable national-level data available concerning drug use among crash-involved drivers, the NTSB analyzed the best available data from laboratories in four jurisdictions that employ protocols that meet or exceed ANSI/ASB Standard 120 (ANSI/ASB 2021). These data provided a unique look at the full range of drugs and drug combinations present in the driver populations examined, which included both crash-involved and non-crash-involved drivers arrested for impaired driving as well as fatally injured drivers.

The research employed a novel drug classification scheme, developed by NTSB in consultation with toxicology experts, to ensure a consistent and responsible approach to assessing multiple-drug presence. Presence alone does not indicate that

drivers were impaired. However, on a population level, for drugs with known impairing effects, an increase in prevalence among drivers arrested for impaired driving or crash-involved drivers may point to a need for countermeasures. Population-level data can also be used along with exposure data to identify drugs or drug combinations that may increase the likelihood of a driver being arrested for impaired driving or increase a driver's crash risk.

Some overall results emerged from the NTSB's analyses:

- Alcohol was the most commonly found drug across all populations, with positivity rates ranging from 44% to 78%.
- Cannabis was the second most common drug identified, with positivity rates ranging from 20% to 36% across the five laboratory sample populations. Cannabis was typically found in combination with alcohol or other drugs.
- The most commonly detected categories of drugs, besides alcohol and cannabis, were sedatives, stimulants, and potentially impairing neuropsychiatric medications. In general, both sedatives and stimulants were more likely to be detected than narcotic analgesics and dissociative anesthetics.
- About half of drivers across all four laboratory sample populations arrested for impaired driving tested positive for more than one category of drug. In the population of fatally injured drivers, about 28% tested positive for more than one category of drug.
- Multiple-category drug prevalence was diverse, and hundreds of combinations of drug categories were observed in this research.
- The most common drug combination was alcohol and cannabis. No other combination of drug categories besides alcohol and cannabis had a greater than 10% prevalence across any of the five populations.
- Alcohol was often detected alone, whereas cannabis was most frequently detected in combination with alcohol or other drugs.
- Across all five laboratory sample populations, there were common subcategories of drugs that were most frequently observed within each drug category. The most commonly observed sedatives were benzodiazepines. The most frequently observed stimulants were cocaine and methamphetamines.
- Different drug presence patterns were found to be sex-based. Males were more likely to test positive for illicit drugs, whereas females were more likely to test positive for drugs that are legally available, such as alcohol or prescription drugs.

- Policies that limit drug testing, such as those that use stop-testing protocols when a driver's BAC is over a certain level, result in a loss of information. Results from the Orange County laboratory showed that if this laboratory had implemented a stop-testing protocol at a BAC of 0.08 g/dL then 4,232 of 14,051 (30.1% of the entire sample) drivers would not have been identified as testing positive for other drugs despite having detectable levels in their system.
- Delays in specimen collection for toxicology testing after an impaired driving arrest or crash can result in critical loss of evidence of impaired driving as drugs can rapidly metabolize out of a driver's system. Laboratories that collected information on the time between the impaired driving event and specimen collection showed a large time delay in specimen collection. The Wisconsin laboratory data showed the average specimen took 1 hour 51 minutes to collect after an arrest. The San Francisco laboratory showed the average time to collect a specimen was 2 hours 4 minutes after an arrest.

The NTSB concludes that alcohol was the most prevalent drug found among impaired drivers in toxicology data reviewed by the NTSB, and about half of all impaired drivers were positive for other drugs or multiple drugs, indicating that although alcohol-related countermeasures must remain the highest priority, countermeasures that effectively address other drugs and drug combinations are also needed. The NTSB also concludes that policies that limit drug testing, such as those that use stop-testing protocols when a driver's BAC is over a certain level, result in a loss of valuable information that could otherwise be used to customize policies, treatment, and other countermeasures. The NTSB further concludes that reducing the time between an impaired driving event and biological specimen collection increases the likelihood that toxicological test results will reflect drug presence at the time of the event.

4. Safety Issues

As a result of this research, the NTSB identified the following safety issues: (1) the need to implement proven countermeasures for alcohol-impaired driving; (2) the need to address the growing problems of cannabis-, other drug-, and multiple-drug-impaired driving; (3) the need to improve drug-impaired driving laws and enforcement; (4) the need to ensure that driving safety is considered in the evaluation of prescription and OTC drugs; and (5) the need to enhance systems for documenting and tracking the incidence of drug use and driving. The sections that follow describe these safety issues and consider countermeasures to reduce the incidence of impairment-related crashes.

Many impaired driving countermeasures are designed to deter drivers from making the decision to drive impaired. History has shown that changing driver behaviors can be exceptionally hard, and additional strategies that improve safety but do not rely on an impaired driver's decision-making are crucial. Recognizing the inherent challenges, we need to not only advocate for these strategies, but also support a Safe System approach. The principles underpinning the Safe System approach acknowledge that humans make mistakes or make bad decisions that lead to traffic crashes, but no one should lose their life or be seriously injured as a result of a crash; the human body has a limited physical ability to tolerate crash forces; roadway safety is a shared responsibility; and all parts of the system must be strengthened so that if one part fails, road users are still protected (DOT 2022).

In 2021, the NTSB hosted a roundtable series on the Safe System approach that included consideration of vehicles, road users, roads, speeds, and postcrash care.[68] There are many safety countermeasures available or in development that do not rely on driver behaviors or decision-making to keep the public safe. Such an approach does not absolve drivers of responsibility but recognizes that overall safety will be improved when we do not solely rely upon drivers to make good choices.

4.1 Need to Implement Proven Countermeasures for Alcohol-Impaired Driving

Alcohol—alone and in combination with other drugs—was the most prevalent drug found in every dataset analyzed for this research. The results showed about one-third of drivers in each of the populations of drivers arrested for impaired driving were positive for alcohol only, and an additional 20% to 40% were positive for alcohol in combination with other impairing drugs. Alcohol prevalence in the Wisconsin laboratory's fatally injured driver sample was lower, but alcohol was still the most

[68] See the NTSB's webpage on "The Safe System Approach: Roundtable Series."

prevalent drug, with 26.6% of drivers testing positive for alcohol only and an additional 17.7% of drivers testing positive for alcohol and other drugs.

Alcohol's relationship to performance decrements and crash risk are clear (Moskowitz and Fiorentino 2000; Blomberg and others 2005). At a BAC of 0.08 g/dL, the per se limit in nearly every state, the risk of crashing is more than doubled. Although there is less research documenting the risk of combining alcohol and other drugs, existing research suggests that doing so can increase crash risk significantly, even when BACs are <0.08 g/dL (Hels and others 2011; Romano, Voas, and Camp 2017). Alcohol is also the drug for which the most is known concerning its negative impact on roadway safety. It is consistently associated with more than 3 in 10 road fatalities (NCSA 2022a). In 2020, NHTSA estimated that 11,654 people died in crashes involving a driver with a BAC >0.08 g/dL—an increase of 14% from 2019, which was more than twice the overall increase of 6.8% in crash fatalities during the same period—so it is more critical than ever to implement known countermeasures (Stewart 2022). The NTSB concludes that alcohol, both alone and in combination with other drugs, continues to be the drug with the most detrimental impact on traffic safety.

Actions to address alcohol-impaired driving can make a difference, as evidenced by the many efforts in the 1980s and 1990s that led to a substantial drop in alcohol-impairment-related fatalities.[69] Additionally, many of the countermeasures described in the NTSB's 2013 *Reaching Zero: Actions to Eliminate Alcohol-Impaired Driving* report remain relevant and needed. Some key recommendations are summarized below, and a full listing of the recommendations and their overall statuses are available in appendix A.

[69] The advocacy efforts of groups, such as Mothers Against Drunk Driving and Remove Impaired Drivers, contributed to numerous legislative changes and to a shift in the cultural acceptance of alcohol-impaired driving. A 1982 law provided incentives to states based on the establishment of a per se BAC limit of 0.10 g/dL (see Alcohol Traffic Safety Programs, Public Law 97–364, 96 Stat. 1738). This law also called for administrative license suspension/revocation for drivers arrested for driving while impaired, mandatory jail time or community service for repeat offenders, and better enforcement of drunk driving laws. Two years later, the National Minimum Drinking Age Act of 1984 (Public Law 98-363, 98 Stat. 435, section 158), which mandated that states would receive reduced federal highway funds if they did not raise the minimum legal drinking age to 21, went into effect. Between 1981 and 1986, a total of 729 new state laws addressing drunk driving were enacted (Lerner 2011, 88–90).

4.1.1 Effective Laws and Enforcement

Several NTSB recommendations promote effective laws and high-visibility enforcement to combat alcohol-impaired driving. The NTSB has recommended that states reduce per se BAC limits for all drivers to 0.05 g/dL or lower (H-13-5) and has called on NHTSA to seek legislative authority to award incentive grants to states to establish such limits (H-13-1).[70] Research has estimated that lowering the BAC limit in every state would likely reduce the number of fatal alcohol crashes by 11%, potentially saving about 1,800 lives per year (Fell and Scherer 2017). In 2018, the state of Utah lowered its per se BAC limit to 0.05 g/dL and subsequently saw reductions in both its fatal crash and fatality rates relative to the rest of the United States (Thomas and others 2022). Specifically, Utah's fatal crash rate and fatality rate reductions from 2016 to 2019 were 19.8% and 18.3%, respectively, compared to 5.6% and 5.9% for the rest of the United States. An evaluation of the law's effects found that Utah drivers reported changed behaviors, such as arranging alternate transportation when drinking away from home. The evaluation did not find any negative effects on alcohol sales, tourism, or tax revenues, nor did it find a marked increase in impaired driving arrests (Thomas and others 2022).

The NTSB has also recommended all-offender interlock laws, that is, laws requiring alcohol ignition interlocks for all individuals convicted of alcohol-impaired driving offenses (H-12-45).[71] In 2012, the NTSB made the recommendation to 33 states, the District of Columbia, and the Commonwealth of Puerto Rico. Since that time, four states, Alabama, Delaware, Idaho, and Tennessee, and the District of Columbia, have enacted such laws. Additionally, a recent study that examined differences among three types of interlock laws between 2001 and 2019 found that all-offender interlock laws were the most effective and were associated with 26% fewer drivers with BACs ≥0.08 g/dL being involved in crashes compared to states with no law (Teoh and others 2021). Enforcement is a key element of addressing alcohol-impaired driving, and the NTSB supports high-visibility enforcement. In 2013, the NTSB recommended that the 50 states, the District of Columbia, and the Commonwealth of Puerto Rico include in their highway safety plans provisions for conducting high-visibility enforcement using passive alcohol-sensing technology during traffic stops, saturation patrols, sobriety checkpoints, and at accident scene

[70] The overall status of Safety Recommendation H-13-5 is classified Open—Unacceptable Response. See appendix A for more information. Safety Recommendation H-13-1 is classified Open—Acceptable Response.

[71] The overall status of H-12-45 is classified Open—Unacceptable Response. See appendix A for more information.

responses (H-13-6).[72] Since that time, the NTSB has classified that recommendation Closed–Acceptable Action for four states—Connecticut, Hawaii, Indiana, and Kansas—because they have implemented such enforcement programs.[73]

Effective laws and enforcement are critical to combating impaired driving. It must also be clear that this enforcement needs to be both fair and equitable. Individuals of all identities and backgrounds must be treated with respect, dignity, and fairness from the decision to make a traffic stop through the final adjudication of a case. As outlined in other areas of this report, enforcement is one valuable component of reducing impaired driving, but it must also be paired with education and evidence-based treatment.

4.1.2 In-Vehicle Technologies

The NTSB has a long history of calling for in-vehicle technologies, such as forward collision avoidance systems, that can reduce the incidence of crashes or mitigate their severity, and the issue is on the 2021–2023 Most Wanted List of Transportation Safety Improvements. Such technologies can reduce the incidence of collisions and injury regardless of the underlying reason and, consequently, they are an important part of a Safe System approach. In terms of preventing alcohol-impaired crashes, alcohol ignition interlock devices can be installed in vehicles to prevent their operation by a driver with a positive BAC. However, such devices have historically been installed after an alcohol-impaired driving arrest or conviction. Currently, no in-vehicle technology is commercially available that can passively detect driver impairment and prevent vehicle operation, although the NTSB has recommended the development and promotion of such a technology.[74]

In 2021, Congress passed a law requiring impaired driving prevention technology to be deployed on all new vehicles within 3 years. Specifically, section 24220 of the IIJA included a requirement for "advanced drunk and impaired driving prevention technology" that can (1) passively monitor the performance of a motor vehicle driver and prevent or limit vehicle operation if impairment is detected and/or

[72] The overall status of H-13-6 is classified Open–Unacceptable Response. See appendix A for more information.

[73] See appendix A for more information.

[74] In 2013, the NTSB recommended that NHTSA and the Automotive Coalition for Traffic Safety work together to accelerate widespread implementation of Driver Alcohol Detection System for Safety (also known as DADSS) technology "by (1) defining usability testing that will guide driver interface design and (2) implementing a communication program that will direct driver education and promote public acceptance" (H-12-43 and H-12-48). Both recommendations are classified Closed—Unacceptable Action. See appendix A for more information.

(2) passively and accurately detect whether the driver's BAC is ≥0.08 g/dL and prevent or limit motor vehicle operation if a BAC at or above this level is detected.[75] In its report of the January 1, 2021, fatal crash in Avenal, California, caused by an alcohol-impaired driver (NTSB 2022a), the NTSB concurred with this legislation and recommended that NHTSA do the following:

> Require that all new vehicles be equipped with passive vehicle-integrated alcohol impairment detection systems, advanced driver monitoring systems, or a combination thereof; the systems must be capable of preventing or limiting vehicle operation if driver impairment by alcohol is detected (H-22-22).[76]

This recommendation, if fully implemented, could have enormous lifesaving potential. For example, one study estimated that requiring in-vehicle systems that prevent vehicle operation by drivers with BACs of 0.08 g/dL and above would save more than 1,000 lives annually within 3 years of the mandate (Farmer 2021). The same study found that if all highway vehicles were equipped with such technology, more than 9,000 lives could be saved annually.[77]

4.1.3 Actions Needed to Reduce Alcohol-Impaired Driving Crashes

For more than 50 years, the NTSB has advocated for changes to reduce the incidence of alcohol-impaired driving crashes, and the agency has issued more than 150 recommendations to address impaired driving. Efforts over the past several decades have yielded meaningful reductions in the number and rate of fatalities involving a driver with a BAC of 0.08 g/dL or higher. However, in 2020, 11,654 people died in crashes in which at least 1 driver had a BAC at or above that threshold, accounting for nearly 1 in 3 roadway fatalities, and alcohol was the most prevalent drug found in each of the laboratory samples analyzed for the present research. This indicates that more must be done to address alcohol-impaired driving.

Recent efforts, including Utah's law reducing its per se BAC limit to 0.05 g/dL; the adoption of all-offender interlock laws in several states; and the federal law requiring advanced drunk and impaired driving prevention technology as standard equipment on new vehicles are important steps toward addressing this problem. Yet,

[75] The Safeguarding Privacy in Your Car Act of 2022, S. 4647, 117th Cong. (2022), proposed to repeal section 24220 of the IIJA.

[76] Safety Recommendation H-22-22 is classified Open—Await Response. See appendix A for more information.

[77] The study also found that a system that prevented drivers from operating a motor vehicle with any BAC would save nearly 12,000 lives per year.

more remains to be done. In 2022, the NTSB completed a review of state progress on 10 recommendations to address alcohol-impaired driving and sent a letter to each state documenting the actions needed to close any open NTSB recommendations.[78] The NTSB also reviewed NHTSA's progress on five impairment-related recommendations and sent a letter encouraging additional action on those that remained open.[79] The NTSB will continue to advocate for adoption of all open recommendations concerning alcohol-impaired driving through its Most Wanted List and other advocacy efforts. The NTSB concludes that implementing countermeasures to reduce alcohol-impaired driving must remain a high priority to reduce impaired driving crashes overall.

4.2 Need to Address the Growing Problem of Cannabis-, Other Drug-, and Multiple-Drug-Impaired Driving

A focus on alcohol-related countermeasures is a necessary step to eliminating impaired driving crashes and injuries. However, if we limit the focus to alcohol, the problem will not be fully solved. The pattern of results across all datasets analyzed for the present research found that many other drugs, alone or in combination, contribute to the problem. This is particularly true for cannabis, which was consistently the second most commonly found drug after alcohol. Between 20% and 36% of drivers across all five laboratory sample populations tested positive for it.

Compared to alcohol, cannabis was more likely to be found in combinations with other drugs. As shown in table 9, in four of the five laboratory populations tested, alcohol was slightly more likely to be detected alone than with one or more other drugs. However, as shown in table 10, most drivers who tested positive for cannabis also tested positive for another potentially impairing drug.

Multiple drug presence was also common, with about half of all drivers in each of the populations arrested for impaired driving testing positive for two or more drug categories. For the Wisconsin laboratory sample of fatally injured drivers, about 28% were positive for multiple categories of drugs. The most commonly found categories of drugs after alcohol and cannabis tended to be sedatives and stimulants, which ranged in positivity across all five driver populations from 7.8% to 26.1% (see figure 5). Narcotic analgesics and potentially impairing neuropsychiatric medications were also relatively common. There are many potential reasons for variability in drug prevalence among the datasets used for this research, including actual differences in

[78] The letters concerned Safety Recommendations H-12-34, H-12-35, H-12-36, H-12-45, H-13-5, H-13-6, H-13-7, H-13-8, H-13-9, and H-13-10. See appendix A for more information.

[79] The letter concerned Safety Recommendations H-12-33, H-13-1, H-18-35, H-18-56, and H-18-57. See appendix A for more information.

driver drug use; variability in the populations sampled, such as fatally injured drivers versus drivers arrested for impaired driving; variances in the drug compounds tested for; and the application of varying cutoff values for reporting results. Although there was some variability among the datasets, the overall pattern of results was similar and demonstrated the prevalence of numerous potentially impairing drugs and drug combinations. The NTSB concludes that although alcohol and cannabis were both highly prevalent in toxicology data reviewed by the NTSB, alcohol was most often detected alone, whereas cannabis was most often detected in combination with alcohol or other drugs. The NTSB also concludes that cannabis and other potentially impairing drugs, especially in combination with and without alcohol, contribute to the problem of impaired driving crashes due to their prevalence and negative impacts on driving performance.

Although cannabis and many other drugs have been shown to impair driving performance and are associated with increased crash risk, there is evidence that, relative to alcohol, awareness about the potential dangers of driving after using other drugs is lower. For example, a 2020 survey conducted by the AAA Foundation for Traffic Safety found that 94% of respondents rated driving after drinking enough alcohol to be over the legal limit as extremely or very dangerous. For driving within an hour after using cannabis or after using potentially impairing prescription drugs, the percentages were 69% and 87%, respectively (AAA FTS 2021).[80]

The AAA Foundation for Traffic Safety survey also found drivers perceived that the chance of being caught by police was higher for alcohol use than for other drug usage. For driving after drinking enough alcohol to be over the legal limit, 66% of drivers reported that it is very likely or somewhat likely a driver would be caught by police. For driving within an hour after using cannabis, 29% of drivers reported that it is very likely or somewhat likely a driver would be caught by police, and for driving while using potentially impairing prescription drugs, 41% of drivers reported that perception. The NTSB considered several countermeasures that could address the growing problem of cannabis-, other drug-, and multiple-drug-impaired driving. This section considers how the problem could be addressed by raising driver awareness of the risks of driving impaired by drugs other than alcohol. The sections that follow discuss strengthening laws, facilitating law enforcement, and improving postmarket surveillance of prescription and OTC drugs.

Public campaigns and drug labeling are two strategies that have the potential to raise awareness about the hazards of cannabis- and other drug-impaired driving and the potential consequences of doing so. In theory, if drivers have greater awareness of the risks, they may be less likely to use drugs if they know they must

[80] The survey used the term "marijuana."

drive or more likely to make plans for alternative forms of transportation when using drugs, leading to a reduction in impaired driving crashes.

4.2.1 Public Campaigns

NHTSA, states, and advocacy groups have led multiple public campaigns designed to reduce the incidence of various types of impaired driving.[81] As early as 1983, NHTSA partnered with the Ad Council to develop the "Drinking and Driving Can Kill a Friendship" campaign to prevent alcohol-impaired driving.[82] In recent years, campaigns have targeted impaired driving with messages such as "Drive Sober or Get Pulled Over," "Drive High—Get a DUI," and "If You Feel Different, You Drive Different." Additionally, the GHSA and the International Council on Alcohol, Drugs, and Traffic Safety (ICADTS) have recently developed documents that can inform cannabis messaging. The GHSA report provides guidance with the goal of facilitating clear communications about cannabis use and roadway safety.[83] ICADTS developed a series of fact sheets that provide research consensus on topics related to cannabis and traffic safety, including summaries of research, cannabis detection and toxicology, and policy and legislative issues.[84]

NHTSA's most recent edition of its *Countermeasures That Work: A Highway Safety Countermeasures Guide for State Highway Safety Offices* rates media campaigns as "promising" (Venkatraman and others 2021).[85] Many studies have evaluated impaired driving media campaigns over the years—mostly focused on alcohol-related campaigns—but there is no clear consensus about their effectiveness in reducing impaired driving crashes. One systematic review of data from nine research papers suggested that media campaigns that are viewed by many and implemented alongside enhanced law enforcement are effective in reducing alcohol-impaired crashes (Elder and others 2004). However, a similar review

[81] See NHTSA's webpages "Drive Sober or Get Pulled Over," "Buzzed Driving is Drunk Driving," "If You Feel Different, You Drive Different," and "There's More Than One Way to Be Under the Influence." See also the GHSA's webpage "Colorado 'Drive High, Get a DUI' Drugged Driving Campaign."

[82] See the Association of National Advertisers Educational Foundation's webpage "Drunk Driving Prevention (1983-Present): Ad Council Campaigns That Have Made a Difference."

[83] See the GHSA's 2022 report, *Cannabis Consumers and Safe Driving: Responsible Messaging*, for more information.

[84] See ICADTS's Fact Sheets on "Cannabis and Driving."

[85] The guide uses a 5-star rating scale. Countermeasures that receive 4 or 5 stars are deemed effective. Countermeasures that receive 3 stars are considered promising and likely to be effective, and those that receive 2 stars or 1 star have not been determined to be effective.

conducted a decade later, which incorporated results from 19 studies, was less conclusive (Yadav and Kobayashi 2015). Its authors noted that although some studies found a significant impact of media campaigns on reducing alcohol-impaired driving crashes, the pooled analysis from all studies did not yield a significant result.

Several recent and ongoing campaigns exist to raise awareness of the risks of driving after using cannabis or other drugs. For example, see the GHSA's "Colorado 'Drive High, Get a DUI' Drugged Driving Campaign" webpage, Massachusetts's 2019 "Cannabis and Alcohol Users Tapped for State's Impaired Driving Campaign" press release, and the Teen Safe Driving Coalition's "Drugged Driving—What You Should Know" webpage. Although their link to reducing impairment-related crashes is not definitive, such campaigns have the potential to raise awareness, which may lead to longer-term changes in societal norms concerning the acceptability of driving after using cannabis or other drugs. Therefore, the NTSB concludes that media campaigns have the potential to raise awareness of the risk of impaired driving associated with cannabis, other drug, and multiple drug use, but it is unclear if they change driver behavior.

4.2.2 Prescription and OTC Drug Labeling

Potentially impairing prescription and OTC drugs were found, both alone and in combination with other drugs, in all of the populations examined in this research. For example, about 1 in 10 drivers tested positive for drugs in the sedative category. The most prevalent subcategories within that category were benzodiazepines, which are commonly prescribed for anxiety or insomnia, and sedating antihistamines, which are commonly found in OTC allergy medicines and sleep aids. It is not possible to know, based on toxicology data alone, whether drivers were using those drugs consistent with labeling. The challenge of communicating driving risk to patients taking prescription and OTC drugs is well documented, and the NTSB has a long history of advocating for more effective and consistent drug labeling. Most notably, on January 13, 2000, the NTSB recommended that the FDA do the following:

> Establish a clear, consistent, easily recognizable warning label for all prescription and over-the-counter medications that may interfere with an individual's ability to operate a vehicle. Require that the label be prominently displayed on all packaging of such medications (I-00-5).

The FDA made important progress before this recommendation was classified Closed—Reconsidered on July 13, 2017.[86] The correspondence between the FDA and the NTSB, as well as contributions by NHTSA, influenced the development of

[86] In its 2017 correspondence closing I-00-5, the NTSB acknowledged certain limitations of the FDA's authority to mandate specific drug warning labels.

"Evaluating Drug Effects on the Ability to Operate a Motor Vehicle: Guidance for Industry," which provides tools for evaluating the potential of new psychoactive drugs to impact the safe operation of a motor vehicle (FDA 2017). This guidance, which is described in greater detail in section 4.4.1, can play a key role in better evaluating the potentially impairing effects of drugs prior to entering the market if it is used consistently by the drug industry. Also in this 2017 guidance, the FDA stated that information from such evaluations should be included in the "clinical studies" section of drug labeling as well as, if appropriate, in other sections, such as "warnings and precautions" and "patient counseling information." Safety Recommendation I-00-5 also facilitated public health awareness efforts from the FDA, which included the development of a website and podcasts on the potential driving impairment risks of many medications, including common OTC medications.

Since Safety Recommendation I-00-5 was closed in 2017, new research has highlighted the prevalence of driving after using potentially impairing prescription and OTC drugs, as well as findings related to patient education and drug labeling. In July 2022, the AAA Foundation for Traffic Safety released results from a national survey of US drivers on the use of potentially impairing medications in relation to driving (Arnold and Kim 2022). About half of the drivers surveyed reported taking at least one potentially impairing medication in the past 30 days, and nearly one in five reported taking two or more potentially impairing medications over this time frame. Nearly half of drivers who reported using one or more potentially impairing medications reported driving within 2 hours of using at least one of these medications. Drivers that received a warning from a healthcare provider about the driving risks associated with a medication were 18% less likely to report having driven within 2 hours of using the medication (Arnold and Kim 2022).

In addition to the high prevalence of prescription and OTC use while driving, other emerging research highlights the need to reexamine shortcomings with drug labeling. For example, another study conducted by the AAA Foundation for Traffic Safety identified current drug labeling as largely insufficient in conveying driving risk to patients (Smith, Turturici, and Camden 2018). This research included a broad, systematic literature review, subject matter expert interviews, and an expert panel that included impaired driving researchers, pharmacists, medical doctors, and government representatives. One reported theme was that

> many Americans simply do not understand the potentially impairing effects of medications based on the labeling and do not realize the warning to 'not operate heavy machinery' applies to their personal vehicle (Smith, Turturici, and Camden 2018).

In addition to recognizing the limitations of current prescription and OTC drug labeling practices, the AAA Foundation for Traffic Safety research identified potential solutions (Smith, Turturici, and Camden 2018). Results from this literature review

indicated that labels that included a pictogram and graded levels of potential risk showed particular promise as a means of improving consumer awareness of driving risk (Emich and others 2014; Monteiro and others 2013; Smyth and others 2013). Furthermore, the expert panel from this research identified "include a symbol/graphic on the prescription label (move toward European style)" as one if its top five countermeasures for addressing prescription-drug- and OTC-impaired driving. Despite the need for improved prescription and OTC drug labeling and general countermeasure strategies available in published research, the current body of research is insufficient to point to a single strategy for improving this labeling. Further research is needed to identify label characteristics that can reduce the likelihood that consumers will drive while impaired by prescription or OTC drugs.

Challenges not only remain with current drug labeling effectiveness at conveying driving risk while taking potentially impairing medications, but also with the consistency of this labeling even when a drug has known impairing effects. For example, diphenhydramine is a sedating antihistamine available OTC that is approved for use in treating allergies as well as for use as a sleep aid, and it has been found to impair driving performance (Weiler and others 2000). According to 21 *CFR* 341.72, when diphenhydramine is marketed as an antihistamine for the treatment of allergies, it is required to include a label advising drivers to "use caution when driving a motor vehicle or operating machinery." However, as shown in table 11, when it is marketed as a sleep aid, there is no such requirement, and the label varies (FDA 2021).[87]

Table 11. Varying warning labels about driving after use of diphenhydramine sleep aids for three different brands on the FDALabel website.

Brand of Diphenhydramine	Advice About Use While Driving	Label Warning
Thirty Madison Sleep Aid	Yes	Do not drive a motor vehicle or operate machinery
Kroger EZ Nite Sleep	Yes	Be careful when driving a motor vehicle or operating machinery
ZzzQuil Nighttime Sleep-Aid	No	—

[87] The "FDALabel: Full-Text Search of Drug Product Labeling" website enables the public to search for and view drug labels.

The NTSB concludes that although the FDA has provided useful guidance to industry concerning evaluating drug effects on driving, additional effort is needed to identify drug label characteristics that can effectively and consistently convey driving risk to consumers. The NTSB therefore recommends that the FDA conduct a study to understand how prescription drug labeling and OTC drug labels could be modified to increase user understanding and compliance with driving-related warnings; publish the study findings.

4.2.3 Cannabis Labeling

Cannabis is generally not legal for medical or recreational use at the federal level in the United States.[88] Consequently, there is no federal requirement for labeling cannabis. By contrast, in Canada, which legalized cannabis at the federal level in 2018, all cannabis products must be labeled with health warnings, including a warning that states the following: "Do not drive or operate heavy equipment after using cannabis. Cannabis can cause drowsiness and impair your ability to concentrate and make quick decisions."

In the United States, the Alcohol Beverage Labeling Act of 1988 requires that alcoholic beverages contain a label that includes the text "consumption of alcoholic beverages impairs your ability to drive a car."[89] Although evidence suggests that alcohol labeling had little effect on behavior change, some authors have suggested that even small effects can be meaningful if a product is widely used (Kaskutas and Greenfield 1992; Greenfield, Graves, and Kaskutas 1999; Stockwell 2006).

A recent study found that among the 31 US states with medical cannabis programs, all have some labeling requirements, and 26 have some requirement for labeling concerning impairment, but not necessarily driving impairment (Kruger, Korach, and Kruger 2022). For example, Maryland law requires that all medical cannabis bear a label that includes the following warning: "Consumption of medical cannabis may impair your ability to drive a car or operate machinery. Please use

[88] On its "FDA and Cannabis: Research and Drug Approval Process" webpage, the FDA notes that the agency has "not approved a marketing application for cannabis for the treatment of any disease or condition." It has, however, approved one cannabis-derived product, cannabidiol (marketed as Epidiolex), which is used to treat seizures associated with rare forms of epilepsy, and two synthetic cannabinoids, dronabinol (marketed as Marinol or Syndros) and nabilone (marketed as Cesamet), which are used to treat severe nausea and vomiting or weight loss for people with certain conditions.

[89] See the Alcohol Beverage Labeling Act of 1988, section 8001, subsection 204, of the Anti-Drug Abuse Act of 1988, Public Law 100–690, 102 Stat. 4181 (1988).

extreme caution."[90] In comparison, Oklahoma law requires that medical cannabis include the following warnings on labels: "keep out of reach of children" and "women should not use marijuana or medical marijuana products during pregnancy because of the risk of birth defects or while breastfeeding"; however, there are no labeling requirements concerning driving or potential impairment of any kind.[91] An NTSB analysis of laws in the 50 states, the District of Columbia, and the Commonwealth of Puerto Rico, identified 23 jurisdictions where cannabis sales are legal but where cannabis label requirements are not required or are inadequate. This includes 12 jurisdictions that have no driving-related label requirements, 4 that have label requirements for only certain cannabis products, and 7 whose labeling requirements do not explicitly warn against driving after cannabis use.[92]

Although it is not clear whether the inclusion of driving-related warnings on cannabis labels would influence driver behaviors or reduce crash risk, a recent national survey found that drivers are less likely to perceive driving after cannabis use to be dangerous compared to driving after alcohol use (AAA FTS 2021). Additionally, the absence of such labeling—especially when alcohol and many prescription and OTC drugs do include warnings about driving—could lead users to believe that cannabis does not impair driving. The NTSB concludes that including driving-related warnings on cannabis products, similar to those on alcohol and many prescription and OTC drugs, would increase awareness of the risks of cannabis-impaired driving. Therefore, the NTSB recommends that the District of Columbia, the Commonwealth of Puerto Rico, and the 21 states where cannabis use is legal but driving-related cannabis warning labels are not required or are inadequate require a warning label on cannabis products advising users not to drive after cannabis use due to its impairing effects. The Canadian labeling requirements or requirements from the several states that do include driving-related warnings may be useful references for those states without such labeling. Additionally, an international standards-setting

[90] See the Maryland Code of Regulations, 10.62.24.01, "Packaging of Medical Cannabis Finished Product."

[91] See Title 310, Oklahoma State Department of Health, Chapter 681, Medical Marijuana Regulations.

[92] The 12 jurisdictions with no driving-related label requirements are Arkansas, the District of Columbia, Florida, Louisiana, Mississippi, Missouri, Ohio, Oklahoma, Oregon, Puerto Rico, Rhode Island, and Virginia. The 4 states that have label requirements for only certain cannabis products are Illinois, Maine, New Jersey, and New York. The 7 states whose labeling requirements do not explicitly warn against driving after cannabis use are Alabama, Arizona, California, Colorado, Maryland, Pennsylvania, and West Virginia.

organization recently adopted a symbol to indicate the presence of "intoxicating cannabinoids" in consumer products.[93]

4.3 Need to Improve Drug-Impaired Driving Laws and Enforcement

Having strong laws and enforcement can help in detecting and removing impaired drivers from the road. It can also foster a general deterrent effect if people recognize that there is a strong likelihood of being caught. All states have laws against driving impaired by alcohol and other drugs, but some laws may be outdated and may not address the complexities of the current environment. Additionally, certain aspects of laws, such as limiting the definition of drug impairment to a certain subset of drugs, may create barriers to swift and effective enforcement. This can impede the ability of a community to address impaired driving through the criminal justice process. This section focuses on laws and policies that could be improved to strengthen and expedite the criminal justice process to reduce the likelihood of impaired driving and impaired driving crashes.

4.3.1 Oral Fluid for Impaired Driving Enforcement

To test for drugs other than alcohol, blood and oral fluid are optimal specimens because they are most likely to provide a snapshot of drugs that were in the system and potentially influencing driving at the time when the impairment-related behaviors were observed. Such specimens are not collected until after an impaired driving arrest has been made. When law enforcement officers conduct a traffic stop for suspected impairment, they first document and assess signs of impairment before making an arrest, including driving behaviors, such as weaving or speeding; driver behaviors, such as slurred speech or stumbling; driver appearance, such as bloodshot eyes or smell of cannabis or alcohol; and performance on standardized tests, such as the SFSTs. When an officer determines that a driver is impaired and makes an arrest, the officer then requests a biological specimen to test for the presence of alcohol and/or other drugs.

[93] (a) See ASTM International's "Standard Specification for International Symbol for Identifying Consumer Products Containing Intoxicating Cannabinoids," ASTM D8441/D8441M-22, for more information. ASTM International was formerly known as the American Society for Testing and Materials. (b) See the Doctors for Cannabis webpage "Universal Cannabis Symbol" for examples of various intoxicating cannabis product symbols.

Collecting blood can be challenging because it may require a search warrant and transportation to a facility where a trained phlebotomist can draw a specimen.[94] This can lead to delays, and by the time the blood specimen is collected, drug metabolism may have taken place (Wood, Brooks-Russell, and Drum 2016). In the present research, the elapsed time between arrest and blood collection averaged about 2 hours, and there was considerable variability in the times.

Because drug metabolism is typically not linear and can vary greatly between individual drivers suspected of being impaired, it is not possible to calculate backward to know the amount of drug present at the time of an arrest or a crash or to know if a parent compound was present if only metabolites are found. Consequently, obtaining a biological specimen near to the time of the event is valuable to understand what drugs were in a driver's system while driving and to facilitate impaired driving prosecution. Some law enforcement organizations have developed specialized phlebotomy programs, which may expedite the collection of blood specimens. In 2019, NHTSA published a Law Enforcement Phlebotomy Toolkit to help law enforcement agencies wishing to implement such programs, and the agency has also established a program to assist with their funding (NHTSA 2019). Other law enforcement agencies have begun collecting oral fluid at the roadside when drivers are arrested for impaired driving.

There are two ways that oral fluid collected at the roadside may be used. First, it may be analyzed with an on-site screening device that provides rapid qualitative—that is, positive or negative—information about the likely presence of different drugs or drug categories. Similar to a preliminary breath test for alcohol, a positive oral fluid drug screen would likely lead to the collection of an evidentiary oral fluid or blood specimen. For example, Indiana began a roadside oral fluid screening program in 2020, and pilot programs have been conducted in several other states (Michigan State Police 2019; Edwards, Smith, and Savage 2017; Moore and others 2022).[95]

Second, evidentiary oral fluid specimens can be sent to a toxicology laboratory for screening and confirmatory testing, which can provide information about specific drugs and may also include information about the quantity of a drug detected in a

[94] (a) A *phlebotomist* is someone trained to collect and prepare blood specimens for testing. (b) In the past decade, there have been multiple Supreme Court decisions concerning the circumstances under which search warrants may or may not be required for the collection of blood during an impaired driving arrest. For example, see Mitchell v. Wisconsin, 588 US (2019); Missouri v. McNeely, 569 US (2013); and Birchfield v. North Dakota, 579 US (2016).

[95] See the Indiana Criminal Justice Institute's "Roadside Oral Fluid Program" webpage for more information.

specimen. Alabama is currently the only state that routinely collects oral fluid in addition to blood for evidentiary purposes.

The potential benefits are that oral fluid collection allows for rapid and less invasive biological specimen collection, and it is less likely to be susceptible to alteration compared to urine. Because it can be collected at the roadside, oral fluid is more likely to provide an accurate snapshot of the presence of psychoactive drugs in a driver's system at the time of an event. It is increasingly recognized as a biological specimen that can provide valid information about driver drug use. For example, in February 2022, the US Department of Transportation (DOT) proposed to allow oral fluid testing as an alternative to urine testing for safety-sensitive transportation employees who are subject to regulatory drug testing.[96]

In 2018, the NTSB recommended that NHTSA develop and disseminate best practices, identify model specifications, and create a conforming products list for oral fluid drug screening devices (H-18-56).[97] In response, NHTSA conducted a study to evaluate on-site oral fluid drug screening technology (Buzby and others 2021). It found variability in the performance of the devices evaluated and affirmed the importance of accuracy and reliability in oral fluid screening devices. In 2022, NHTSA committed to working with the National Institute of Standards and Technology to develop performance standards and testing procedures for oral fluid screening devices.

Also in 2022, AAA published a comprehensive toolkit for the use of oral fluid to detect drugged drivers (Moore and others 2022). The toolkit describes the benefits of oral fluid for use in drug-impaired driving enforcement. It also provides guidance on oral fluid legislation and policy considerations, the tools for oral fluid field screening, laboratory oral fluid confirmation, oral fluid pilot programs, and education for the judiciary on the consideration of oral fluid evidence.

Although there is increasing recognition that oral fluid can provide valid results and is less invasive, easier, and quicker to collect, several states do not authorize its use. As shown in figure 11, as of February 2022, 15 states' implied consent laws allowed for the collection of oral fluid.[98] In 28 states and the District of Columbia, it

[96] See DOT's notice of proposed rulemaking titled "Procedures for Transportation Workplace Drug and Alcohol Testing Programs: Addition of Oral Fluid Specimen Testing for Drugs," published at 87 *Federal Register* 11156 on February 28, 2022.

[97] Safety Recommendation H-18-56 is classified Open—Acceptable Response. See appendix A for more information.

[98] Implied consent laws generally state that when drivers apply for a license to drive, they agree to comply with requests from law enforcement officers to collect certain specimens for alcohol or other drug testing.

was not authorized. In six states, it was authorized by an impaired driving statute but not mentioned as part of the implied consent laws, and in one state (Alabama), it was authorized both in its implied consent law and impaired driving statute.

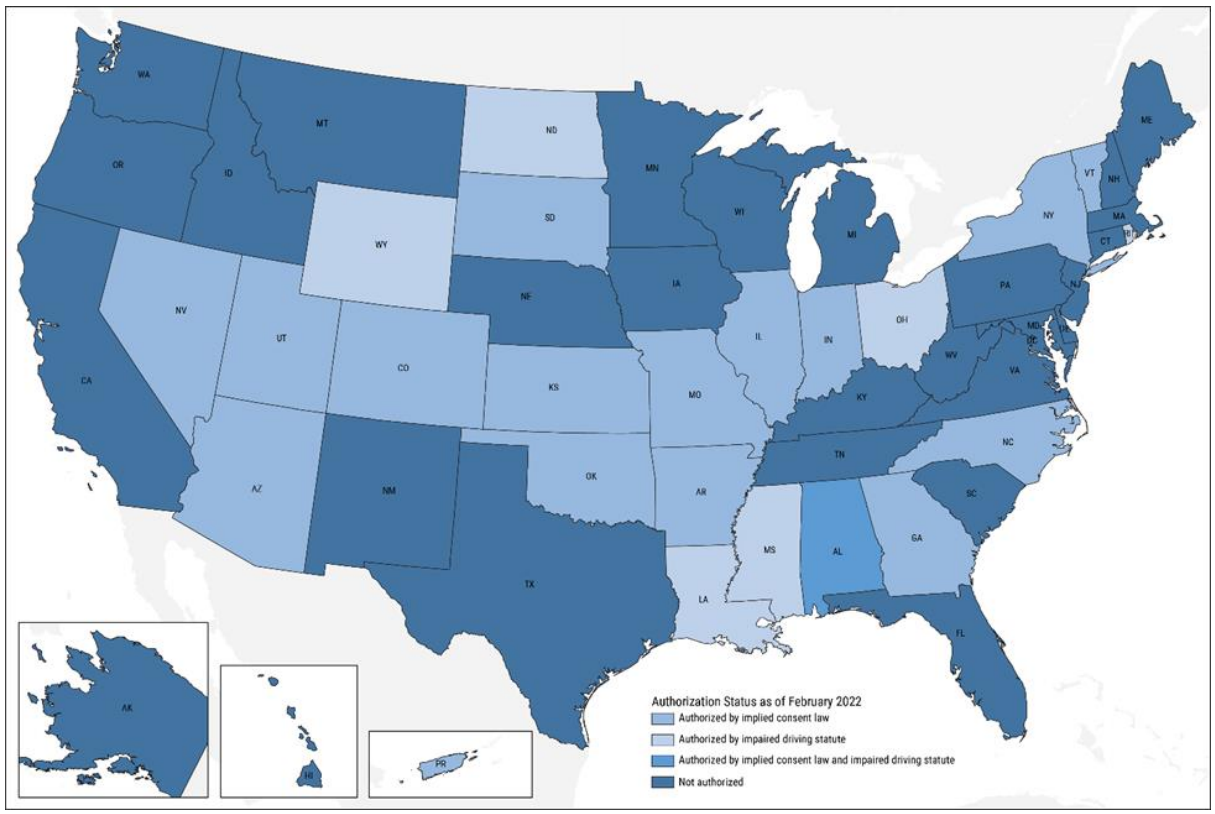

Figure 11. Oral fluid collection laws for impaired driving enforcement (Source: Moore and others 2022).

The NTSB concludes that oral fluid is a valuable but underutilized biological specimen for the detection of drug use by drivers and can support the enforcement of impaired driving laws. Therefore, the NTSB recommends that the District of Columbia and the 28 states that do not currently explicitly allow oral fluid collection and testing modify their impaired driving laws to allow for oral fluid collection, screening, and testing for the detection of drug use by drivers.[99]

[99] The states are Alaska, California, Connecticut, Delaware, Florida, Hawaii, Idaho, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington, West Virginia, and Wisconsin.

4.3.2 Impairing Drug Definitions in Impaired Driving Statutes

Certain states' impaired driving laws only allow drug-impaired driving violations when a driver is using certain drugs. By contrast, most states have a broad definition that includes any drug that may impair driving. In a state that defines a limited set of drugs, a driver who is arrested and found to be impaired by a drug that is not explicitly listed in the statute will likely not be prosecuted. For example, one report describes several case studies from Florida in which drivers who exhibited clear signs of impairment were not prosecuted for impaired diving because they had used several prescription drugs that were not identified in the Florida statute (Tiscione and others 2018).[100] A similar problem could result from drivers impaired by novel psychoactive substances, as new and unique formulations of those drugs continue to be developed. This can severely limit the ability for the criminal justice system to address drug-impaired driving.

Statutes should define drug-impaired driving as driving that is caused by impairment from any drugs rather than limiting their statutes to illicit drugs or to a set of drugs presently associated with impairment. Some states and other organizations have recently made efforts to address this issue. For example, in 2022, the New York State Senate and Assembly sponsored bills to modify its laws related to drug-impaired driving.[101] The bills, which did not ultimately pass, proposed several changes, including broadening the definition of "drug" to include any drug that impairs a driver rather than a specific list of drugs.

The NTSB concludes that laws that specify only certain drugs that can impair driving restrict the ability to prosecute drivers impaired by other drugs or drug combinations that are not specified in the statute, thereby limiting the ability to fully address drug-impaired driving. Therefore, the NTSB recommends that the five states that restrict drug-impaired driving statutes to a limited set of drugs enact laws specifying that drivers under the influence of a drug or multiple drugs that may impair driving are considered to be impaired under the definition of drug-impaired driving.[102]

[100] Other drivers had used a combination of drugs, some of which were included in the statute and others that were not; however, because prosecutors could not demonstrate that the drugs specifically covered in the statute caused the impairment, they were unable to support prosecution for impaired driving.

[101] See the New York State Senate Bills S8913 and A9554 for more information.

[102] The states that restrict drug-impaired driving statutes to a limited set of drugs are Alaska, Florida, Massachusetts, New York, and Oregon.

4.3.3 Electronic Warrants

Analyses from the crash-involved impaired driving arrest population in the Wisconsin laboratory dataset and the impaired driving arrest population in the San Francisco laboratory dataset found that the average elapsed time between traffic violation and blood specimen collection was about 2 hours. Such delays, and the resulting drug metabolism that takes place, can make enforcement particularly problematic in jurisdictions where laws specify a certain drug per se limit (Wood, Brooks-Russell, and Drum 2016). This was evidenced in the Orange County laboratory dataset where nearly one-third of drivers arrested for impaired driving, who only tested positive for cannabis, had THC levels below 5 ng/mL, which is a per se or permissible inference threshold for cannabis impairment in 4 states.[103] However, many other drugs can also quickly metabolize below detectable levels in a driver's system, and all toxicological evidence of drug use may metabolize out of a driver's system with delays in collection of a biological specimen for testing. Indeed, one advantage of blood testing is the ability to detect recent use. This, unfortunately, also means these specimens need to be collected efficiently to detect usage.

Countermeasures described in earlier sections, including programs that train law enforcement officers to become phlebotomists and facilitating the collection of oral fluid as an alternative biological specimen both have the potential to overcome this challenge. The use of electronic search warrants is another countermeasure that can potentially facilitate and improve drug-impaired driving enforcement. A traditional process for obtaining a search warrant may involve an arresting officer completing affidavit and warrant forms, contacting an on-call prosecutor or judge, faxing forms for review and signature, and, if granted, awaiting the return of the signed forms (Berning and others 2007). By contrast, electronic warrant systems, which allow for the requesting and transmitting of search warrants through online management systems, can streamline the impaired driving arrest process and lead to more timely collection of biological specimens from impaired driving suspects.

There are a number of published resources on implementing expedited warrants. In 2018, the Foundation for Advancing Alcohol Responsibility published a report, *Improving DUI System Efficiency: A Guide to Implementing Electronic Warrants*, which provides detailed guidance for communities wishing to implement an electronic warrant system (Borakove and Banks 2018). The guide includes sections on model legislation, stakeholder engagement, funding, policy and operations, training, and measuring effectiveness. It also includes several case studies of communities that successfully implemented electronic warrant systems. Additionally, in 2021, NHTSA published a similar report, *Practices for Implementing Expedited Search Warrant Programs for Obtaining Evidence from Impaired Drivers*, which

[103] The four states are Illinois, Montana, Washington, and Colorado.

provides best practices for implementing expedited warrants (Symoun and others 2021). NHTSA has also established a funding support program to assist agencies in their efforts to implement or enhance electronic warrant programs.

The use of electronic warrants is a straightforward process that can expedite the collection of biological specimens during drug-impaired driving arrests, but their use is not authorized by certain states. Reviews of state legislation and practices concerning the use of electronic warrants for impaired driving enforcement have yielded varied findings. A Foundation for Advancing Alcohol Responsibility analysis concluded that 26 states and the District of Columbia have specific legislation authorizing the use of electronic warrants, and an additional 8 states have court rules that authorize their use (Borakove and Banks 2018). In 2019, the AAA Foundation for Traffic Safety published the results of a survey that asked states to report on policies and practices related to drug-impaired driving (Taylor, McKnight, and Treffers 2019). Of the District of Columbia and the 44 states that responded, 5 reported regularly using electronic warrants statewide, 26 reported some use, and 14 reported not using them. Of the 14 states that reported not using electronic warrants, 12 did not have legislative authority to use electronic warrants, and 2 states reported administrative obstacles to implementing a program.[104] Although both reports noted that the presence of explicit legislative authority may not be necessary to establish an electronic warrant program, such policies can be useful for encouraging uniform practices and to guard against legal challenges (Borakove and Banks 2018; Taylor, McKnight, and Treffers 2019).

The NTSB concludes that the use of electronic warrants during the impaired driving arrest process can expedite the collection of biological specimens, thereby increasing the likelihood that impairing drugs present at the time of driving will be detected. Therefore, the NTSB recommends that the Commonwealth of Puerto Rico and the 17 states that have not established electronic warrant programs for impaired driving enforcement allow the use of electronic warrants to obtain biological specimens during impaired driving arrests by modifying laws or removing administrative barriers.

4.3.4 State Efforts to Address Drug-Impaired Driving

Modifying laws to allow for any impairing drug to be included in the definition of drug-impaired driving and to authorize the use of oral fluid testing and electronic

[104] The 14 states that reported not using electronic warrants were Alabama, Connecticut, Georgia, Hawaii, Idaho, Iowa, Maine, Massachusetts, Mississippi, New Mexico, North Carolina, Rhode Island, Virginia, and West Virginia. The NTSB contacted the Commonwealth of Puerto Rico and the six states that did not respond to the AAA FTS survey and determined that three additional states, Alaska, New York, and South Carolina, do not use electronic warrants. Puerto Rico did not respond.

warrants are important steps toward addressing drug-impaired driving. However, to fully realize the potential benefits of strong laws, states need to invest in establishing systems or programs to facilitate their enforcement. Establishing and maintaining such programs requires commitment from multiple stakeholders as well as financial resources. Furthermore, there are many different approaches that states and communities might take to address these issues. For instance, to expedite the collection of biological samples, one state might invest in providing phlebotomy training to law enforcement while another might establish an evidentiary oral fluid program. A state may need to consider many factors to customize an approach that is most likely to lead to reductions in impaired driving.

As part of its efforts to address drug-impaired driving, NHTSA recently developed and published a Drug-Impaired Driving Criminal Justice Evaluation Tool. The tool is comprised of a series of worksheets addressing many facets of drug-impaired driving prevention. It is designed to be used by state, local, territorial, or tribal government agencies to "assist with identifying program strengths and opportunities for improvements." The worksheet topics include law enforcement, prosecution, judiciary, community supervision, toxicology, treatment, emergency medical services, data, legislation, and program and communications.[105] After completing a self-evaluation using the Drug-Impaired Driving Criminal Justice Evaluation Tool, agencies may submit applications to NHTSA for financial support of projects designed to address challenges identified through the tool's use.

As of October 2022, within 4 months of launching the tool, NHTSA reported that 10 states or other agencies had submitted applications based on using the tool and that about 10 others had indicated that they were using the tool to conduct an evaluation and intended to apply for funding.[106] The NTSB concludes that NHTSA's Drug-Impaired Driving Criminal Justice Evaluation Tool can provide valuable guidance to help states and communities identify opportunities to improve efforts to address drug-impaired driving. Therefore, the NTSB recommends that the 50 states, the District of Columbia, and the Commonwealth of Puerto Rico complete an assessment using NHTSA's Drug-Impaired Driving Criminal Justice Evaluation Tool, and, if gaps are identified, apply to NHTSA for support in establishing programs to reduce drug-impaired driving.

[105] See NHTSA's "Drug-Impaired Driving Criminal Justice Evaluation Tool" webpage for more information and to download the tool and review the worksheet topics.

[106] Jennifer Davidson, NHTSA, personal communication, October 26, 2022.

4.4 Need to Ensure that Driving Safety Is Considered in the Evaluation of Prescription and OTC Drugs

As new drugs are developed and evaluated, an opportunity exists to consider potential impairing effects on driving. This section discusses the current efforts underway to evaluate how prescription and OTC drugs may affect driving safety and the importance of continued postmarket surveillance of the effects of drugs on driving safety.

4.4.1 Evaluating Potential Effects on Driving Safety During Drug Development

In 2008, in response to a 2000 NTSB recommendation to the DOT, NHTSA convened an expert panel to identify drugs that were safe for driving and those that were hazardous so that transportation operators could make safer choices about drug use (I-00-2).[107] The panel agreed that drivers need better information about how drugs affect their ability to operate motor vehicles but noted that there was incomplete information available to make a definitive classification for many drugs. The panel instead proposed a protocol to assess the driving impairment potential of various drugs (Kay and Logan 2011). The protocol includes three components:

- **pharmacology/toxicology review**, which refers to the evaluation of the likelihood that a drug or drug combination will affect brain functions used for driving
- **epidemiology review**, which refers to the examination of the association between drug presence and crashes, such as studies that compare drug use between crash-involved drivers and non-crash-involved drivers
- **standardized behavioral assessment**, which refers to experimental research on how drugs affect behaviors needed for safe vehicle operation, such as studies that employ dosing protocols and evaluate performance in controlled settings, such as driving simulators or test tracks. A standardized behavioral assessment is designed to be undertaken if the potential for impairment is identified in the other components

In 2017, the FDA published guidance for the drug industry, "Evaluating Drug Effects on the Ability to Operate a Motor Vehicle: Guidance for Industry," based on NHTSA's expert panel's protocol (FDA 2017). The guidance states that all drugs should be evaluated for potential central nervous system-impairing effects during the first phase of drug development. If there is evidence of impairing effects, additional

[107] Safety Recommendation I-00-2 is classified Closed—Unacceptable Action.

research in subsequent trials should examine potential impairment over the full range of drug exposure that may occur.[108] The guidance suggests the use of dedicated driving studies if the initial evaluation indicates a potential for driving impairment. Such targeted studies could be particularly important because research has indicated that drug-impaired drivers are not able to accurately predict their levels of impairment prior to driving (Verster and Roth 2012).

There is evidence that some drugmakers have applied the 2017 FDA guidance. For example, in January 2022, the FDA approved daridorexant (marketed as QUVIVIQ) to treat insomnia in adults. Its patient package insert includes a section that describes a driving study that was conducted to evaluate the effects of nighttime dosing on next-morning driving performance.[109] The study examined next-day driving performance in a driving simulator among 60 participants ages 50 to 79 years. Statistically significant driving performance impairment was observed the day after the first dose. After 4 consecutive nights of treatment, there was no overall significant driving impairment; however, driving remained impaired for some participants. As a result, the daridorexant drug labeling calls on prescribers to caution patients about the potential for next-morning driving impairment after taking daridorexant.[110] It also suggests that patients should not drive after taking the drug if a higher than recommended dose is taken or if it is taken with less than a full night of sleep remaining.

The 2017 FDA guidance is useful; however, this guidance does not appear to be used regularly by drug manufacturers. The FDA reviews about 50 new drug applications each year.[111] A NHTSA study that sought information about published reports and clinical trials that used the tiered assessment protocol was only able to find four examples since 2017 in which driving studies were conducted.[112] It is possible that, for the remaining drugs, initial reviews did not suggest a need for driving studies. Also, considering that it may take years to develop a new drug, it is possible that some drug sponsors did not have an opportunity to incorporate driving

[108] The guidance also noted that even some non-psychoactive drugs, for example, those that could impair vision or result in loss of consciousness from hypoglycemia, could impair driving ability and should therefore be considered.

[109] See the daridorexant patient package insert, section 14.2, "Special Safety Studies, Effects on Driving," for more information.

[110] For more information about the effectiveness of prescription and OTC drug labeling, see section 4.2.2.

[111] See the FDA's "New Drugs at FDA: CDER's New Molecular Entities and New Therapeutic Biological Products" webpage for more information.

[112] DeReece Smither, NHTSA, personal communication, October 20, 2021.

studies if their clinical programs were already underway when the 2017 guidance was issued. However, because the FDA has not tracked whether drug sponsors are aware of or are following the guidance, it is not possible to know whether it is being followed consistently.

In an effort to help drug developers and the FDA identify drugs that could pose a risk to safe driving early in the drug development process, NHTSA has also sponsored a study designed to validate a simulator-based "drug-impaired driving scenario."[113] The drug-impaired driving scenario study will evaluate cannabis, the benzodiazepine alprazolam, and a placebo during a simulated drive in which the standard deviation of lateral position, lane exceedances, and reaction time will be measured. If the study can demonstrate a link among drug use, performance on the scenario, and crash risk, it could be a very valuable tool for drug safety evaluation.

The NTSB concludes that the FDA has recognized the importance of evaluating the potential for driver impairment during the development of new drugs and has provided guidance for a systematic method of doing so, but it is unknown if its guidance is consistently applied. Therefore, the NTSB recommends that the FDA develop a system to audit drugmaker compliance with its 2017 "Evaluating Drug Effects on the Ability to Operate a Motor Vehicle: Guidance for Industry."

4.4.2 Continued Surveillance of Prescription and OTC Drugs

In some instances, drug labeling or dosing recommendations have been modified after the FDA became aware of driving-related safety issues. For example, zolpidem, a drug used to treat insomnia, was approved by the FDA in 1992 under the brand name Ambien.[114] By 2006, it was the 13th highest selling brand-name drug. Several subsequent research studies raised concerns about zolpidem, including one that showed a 220% increase in emergency department visits involving adverse reactions associated with its use from 2005 to 2010 (SAMHSA 2013) and an increased risk of motor vehicle crashes the day after its use (Yang and others 2011).

In March 2007, the FDA requested that manufacturers of sedative-hypnotic drugs, including Ambien, strengthen product labeling to describe risks of the drugs, including "complex sleep-related behaviors which may include sleep-driving, making phone calls, and preparing and eating food (while asleep)" (FDA 2007). In January 2013, the FDA required manufacturers to lower their recommended bedtime doses for certain drugs containing zolpidem, particularly for women (FDA 2013a). It

[113] See the US National Library of Medicine's clinical trials webpage "Validation of the Drug Impaired Driving Scenario (DIDS) on the CRCDS-miniSim (PDID)" for more information.

[114] In April 2007, the FDA approved zolpidem in its generic form.

also urged health care providers to caution patients about the risks of next-morning activities, including driving. The 2013 drug safety communication referred to driving simulator and laboratory studies submitted to the FDA that showed an elevated risk of a motor vehicle crash after using zolpidem. In May 2013, the FDA approved labeling changes for the new dosing recommendations. The FDA also warned that patients who used extended-release zolpidem should not drive or do other activities that require alertness the day after taking the drug (FDA 2013b).

In the case of zolpidem, it took several years before its effects were fully understood and prescribing and labeling were modified. Ideally, if drug manufacturers are following the 2017 FDA guidance during drug development, potentially risky driving-related drug side effects should be discovered, and drug labeling should take place before a drug goes to market. However, continued postmarket drug safety monitoring remains a valuable tool for identifying unintended adverse effects, particularly since the premarket evaluations cannot address all possible types of drug use and users. For example, they cannot anticipate all possible drug interactions.

The FDA administers several programs for postmarket monitoring of drug safety risks. The FDA Amendments Act of 2007 directed the agency to develop a postmarket risk identification and analysis system.[115] In response, the FDA developed its Sentinel System, which leverages electronic health records and medical billing information from numerous health care organizations.[116] The FDA queries these data to identify and study potential adverse drug effects. The FDA also reviews medical literature and conducts analyses of the FDA Adverse Event Reporting System, an FDA-sponsored database that contains adverse drug event reports, medication error reports, and product quality complaints submitted by industry and the public (FDA 2019a).[117] Industry submitters may include drug manufacturers, distributors, and others. Public submissions may come from health care providers, consumers, or family members. The FDA identifies safety issues in the database using data-mining, aggregate analysis, and case-based evaluation.

In 2019, the FDA described its 5-year strategy to expand the Sentinel System's foundation, including a plan to broaden its stakeholder community and its use of "real-world data" for surveillance (FDA 2019b). According to the FDA, real-world data may come from many sources, including electronic health records, claims and billing

[115] FDA Amendments Act of 2007, Public Law 110–85, 121 Stat. 823 (2007). See section 905.

[116] For more information about the Sentinel System, see the "Sentinel Initiative" webpage.

[117] See the FDA's "FDA Adverse Event Reporting System (FAERS) Public Dashboard" webpage for more information. A separate but analogous system is used to track vaccine safety.

activities, product and disease registries, patient-generated data, and data gathered from other sources.

In the present research, more than 1 in 10 drivers arrested for impaired driving tested positive for sedatives, narcotic analgesics, or potentially impairing neuropsychiatric medications, which are categories comprised predominantly of prescription and OTC drugs. If the prevalence of certain drugs or drug combinations in crash-involved impaired driving populations is higher than would be expected in the general driving population, it may indicate a heightened crash risk associated with those drugs. Several epidemiological studies, including those referenced in this report, have already documented the crash risk associated with certain prescription and OTC drugs, and the FDA has required warnings about driving for several of the drugs. Incorporating transportation safety data and research into the FDA's postmarket drug surveillance efforts could further enhance the agency's ability to identify drugs that may impair driving and increase crash risk.

The NTSB concludes that the FDA's drug safety surveillance systems have improved the likelihood that adverse drug effects will be detected and addressed; however, the surveillance systems could be enhanced by better incorporating information about drug use and driving safety. Therefore, the NTSB recommends that the FDA incorporate additional data and research concerning drug use and driving to improve FDA drug safety surveillance systems. For example, the FDA could conduct a review of epidemiological studies to identify drugs that may be associated with heightened crash risk, or it could examine drug prevalence data from the present research or from NHTSA's recent research on drug prevalence among crash-involved drivers admitted to trauma centers.

4.5 Need to Enhance Systems for Documenting and Tracking the Incidence of Drug Use and Driving

The NTSB has a long history of advocating for improvements in the collection, testing, and reporting of alcohol and other drug data.[118] A robust data system can benefit safety in several ways. For example, established evidence of impaired driving paired with timely tests for a standard set of commonly used impairing drugs can facilitate arrest and prosecution of impaired drivers. It also increases the likelihood that a driver's potential drug use problems may be identified and result in treatment. A systematic approach to collecting, testing, and reporting drug data can also facilitate tracking trends in drug use as well as the development of data-driven

[118] For a detailed history, see NTSB's June 24, 2022, response to NHTSA's request for comments titled "Barriers and Solutions for Submitting Toxicology Data to [FARS] Pursuant to Recommendations for Toxicological Investigation of Drug-Impaired Driving and Motor Vehicle Fatalities," published at 87 *Federal Register* 24390 on April 25, 2022.

countermeasures and the evaluation of their effects. Such improvements rely on resources and support from multiple stakeholders.

4.5.1 BAC Testing and Reporting

In 2012, the NTSB recommended that NHTSA disseminate BAC testing and reporting guidelines to the 50 states, the Commonwealth of Puerto Rico, and the District of Columbia (H-12-32).[119] We also made two recommendations to the 45 states with low reporting rates, the Commonwealth of Puerto Rico, and the District of Columbia, to take steps to increase their BAC reporting rates (H-12-34 and H-12-35).[120] Since those recommendations were issued, some states have improved their reporting rates, but on the national level, reporting has decreased. During the most recent 3 years from 2018 to 2020, the average rates of BAC reporting were about 5 percentage points lower than in 2012 for both fatally injured and surviving drivers.

In 2022, the NTSB classified Safety Recommendation H-12-34 Closed—Acceptable Action for the 2 recipients that completed the recommended action, Open—Acceptable Response for 30 recipients, Open—Acceptable Alternate Response for 3 recipients, and Open—Unacceptable Response for 12 recipients. The NTSB also classified Safety Recommendation H-12-35 Closed—Acceptable Action for 2 recipients that completed the recommended action, Open—Acceptable Response for 25 recipients, and Open—Unacceptable Response for 20 recipients.

The NTSB concludes that although a few states have taken some steps toward improving BAC reporting rates, additional efforts by most states to improve BAC collection, documentation, and reporting are needed to ensure accurate tracking of national alcohol-impaired driving trends and to develop and evaluate appropriate countermeasures.

4.5.2 Other Drug Testing and Reporting

In 2012, as a result of the NTSB *Reaching Zero* forum, the NTSB observed that no standard guidance existed for states regarding a minimum set of drugs that should be evaluated, recommended methods for drug testing, or reporting thresholds for crash databases. Because establishing standardized postcrash drug

[119] Safety Recommendation H-12-32 is classified Closed—Acceptable Action as of December 13, 2021. See appendix A for more information.

[120] Safety Recommendations H-12-34 and H-12-35 have an overall classification of Open—Acceptable Response. See appendix A for more information.

testing and reporting is a needed first step toward improving our understanding of the problem of drug-impaired driving, the NTSB recommended that NHTSA

> Develop and disseminate to appropriate state officials a common standard of practice for drug toxicology testing, including (1) the circumstances under which tests should be conducted, (2) a minimum set of drugs for which to test, and (3) cutoff values for reporting the results (H-12-33).[121]

In its letter to NHTSA concerning that recommendation, the NTSB acknowledged the efforts of ICADTS and of the NSC ADID as examples of sources for standard practices. In 2016, NHTSA provided support for an effort to review and update the NSC ADID recommendations for the toxicological investigation of drug-impaired driving cases and motor vehicle fatalities. The resulting NSC ADID report, which was part of a regularly produced survey of forensic toxicology laboratories in the US and Canada, provided a set of recommendations concerning which drugs should be routinely tested for, as well as screening and confirmation cutoffs for analyses in blood, urine, and oral fluid (Logan and others 2018).

In 2018, NHTSA established an expert working group on toxicology data collection to improve overall understanding of the national scope and prevalence of drug-impaired driving. The working group drafted guidance for the forensic toxicology community; however, the draft guidance was never shared with the public, and the working group stopped meeting in 2019.[122] In the meantime, the NSC ADID group published an updated set of recommendations (D'Orazio and others 2021), and many of those recommendations were codified in ANSI/ASB Standard 120 (ANSI/ASB 2021).

The NSC ADID recommendations and ANSI/ASB Standard 120 provide guidance on the scope of testing; the recommended matrix to be tested, such as blood or oral fluid; and the minimum laboratory detection cutoffs for the testing of these drugs. The NSC ADID recommendations go one step further by suggesting the elimination of stop-testing procedures, where further drug testing is cancelled if a driver has a BAC over a certain threshold. The standardization of the drug panel, meaning which specific drugs are tested, is valuable because there are potentially thousands of drugs that could be tested, and testing of additional drugs can add cost and time constraints. Table 12 shows the drugs included in ANSI/ASB Standard 120.

[121] Safety Recommendation H-12-33 is classified Open—Acceptable Response. See appendix A for more information.

[122] See the NTSB's June 24, 2022, comments to the docket.

Table 12. Minimum drugs to be tested for according to ANSI/ASB Standard 120, adapted from the NSC ADID Tier I Compounds (D'Orazio and others 2021).

Drug Category	Drugs Tested
Cannabinoids	THC 11-nor-delta-9-carboxy-THC 11 hydroxy delta–9-THC
Ethanol	–
Narcotic Analgesics	Morphine Codeine 6-acetylmorphine Hydrocodone Oxycodone Methadone Fentanyl Buprenorphine Norbuprenorphine Tramadol O-desmethyltramadol
CNS Stimulants	Amphetamine Methamphetamine MDA MDMA Cocaine Cocaethylene Benzoylecgonine
CNS Depressants	Carisoprodol Meprobamate Zolpidem Alprazolam Clonazepam 7-aminoclonazepam Lorazepam Nordiazepam Oxazepam Temazepam

In March 2022, NHTSA published a report providing a detailed exploration of the challenges in driver drug testing and reporting in the United States to "lay the groundwork for improving the data collection and reporting" (Berning and others 2022). The report describes numerous problems and challenges at all stages of the current process, including obstacles in obtaining toxicological specimens and ordering drug tests, inconsistencies in testing and reporting procedures, and delays and challenges in transferring toxicology findings into crash databases. It also describes some of the measures that NHTSA has taken, or plans to take, to address those problems. For example, NHTSA has expanded the number of drugs that can be entered into FARS. Additionally, in April 2022, in response to a congressional mandate in section 25025 of the IIJA, NHTSA issued a request for comments titled "Barriers and Solutions for Submitting Toxicology Data to [FARS] Pursuant to Recommendations for Toxicological Investigation of Drug-Impaired Driving and Motor Vehicle Fatalities," published at 87 *Federal Register* 24390. In its response to

this request, the NTSB strongly encouraged NHTSA to use the information it gathered to take steps to improve BAC and other drug reporting for all drivers in fatal crashes.[123]

The NTSB's FARS analysis confirmed that national-level reporting of nonalcohol drugs continues to be inadequate. Drug tests were reportedly conducted for an average of 60% of fatally injured drivers and 18% of surviving drivers in fatal crashes between 2018 and 2020, which is 1 to 2 percentage points less than in 2012. There is also substantial variability among reported testing rates by state. Even if reporting rates increased, the variability in testing and reporting protocols that currently exist would not allow for meaningful summaries of the reported data.

Importantly, these standards and improvements to the consistency of toxicology testing not only enhance traffic data, which may then be used to evaluate drug trends and evaluate countermeasures, but they are also invaluable for helping individuals arrested for impaired driving get appropriate treatment. For example, if a driver is arrested for a DUI with alcohol and other drugs in their system, but their blood sample is never tested for drugs other than alcohol because of stop-testing procedures or because the specific drugs influencing them were not included in the drug panel, then this driver may only receive treatment and countermeasures targeted toward alcohol. The many substance abuse challenges stemming from other drugs may not be addressed, denying them the treatment help they need and increasing their likelihood of recidivating. The NTSB concludes that because there is no common standard of practice for the collection, testing, and reporting of driver drug toxicology data in the United States, critical information that could improve understanding of drug trends and prevalence, assist with the evaluation of countermeasures, and better guide treatment options for DUI offenders is not being captured or analyzed. Additionally, the NTSB concludes that widespread adoption of ANSI/ASB Standard 120 would improve our understanding of the prevalence of drug use among crash-involved drivers and drivers arrested for impaired driving. Therefore, the NTSB classifies Safety Recommendation H-12-33 Closed—Acceptable Action/Superseded and recommends that NHTSA disseminate ANSI/ASB Standard 120 to state officials for use as the common standard of practice for drug toxicology testing (Safety Recommendation H-22-33).

NHTSA has recently taken steps to support improvements in toxicology testing. In 2021, NHTSA funded a task order to support state drug-impaired driving toxicology meetings in up to 10 states for the purpose of increasing communication among state and local laboratories and partners, providing training for toxicologists and prosecutors on courtroom testimony, standardizing testing procedures among state agencies, and coordinating data collection and reporting to state partners and

[123] See the NTSB's June 24, 2022, comments to the docket.

FARS to strengthen state drug-impaired driving testing and reporting within each demonstration state. The agency also established a Toxicology Liaison Program to support liaisons in three NHTSA regions.[124] These liaisons provide a knowledge resource to states and toxicology laboratories to help them strengthen their drug testing programs. The NHTSA toxicology liaisons are in a good position to accomplish Safety Recommendation H-22-33 by sharing information about ANSI/ASB Standard 120 with relevant state officials.

Toxicology laboratories will also likely need resources to meet the standard. For example, some laboratories will need upgraded instruments for drug testing, which will necessitate training on the new instruments and protocols. They may also require additional staff to address the increased workload. Forensic toxicology laboratories are already strained. A report from the National Institute of Justice showed a 26% increase in expenditures for toxicology from fiscal year 2015–2016 to fiscal year 2016–2017, which it attributed in part to the opioid crisis (NIJ 2019). The report also noted that, compared to deoxyribonucleic acid (DNA) testing, other forensic disciplines, including toxicology, receive considerably less federal funding.[125]

NHTSA is well-positioned to provide funding and other support to help toxicology laboratories meet ANSI/ASB Standard 120. The agency has recently established three reimbursement-based drug-impaired driving funding programs, including one to support implementation of law enforcement phlebotomy programs, one to support electronic warrant implementation, and the aforementioned Drug-Impaired Driving Criminal Justice Evaluation Tool, which enables support for various programs. The funding for these three programs must be expended by March 2023, July 2023, and September 2023, respectively.[126] NHTSA has demonstrated a dedication to helping states improve toxicology testing, and the newly developed programs and funding provide important resources. Yet, more is needed to help states address increased toxicology demands while meeting ANSI/ASB Standard 120. As NHTSA continues its efforts to support improvements to toxicology testing, creating a reimbursement program dedicated to funding laboratory improvements would further foster widespread adoption of ANSI/ASB Standard 120. NHTSA could also assist toxicology laboratories with achieving this goal by seeking authority to remove restrictions that may make it difficult to obtain

[124] Tara Kelley-Baker, NHTSA, personal communication, August 15, 2022.

[125] Much of the federal funding for DNA testing stemmed from a movement in the 1990s to establish and promote a standard approach to DNA analysis. The DNA Identification Act of 1994, Public Law 103–322, 108 Stat. 2065, required that the Federal Bureau of Investigation ensure that all DNA laboratories that received federal grant funds or participated in the National DNA Index System demonstrate compliance with the quality assurance standards.

[126] Tara Kelley-Baker, NHTSA, personal communication, September 9, 2022.

needed toxicology equipment, such as, the restrictions described in section 165 of the Surface Transportation Act of 1982, commonly referred to as the Buy America Act.[127] Therefore, the NTSB recommends that NHTSA establish a program to support toxicology laboratories' compliance with ANSI/ASB Standard 120.

States can also play an important role in promoting the adoption of standard practices for drug toxicology testing. In its 2022 report on the fatal Avenal, California, collision involving a driver who tested positive for alcohol and cannabis, the NTSB noted that the county where the crash occurred does not routinely test fatally injured drivers for cannabis. The report also described the efforts of the California Highway Patrol's Impaired Driving Task Force. The task force, formed in 2017, met multiple times over several years and, in January 2021, released a report containing recommendations to prevent impaired driving as well as to reduce and mitigate its effects (CHP 2021). Several recommendations addressed improvements to forensic toxicology testing, including improving standardization of the conduct of tests and allocating funds for toxicology testing equipment and personnel.

In the Avenal report, the NTSB recommended that the state of California enact legislation to require forensic toxicology laboratories to follow the standards recommended by the NSC ADID. The recommendation also called for a provision in the legislation to require laboratories to update the testing protocol if additional federal guidance is provided (H-22-23).[128]

Enacting legislation requiring that laboratories follow ANSI/ASB Standard 120 regardless of driver BAC is one way to achieve this goal. Another way would be to provide incentives to states or laboratories that commit to meeting the standard. For example, in 2022, the California Highway Patrol established a grant program for the

[127] (a) The Surface Transportation Act of 1982, Public Law 97–424, 96 Stat. 2097 (1983). (b) For example, NHTSA's September 15, 2022, notice of proposed rulemaking titled "Uniform Procedures for State Highway Safety Grant Programs," published at 87 *Federal Register* 56756, stated that the Buy America Act requires its grant recipients "to purchase with federal funds only steel, iron, and manufactured products produced in the United States, unless the Secretary of Transportation determines that such domestically produced items would be inconsistent with the public interest, that such materials are not reasonably available and of a satisfactory quality, or that inclusion of domestic materials will increase the cost of the overall project contract by more than 25 percent."

[128] On August 29, 2022, the California governor approved a law which will require coroners or medical examiners to perform alcohol and other drug screening and confirmation tests on people who die while driving a motor vehicle. See California Senate Bill 925, Chapter 223 (2022).

improvement and standardization of practices in toxicology laboratories supporting impaired driving efforts.[129]

California Highway Patrol's Impaired Driving Task Force provides an example of how key stakeholders can work together to develop recommendations that can lead to meaningful progress in improving and standardizing drug toxicology testing. Therefore, the NTSB recommends that the 50 states, the District of Columbia, and the Commonwealth of Puerto Rico require government-funded laboratories that conduct forensic toxicology testing to adopt and routinely apply (regardless of driver BAC) ANSI/ASB Standard 120, and provide funding for equipment, personnel, and training, to facilitate testing meeting that standard. Consequently, the NTSB also classifies Safety Recommendation H-22-23 Closed—Superseded by Safety Recommendation H-22-40.[130]

It should be noted the goal of these recommendations is not to expand the number of people subjected to blood testing. Rather, these recommendations seek to standardize the testing that does occur. This not only improves the quality of data that can be used for research and countermeasure development but would also assist with guiding treatment. Applying consistent standards for toxicological testing, rather than allowing individual variability in testing—for example, law enforcement requesting the scope of the drug panel for each individual case—may also facilitate more equitable testing outcomes.

Standardizing testing and reporting protocols will lead to a substantial improvement in the understanding of drug use among drivers. Progress in this area can be further augmented if those who analyze drug prevalence data, such as policymakers and researchers, adopt a standardized approach to classifying and tracking drug prevalence, which may improve the comparability of results. The classification scheme used in this research provides one example of an approach that could be adopted by others. A full list of the drugs, metabolites, and classifications used in this research is available in the NTSB public docket.[131]

[129] See the California Grants Portal webpage "Toxicology Driving Under the Influence/Driving Under the Influence of Drugs: Crime Laboratories."

[130] The NTSB recognizes that Safety Recommendation H-22-23 is currently classified Open—Await Response but contends that superseding it with Safety Recommendation H-22-40 better clarifies the intent of the recommendation for all states, the District of Columbia, and the Commonwealth of Puerto Rico.

[131] See the NTSB public docket, case number DCA21SS003.

4.5.3 Sentinel Surveillance Systems to Track Drug Use in Crash-Involved Drivers

It will take time for jurisdictions to meet ANSI/ASB Standard 120. In the meantime, efforts like the development of sentinel surveillance systems are needed to monitor changing trends in driver drug use in the United States. In the public health community, the term *sentinel surveillance system* is used to describe a collection of reporting sites that provide timely and high-quality data concerning a potential public health issue. Sentinel surveillance systems are most commonly used to track health issues, such as infectious disease outbreaks and trends. Sentinel surveillance systems can also be used to measure trends in the prevalence of drug use and driving.

In 2019, the AAA Foundation for Traffic Safety published a study examining potential strategies for developing a sentinel surveillance system of drug use by drivers (Kelley-Baker, Smith, and Dunn 2019). The authors examined if existing databases could be used for such a system and put forward several optimal standards for data that could form such a system, such as the inclusion of drug test results that were based on a consistent drug-testing protocol, the inclusion of driving-related data, and the representativeness and timeliness of data. The study assessed 10 transportation-related and 10 trauma-related data sources using those standards and determined that trauma centers could potentially form the basis of a sentinel surveillance system for drug use and driving.

Since this AAA Foundation for Traffic Safety study was published in 2019, several studies have been conducted using a similar trauma center approach (Brubacher and others 2022; Esther and others 2022; Thomas and others 2020). Most notably, research begun by NHTSA in September 2019 tracked drug use among drivers at several Level I trauma centers in the United States; continued efforts such as these could provide useful information to guide drug-impaired driving countermeasures (Thomas and others 2020). For example, the NHTSA trauma center study was able to document substantial increases in potentially impairing drug presence among drivers admitted to trauma centers after the declaration of the COVID-19 public health emergency.[132] Another potential benefit of trauma center research is that, by employing comprehensive toxicological testing that goes beyond ANSI/ASB Standard 120, such research could identify the emergence of new potentially impairing drugs that are not included in the standard.

A drawback of the NHTSA trauma center work was that the population sampled was not representative, meaning its findings could not be generalized to the broader national population. Ideally, if the network of trauma centers contributing

[132] See section 1.1 of this report for further discussion of this study.

driver toxicology data could be expanded, it could allow for improved tracking of driver drug use trends and better identification of new drugs or drug combinations that may impair drivers. The NTSB concludes that a trauma center-based sentinel surveillance system could provide important information to understand drug prevalence in crash-involved drivers, to identify new drugs or combinations of drugs that may impair drivers, and to assist in the development of policy to reduce impaired driving crashes. Therefore, the NTSB recommends that NHTSA establish a trauma center-based sentinel surveillance system to track drug use among crash-involved drivers.

4.5.4 Driver Pretrial Services, Monitoring, Specialty Courts, and Treatment

Effective countermeasures to impaired driving must not only reflect enforcement and testing, but also recognize the need for education, support, and treatment intervention. These types of countermeasures appreciate that impaired driving is often not a single event, but rather may be intricately linked with substance abuse, addiction, and other at-risk behavioral patterns. This is highlighted by the high recidivism rates associated with impaired driving offenses.[133] Unfortunately, a traffic stop or crash may be how drivers are first identified as suffering from a condition, such as substance use disorder, or informed that their medication may be impairing their driving performance.

Effective treatment and services rely on fully understanding the driver and the nature of their impaired driving offense. In this way, comprehensive toxicology procedures, such as refraining from stop-testing procedures, and other forms of screening not only generate critical data for countermeasure development and evaluation, but also help identify the substances being abused by drivers to develop effective treatment strategies for that individual. For example, a driver with an opioid addiction who is arrested with a BAC over the stop-testing limit may never be tested for other drugs. In this case, the driver may be ordered to install an ignition interlock that would address alcohol impairment but would not address the impairment caused by opioid use. Importantly, the failure to identify other drug usage and addictions beyond alcohol also would not allow for treatment to target the different patterns of behavior and addiction caused by different drugs.

There are a number of approaches to address recidivism, such as pretrial services, early intervention services, monitoring, supervision, and treatment courts (Casanova Powell 2020). These are generally programs designed to better screen

[133] *Recidivism* refers to an individual repeating the same offense. It is estimated that recidivism rates are 25.0% for impaired driving arrests and 29.5% for convictions (Warren-Kigenyi and Coleman 2014).

and monitor drivers for increased risk, for example, by monitoring alcohol or drug abuse; to provide effective supervision of these drivers; and to process these cases through specialized treatment courts, such as DUI courts or drug courts. Many of these programs, including court monitoring, alcohol problem assessment and treatment, alcohol ignition interlocks, DUI offender monitoring, alcohol screening, and brief interventions, are listed in NHTSA's *Countermeasures that Work* (Venkatraman and others 2021).[134]

Such programs are designed to address the unique needs and risks of drivers. Furthermore, these programs can also be tailored to specifically help vulnerable populations with high rates of risk, recidivism, or incarceration. These approaches are designed to maximize outcomes by providing culturally competent treatment options. For example, the state of Missouri has a program called Habilitation Empowerment Accountability Therapy. This program is an Afro-centric, strength-focused, and trauma-informed cognitive behavioral therapy designed to improve outcomes for Black men in treatment court.[135] Another program is Justice for Vets, which focuses on the unique needs and circumstances of veterans through a specialized treatment court.[136]

There is a growing recognition of the need for treatment approaches that are rehabilitative as opposed to strictly punitive. The ICADTS recently launched a working group on pretrial services that will document international best practices and develop training materials for early intervention and post-conviction programs. These materials will provide valuable tools for documenting evidence-based programs and helping communities adopt these programs.

The NTSB concludes that early intervention and post-conviction intervention treatments can be effective tools for reducing impaired driving recidivism. The NTSB will continue to monitor the research in this area and will advocate for those programs that are demonstrated to reduce impaired driving crashes or recidivism.

[134] *Brief interventions* focus on quickly screening an individual to identify the severity of substance use and needed level of treatment. A brief intervention can increase insight, awareness, and motivation to change and can involve referral to more extensive treatment and specialty care. See the Substance Abuse and Mental Health Services Administration's webpage on "Screening, Brief Intervention, and Referral to Treatment (SBIRT)" for more information.

[135] For more information, see Missouri Commissioner Casey Clevenger's presentation, "Improving Access and Outcomes for High Risk Participants in Your Courts," at the 2022 Lifesavers National Conference on Highway Safety Priorities in Chicago, Illinois.

[136] See the Justice for Vets website for further information.

5. Conclusions

5.1 Findings

1. Multiple drugs and drug categories—including alcohol, cannabis, and numerous illicit, prescription, and over-the-counter drugs—can impair driving performance and are associated with increased crash risk.

2. Drug data in national-level databases continue to be unreliable and cannot be used to estimate drug prevalence among drivers.

3. Alcohol was the most prevalent drug found among impaired drivers in toxicology data reviewed by the National Transportation Safety Board, and about half of all impaired drivers were positive for other drugs or multiple drugs, indicating that although alcohol-related countermeasures must remain the highest priority, countermeasures that effectively address other drugs and drug combinations are also needed.

4. Policies that limit drug testing, such as those that use stop-testing protocols when a driver's blood alcohol concentration is over a certain level, result in a loss of valuable information that could otherwise be used to customize policies, treatment, and other countermeasures.

5. Reducing the time between an impaired driving event and biological specimen collection increases the likelihood that toxicological test results will reflect drug presence at the time of the event.

6. Alcohol, both alone and in combination with other drugs, continues to be the drug with the most detrimental impact on traffic safety.

7. Implementing countermeasures to reduce alcohol-impaired driving must remain a high priority to reduce impaired driving crashes overall.

8. Although alcohol and cannabis were both highly prevalent in toxicology data reviewed by the National Transportation Safety Board, alcohol was most often detected alone, whereas cannabis was most often detected in combination with alcohol or other drugs.

9. Cannabis and other potentially impairing drugs, especially in combination with and without alcohol, contribute to the problem of impaired driving crashes due to their prevalence and negative impacts on driving performance.

10. Media campaigns have the potential to raise awareness of the risk of impaired driving associated with cannabis, other drug, and multiple drug use, but it is unclear if they change driver behavior.

11. Although the US Food and Drug Administration has provided useful guidance to industry concerning evaluating drug effects on driving, additional effort is needed to identify drug label characteristics that can effectively and consistently convey driving risk to consumers.

12. Including driving-related warnings on cannabis products, similar to those on alcohol and many prescription and over-the-counter drugs, would increase awareness of the risks of cannabis-impaired driving.

13. Oral fluid is a valuable but underutilized biological specimen for the detection of drug use by drivers and can support the enforcement of impaired driving laws.

14. Laws that specify only certain drugs that can impair driving restrict the ability to prosecute drivers impaired by other drugs or drug combinations that are not specified in the statute, thereby limiting the ability to fully address drug-impaired driving.

15. The use of electronic warrants during the impaired driving arrest process can expedite the collection of biological specimens, thereby increasing the likelihood that impairing drugs present at the time of driving will be detected.

16. The National Highway Traffic Safety Administration's Drug-Impaired Driving Criminal Justice Evaluation Tool can provide valuable guidance to help states and communities identify opportunities to improve efforts to address drug-impaired driving.

17. The US Food and Drug Administration has recognized the importance of evaluating the potential for driver impairment during the development of new drugs and has provided guidance for a systematic method of doing so, but it is unknown if its guidance is consistently applied.

18. The US Food and Drug Administration's drug safety surveillance systems have improved the likelihood that adverse drug effects will be detected and addressed; however, the surveillance systems could be enhanced by better incorporating information about drug use and driving safety.

19. Although a few states have taken some steps toward improving blood alcohol concentration (BAC) reporting rates, additional efforts by most states to improve BAC collection, documentation, and reporting are needed to ensure accurate tracking of national alcohol-impaired driving trends and to develop and evaluate appropriate countermeasures.

20. Because there is no common standard of practice for the collection, testing, and reporting of driver drug toxicology data in the United States, critical information that could improve understanding of drug trends and prevalence, assist with the evaluation of countermeasures, and better guide treatment options for driving-under-the-influence offenders is not being captured or analyzed.

21. Widespread adoption of the American National Standards Institute/American Academy of Forensic Sciences Standards Board *Standard for the Analytical Scope and Sensitivity of Forensic Toxicological Testing of Blood in Impaired Driving Investigations*, ANSI/ASB Standard 120, would improve our understanding of the prevalence of drug use among crash-involved drivers and drivers arrested for impaired driving.

22. A trauma center-based sentinel surveillance system could provide important information to understand drug prevalence in crash-involved drivers, to identify new drugs or combinations of drugs that may impair drivers, and to assist in the development of policy to reduce impaired driving crashes.

23. Early intervention and post-conviction intervention treatments can be effective tools for reducing impaired driving recidivism.

6. Recommendations

6.1 New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following new safety recommendations.

To the National Highway Traffic Safety Administration:

Disseminate the American National Standards Institute/American Academy of Forensic Sciences Standards Board *Standard for the Analytical Scope and Sensitivity of Forensic Toxicological Testing of Blood in Impaired Driving Investigations*, ANSI/ASB Standard 120, to state officials for use as the common standard of practice for drug toxicology testing. (H-22-33) *[This new recommendation supersedes Safety Recommendation H-12-33.]*

Establish a program to support toxicology laboratories' compliance with the American National Standards Institute/American Academy of Forensic Sciences Standards Board *Standard for the Analytical Scope and Sensitivity of Forensic Toxicological Testing of Blood in Impaired Driving Investigations*, ANSI/ASB Standard 120. (H-22-34)

Establish a trauma center-based sentinel surveillance system to track drug use among crash-involved drivers. (H-22-35)

To the US Food and Drug Administration:

Conduct a study to understand how prescription drug labeling and over-the-counter drug labels could be modified to increase user understanding and compliance with driving-related warnings; publish the study findings. (H-22-36)

Develop a system to audit drugmaker compliance with your 2017 "Evaluating Drug Effects on the Ability to Operate a Motor Vehicle: Guidance for Industry." (H-22-37)

Incorporate additional data and research concerning drug use and driving to improve US Food and Drug Administration drug safety surveillance systems. (H-22-38)

To the 50 states, the District of Columbia, and the Commonwealth of Puerto Rico:

Complete an assessment using the National Highway Traffic Safety Administration's (NHTSA) Drug-Impaired Driving Criminal Justice Evaluation Tool, and, if gaps are identified, apply to NHTSA for support in establishing programs to reduce drug-impaired driving. (H-22-39)

Require government-funded laboratories that conduct forensic toxicology testing to adopt and routinely apply (regardless of driver blood alcohol concentration) the American National Standards Institute/American Academy of Forensic Sciences Standards Board *Standard for the Analytical Scope and Sensitivity of Forensic Toxicological Testing of Blood in Impaired Driving Investigations*, ANSI/ASB Standard 120, and provide funding for equipment, personnel, and training, to facilitate testing meeting that standard. (H-22-40) *[This new recommendation supersedes Safety Recommendation H-22-23.]*

To the District of Columbia and the states of Alaska, California, Connecticut, Delaware, Florida, Hawaii, Idaho, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, Washington, West Virginia, and Wisconsin:

Modify your impaired driving laws to allow for oral fluid collection, screening, and testing for the detection of drug use by drivers. (H-22-41)

To the District of Columbia, the Commonwealth of Puerto Rico, and the states of Alabama, Arizona, Arkansas, California, Colorado, Florida, Illinois, Louisiana, Maine, Maryland, Mississippi, Missouri, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Virginia, and West Virginia:

Require a warning label on cannabis products advising users not to drive after cannabis use due to its impairing effects. (H-22-42)

To the Commonwealth of Puerto Rico and the states of Alabama, Alaska, Connecticut, Georgia, Hawaii, Idaho, Iowa, Maine, Massachusetts, Mississippi, New Mexico, New York, North Carolina, Rhode Island, South Carolina, Virginia, and West Virginia:

Allow the use of electronic warrants to obtain biological specimens during impaired driving arrests by modifying laws or removing administrative barriers. (H-22-43)

To the states of Alaska, Florida, Massachusetts, New York, and Oregon:

Enact laws specifying that drivers under the influence of a drug or multiple drugs that may impair driving are considered to be impaired under the definition of drug-impaired driving. (H-22-44)

6.2 Previously Issued Recommendations Classified in This Report

To the National Highway Traffic Safety Administration:

Develop and disseminate to appropriate state officials a common standard of practice for drug toxicology testing, including (1) the circumstances under which tests should be conducted, (2) a minimum set of drugs for which to test, and (3) cutoff values for reporting the results. (H-12-33)

The classification of Safety Recommendation H-12-33 is changed from Open—Acceptable Response to Closed—Acceptable Action/Superseded by new Safety Recommendation H-22-33 in section 4.5.2 of this report.

To the state of California:

Enact legislation that requires forensic toxicology laboratories to follow the standards recommended by the National Safety Council's Alcohol, Drugs, and Impairment Division; the legislation should include a provision requiring laboratories to update the testing protocol if additional federal guidance is provided. (H-22-23)

The classification of Safety Recommendation H-22-23 is changed from Open—Await Response to Closed—Superseded by new Safety Recommendation H-22-40 in section 4.5.2 of this report.

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

JENNIFER HOMENDY
Chair

MICHAEL GRAHAM
Member

BRUCE LANDSBERG
Vice Chairman

THOMAS CHAPMAN
Member

Report Date: December 13, 2022

Board Member Statement

Member Chapman filed the following concurring statement on December 13, 2022.

Thomas B. Chapman
Statement of Concurrence

Safety Research Report–*Alcohol, Other Drug, and Multiple Drug Use Among Drivers*

I concur and join in the Board's unanimous adoption of the safety research report.

Congratulations to our team for the fine job done on this report. It is an important contribution in an area of great challenge and exemplifies the quality work typical of NTSB's outstanding staff. Especially impressive is the innovative approach to analyzing the presence of potentially impairing drugs in driver specimens submitted to four US laboratories.

Appendixes

Appendix A: NTSB Impairment-Related Recommendations

Table A-1 provides the number; classification as of December 13, 2022; date closed; and recommendation text for all NTSB impairment-related recommendations related to the highway mode. For recommendations issued to multiple recipients, such as states or associations, the classification status shown in the table below reflects the overall status and is annotated as such. Each individual recipient receives a classification based on their specific response to the recommendation; the overall classification is determined by the plurality status of the open recipients. Further information about the recommendations in this table can be found using the CAROL Query or by clicking on the hyperlinks provided below.

Table A-1. NTSB impairment-related recommendations.

Number	Classification	Date Closed	Recommendation
H-22-23	Closed in this report		To the state of California: Enact legislation that requires forensic toxicology laboratories to follow the standards recommended by the National Safety Council's Alcohol, Drugs, and Impairment Division; the legislation should include a provision requiring laboratories to update the testing protocol if additional federal guidance is provided. (Superseded by Safety Recommendation H-22-40)
H-22-22	Open—Await Response		To the National Highway Traffic Safety Administration: Require that all new vehicles be equipped with passive vehicle-integrated alcohol impairment detection systems, advanced driver monitoring systems, or a combination thereof; the systems must be capable of preventing or limiting vehicle operation if driver impairment by alcohol is detected.
H-18-61	Closed—Acceptable Action	December 21, 2020	To the Texas Department of Transportation: Promote the importance of attending drug-impaired driving enforcement training and increase training access to meet the demands of local and state law enforcement.
H-18-60	Open—Await Response		To the State of Texas: Conduct an executive-level review of your impaired driving program and implement data-driven strategies that result in a downward trend in the number of fatalities, injuries, and crashes involving alcohol- and other drug-impaired drivers.

Number	Classification	Date Closed	Recommendation
H-18-57	Closed–Acceptable Action	September 20, 2022	To the National Highway Traffic Safety Administration: Evaluate best practices and countermeasures found to be the most effective in reducing fatalities, injuries, and crashes involving drug-impaired drivers and provide additional guidance to the states on drug-impaired driving in Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices.
H-18-56	Open–Acceptable Response		To the National Highway Traffic Safety Administration: Develop and disseminate best practices, identify model specifications, and create a conforming products list for oral fluid drug screening devices.
H-18-35	Open–Acceptable Response		To the National Highway Traffic Safety Administration: Examine the influence of alcohol and other drug use on motorcycle rider crash risk compared to that of passenger vehicle drivers, and develop guidelines to assist states in implementing evidence-based strategies and countermeasures to more effectively address substance-impaired motorcycle rider crashes.
H-16-8	Open–Unacceptable Response		To the Federal Motor Carrier Safety Administration: Disseminate information to motor carriers about using hair testing as a method of detecting the use of controlled substances, under the appropriate circumstances.
H-15-43	Open–Await Response (overall)		To American Bus Association, American Trucking Associations, Commercial Vehicle Safety Alliance, Owner-Operator Independent Drivers Association, United Motorcoach Association: Inform your members about the dangers of driver use of synthetic drugs and encourage them to take steps to prevent drivers from using these substances.
H-15-39	Open–Acceptable Response		To the Federal Motor Carrier Safety Administration: Work with motor carrier industry stakeholders to develop a plan to aid motor carriers in addressing commercial motor vehicle driver use of impairing substances, particularly those not covered under current drug-testing regulations such as by promoting best practices by carriers, expanding impairment detection training and authority, and developing performance-based methods of evaluation.

Number	Classification	Date Closed	Recommendation
H-15-38	Open–Acceptable Alternate Response		To the Federal Motor Carrier Safety Administration: Determine the prevalence of commercial motor vehicle driver use of impairing substances, particularly synthetic cannabinoids, and develop a plan to reduce the use of such substances.
H-13-10	Open–Acceptable Response (overall)		To the 9 States (Kentucky, Montana, Michigan, New Jersey, Pennsylvania, Rhode Island, South Carolina, South Dakota, and Tennessee) that do not have administrative license suspension or revocation laws and the Commonwealth of Puerto Rico: Establish administrative license suspension or revocation laws that require drivers arrested for driving while intoxicated (DWI) to use an alcohol ignition interlock on their vehicle for a period of time before obtaining full license reinstatement.
H-13-9	Open–Unacceptable Response (overall)		To the 41 states that have administrative license suspension or revocation laws and the District of Columbia: Incorporate into your administrative license suspension or revocation laws a requirement that drivers arrested for driving while intoxicated (DWI) use an alcohol ignition interlock on their vehicle for a period of time before obtaining full license reinstatement.
H-13-8	Closed–Acceptable Action (overall)	June 21, 2022	To the 50 states, the Commonwealth of Puerto Rico, and the District of Columbia: Take the following steps to move toward zero deaths from impaired driving: (1) set specific and measurable targets for reducing impaired driving fatalities and injuries, (2) list these targets in your impaired driving prevention plan or highway safety plan, and (3) provide a mechanism for regularly assessing the success of implemented countermeasures and determining whether the targets have been met.

Number	Classification	Date Closed	Recommendation
H-13-7	Open–Acceptable Response (overall)		To the 50 states, the Commonwealth of Puerto Rico, and the District of Columbia: Include in your impaired driving prevention plan or highway safety plan elements to target repeat offenders and reduce driving while intoxicated (DWI) recidivism; such elements should include measures to improve compliance with alcohol ignition interlock requirements; the plan should also provide a mechanism for regularly assessing the success of these efforts. [This recommendation supersedes Safety Recommendation H-00-26.]
H-13-6	Open–Unacceptable Response (overall)		To the 50 states, the Commonwealth of Puerto Rico and the District of Columbia: Include in your impaired driving prevention plan or highway safety plan provisions for conducting high-visibility enforcement of impaired driving laws using passive alcohol-sensing technology during law enforcement contacts, such as routine traffic stops, saturation patrols, sobriety checkpoints, and accident scene responses.
H-13-5	Open–Unacceptable Response (overall)		To the 50 U.S. states and the Commonwealth of Puerto Rico and the District of Columbia: Establish a per se blood alcohol concentration (BAC) limit of 0.05 or lower for all drivers who are not already required to adhere to lower BAC limits.
H-13-4	Closed–Acceptable Alternate Action	November 13, 2017	To the National Highway Traffic Safety Administration: Develop and disseminate to the states best practices for driving while intoxicated (DWI) courts.
H-13-3	Closed–Acceptable Action	July 30, 2014	To the National Highway Traffic Safety Administration: Create incentives for states to adopt the alcohol ignition interlock best practices developed in response to Safety Recommendation H-13-2.
H-13-2	Closed–Exceeds Recommended Action	July 30, 2014	To the National Highway Traffic Safety Administration: Develop and disseminate to the states best practices for increasing alcohol ignition interlock installation and compliance that are based on recent National Highway Traffic Safety Administration research.

Number	Classification	Date Closed	Recommendation
H-13-1	Open–Acceptable Response		To the National Highway Traffic Safety Administration: Seek legislative authority to award incentive grants for states to establish a per se blood alcohol concentration (BAC) limit of 0.05 or lower for all drivers who are not already required to adhere to lower BAC limits.
H-12-48	Closed–Unacceptable Action	September 20, 2022	To the Automotive Coalition For Traffic Safety: Work with the National Highway Traffic Safety Administration to accelerate widespread implementation of Driver Alcohol Detection System for Safety (DADSS) technology by (1) defining usability testing that will guide driver interface design and (2) implementing a communication program that will direct driver education and promote public acceptance.
H-12-45	Open–Unacceptable Response (overall)		To 33 states, the Commonwealth of Puerto Rico, and the District of Columbia: Enact laws to require the use of alcohol ignition interlock devices for all individuals convicted of driving while intoxicated (DWI) offenses.
H-12-43	Closed–Unacceptable Action	September 20, 2022	To the National Highway Traffic Safety Administration: Work with the Automotive Coalition for Traffic Safety, Inc., to accelerate widespread implementation of Driver Alcohol Detection System for Safety (DADSS) technology by (1) defining usability testing that will guide driver interface design and (2) implementing a communication program that will direct driver education and promote public acceptance.
H-12-37	Open–Await Response (overall)		To the International Association of Chiefs of Police and the National Sheriffs' Association: Inform your members of the value of collecting place of last drink (POLD) data as part of any arrest or accident investigation involving an alcohol-impaired driver.
H-12-36	Open–Unacceptable Response (overall)		To the 50 states, the Commonwealth of Puerto Rico, and the District of Columbia: Require law enforcement agencies to collect place of last drink (POLD) data as part of any arrest or accident investigation involving an alcohol-impaired driver.

Number	Classification	Date Closed	Recommendation
H-12-35	Open–Acceptable Response (overall)		To the 45 states, the Commonwealth of Puerto Rico, and the District of Columbia, which have low reporting rates for BAC testing: Once the National Highway Traffic Safety Administration has developed the blood alcohol concentration (BAC) testing and reporting guidelines recommended in Safety Recommendation H-12-32, incorporate the guidelines into a statewide action plan to achieve BAC reporting rates of at least 80 percent of fatally injured drivers and at least 60 percent of drivers who survived fatal crashes.
H-12-34	Open–Acceptable Response (overall)		To the 45 states, the Commonwealth of Puerto Rico, and the District of Columbia, which have low reporting rates for BAC testing: Increase your collection, documentation, and reporting of blood alcohol concentration (BAC) test results by taking the following actions, as needed, to improve testing and reporting rates: (1) enact legislation, (2) issue regulations, and (3) improve procedures used by law enforcement agencies or testing facilities.
H-12-33	Closed in this report		To the National Highway Traffic Safety Administration: Develop and disseminate to appropriate state officials a common standard of practice for drug toxicology testing, including (1) the circumstances under which tests should be conducted, (2) a minimum set of drugs for which to test, and (3) cutoff values for reporting the results. (Superseded by Safety Recommendation H-22-33)
H-12-32	Closed–Acceptable Action	December 13, 2021	To the National Highway Traffic Safety Administration: Develop and disseminate to the 50 states, the Commonwealth of Puerto Rico, and the District of Columbia blood alcohol concentration testing and reporting guidelines based on the 2012 report State Blood Alcohol Concentration Testing and Reporting for Drivers Involved in Fatal Crashes: Current Practices, Results, and Strategies, 1997–2009.

Number	Classification	Date Closed	Recommendation
H-09-18	Closed—Acceptable Action	February 1, 2017	To the Federal Motor Carrier Safety Administration: Establish a regulatory requirement within 49 *Code of Federal Regulations* 382.405 that provides the National Transportation Safety Board, in the exercise of its statutory authority, access to all positive drug and alcohol test results and refusal determinations that are conducted under the U.S. Department of Transportation testing requirements.
H-04-48	Closed—Acceptable Alternate Action	June 22, 2006	To the Federation of State Medical Boards: Work with member organizations to ensure that continuing medical education requirements in all States include a course addressing the driving risks associated with certain medical conditions and medications, as well as the existence and function of State reporting laws and procedures regarding medically impaired drivers.
H-04-47	Closed—Acceptable Alternate Action (overall)	April 2, 2014	To the Association of American Medical Colleges, the American Osteopathic Association, and the Liaison Committee on Medical Education: Require medical schools to teach students about the driving risks associated with certain medical conditions and medications, the existence and function of State reporting laws regarding medically high-risk drivers, and the methods and resources for counseling such drivers.

Number	Classification	Date Closed	Recommendation
H-04-41	Closed—Unacceptable Action	November 13, 2017	To the National Highway Traffic Safety Administration: Once the most effective reporting methods and licensing countermeasures have been determined, develop a model comprehensive medical oversight program for States to use to oversee medically impaired drivers. Such a program should include, as a minimum: a. Methods to provide information to the public on resource availability and on the medical oversight laws and procedures to assist medically high-risk drivers. b. Plans and strategies to simplify and maximize reporting of potential driver medical impairment to medical evaluation units of State driver licensing organizations by law enforcement officers, health care providers, emergency services providers, and the public. c. Methods to capture all cases of motor vehicle incidents or accidents potentially related to driver medical impairment. d. Standardized methods of driver evaluation for potentially medically impaired drivers incorporating medical records review, systematic testing, and on-road appraisals, as needed. e. Methods for timely and appropriate restriction of driving privileges for drivers found to have medical conditions or treatments that impair their ability to safely operate a motor vehicle.

Number	Classification	Date Closed	Recommendation
H-04-16	Closed—Acceptable Alternate Action	December 28, 2021	To the National Association for the Education of Young Children: As part of your accreditation program, establish a transportation safety accreditation that requires applicants to implement the following elements: Use of vehicles built to school bus standards or of multifunction school activity buses; A regular vehicle maintenance and inspection program; A requirement that occupants wear age-appropriate restraints at all times; A requirement that drivers receive a criminal background check and have a medical examination to determine fitness to drive; Preemployment, random, postaccident, and "for cause" drug testing for all child care transportation providers and the prohibition of anyone who tests positive for drugs from transporting children; Review by an oversight agency of periodic driver background checks, medical examinations, and drug test results; and A requirement that child care vehicles be labeled with the child care center's and oversight agency's names and phone numbers.
H-04-13	Closed—Unacceptable Action (overall)	February 3, 2021	To the states and the District of Columbia child care transportation oversight agencies: Implement an oversight program for child care transportation that includes the following elements: Review by an oversight agency of periodic driver background checks, medical examinations, and drug test results.
H-04-12	Closed—Unacceptable Action (overall)	February 3, 2021	To the states and the District of Columbia child care transportation oversight agencies: Implement an oversight program for child care transportation that includes the following elements: Preemployment, random, postaccident, and "for cause" drug testing for all child care transportation providers and the prohibition of anyone who tests positive for drugs from transporting children.

Number	Classification	Date Closed	Recommendation
H-01-27	Closed–Acceptable Action	March 17, 2003	To the National Conference of State Legislatures: Inform State legislatures about this accident and make them aware of the importance of establishing immunity laws for the good-faith reporting of potentially impaired commercial drivers by all individuals and of ensuring that the medical community and the commercial transportation industry are familiar with these laws.
H-01-25	Closed–Acceptable Action	February 1, 2017	To the Federal Motor Carrier Safety Administration: Develop a system that records all positive drug and alcohol test results and refusal determinations that are conducted under the U.S. Department of Transportation testing requirements, require prospective employers to query the system before making a hiring decision, and require certifying authorities to query the system before making a certification decision.
H-00-27	Closed–Acceptable Alternate Action	October 6, 2003	To the United States Department of Transportation: Evaluate modifications to the provisions of the Transportation Equity Act for the 21st Century so that it can be more effective in assisting the states to reduce the hard core drinking driver problem. Recommend changes to Congress as appropriate. Considerations should include (a) a revised definition of "repeat offender" to include administrative actions on DWI offenses; (b) mandatory treatment for hard core offenders; (c) a minimum period of 10 years for records retention and DWI offense enhancement; (d) administratively imposed vehicle sanctions for hard core drinking drivers; (e) elimination of community service as an alternative to incarceration; and (f) inclusion of home detention with electronic monitoring as an alternative to incarceration.

Number	Classification	Date Closed	Recommendation
H-00-26	Closed–Superseded (overall)	June 3, 2013	To the 50 states and the mayor and council of the District of Columbia: Establish a comprehensive program that is designed to reduce the incidence of alcohol-related crashes and fatalities caused by hard core drinking drivers and that includes elements such as those suggested in the National Transportation Safety Board's model program. (Superseded by Safety Recommendation H-13-7, H-00-26 was superseded to all the addressees except: Virginia, California, Nebraska, New Hampshire, Ohio, and Utah)
H-00-15	Closed–Unacceptable Action	May 1, 2012	To the Federal Motor Carrier Safety Administration: Establish, in coordination with the U.S. Department of Transportation, the Federal Railroad Administration, the Federal Transit Administration, and the U.S. Coast Guard, comprehensive toxicological testing requirements for an appropriate sample of fatal highway, railroad, transit, and marine accidents to ensure the identification of the role played by common prescription and over-the-counter medications. Review and analyze the results of such testing at intervals not to exceed every 5 years.
H-00-14	Closed–Unacceptable Action	May 1, 2012	To the Federal Motor Carrier Safety Administration: Establish and implement an educational program targeting highway vehicle operators that, at a minimum, ensures that all operators are aware of the source of information described in Safety Recommendation H-00-13 regarding the hazards of using specific medications when driving.
H-00-13	Closed–Unacceptable Action	May 1, 2012	To the Federal Motor Carrier Safety Administration: Develop, then periodically publish, an easy-to-understand source of information for highway vehicle operators on the hazards of using specific medications when driving.

Number	Classification	Date Closed	Recommendation
H-00-12	Closed–Unacceptable Action	May 1, 2012	To the Federal Motor Carrier Safety Administration: Establish, with assistance from experts on the effects of pharmacological agents on human performance and alertness, procedures or criteria by which highway vehicle operators who medically require substances not on the U.S. Dept. of Transportation's list of approved medications may be allowed, when appropriate, to use those medications when driving.
I-00-5	Closed–Reconsidered	July 13, 2017	To the US Food and Drug Administration: Establish a clear, consistent, easily recognizable warning label for all prescription and over-the-counter medications that may interfere with an individual's ability to operate a vehicle. Require that the label be prominently displayed on all packaging of such medications.
I-00-2	Closed–Unacceptable Action	July 6, 2010	To the US Department of Transportation: Develop, with assistance from experts on the effects of pharmacological agents on human performance and alertness, a list of approved medications and/or classes of medications that may be used safely when operating a vehicle.
H-93-7	Closed–Acceptable Action (overall)	January 21, 1998	To the 50 states, the Commonwealth of Puerto Rico, the territories, and the mayor and city council of the District of Columbia: Enact comprehensive laws that prohibit drivers under the age of 21 from driving with any measurable blood alcohol concentration (any level above 0.00 BAC), to include: public information programs targeted to youth to enhance the effect of the new law.
H-93-6	Closed–Acceptable Action (overall)	January 21, 1998	To the 50 states, the Commonwealth of Puerto Rico, the territories, and the mayor and city council of the District of Columbia: Enact comprehensive laws that prohibit drivers under the age of 21 from driving with any measurable blood alcohol concentration (any level above 0.00 BAC), to include: a period of extended license suspension/revocation (including a period of loss of driving privileges without exemption) for underage offenders in addition to any criminal sanctions that may be specified.

Number	Classification	Date Closed	Recommendation
H-93-5	Closed–Acceptable Action (overall)	January 21, 1998	To the 50 states, the Commonwealth of Puerto Rico, the territories, and the mayor and city council of the District of Columbia: Enact comprehensive laws that prohibit drivers under the age of 21 from driving with any measurable blood alcohol concentration (any level above 0.00 BAC), to include: provisions for administrative license revocation.
H-93-4	Closed–Acceptable Action (overall)	November 4, 2003	To the 50 states, the Commonwealth of Puerto Rico, the territories, and the mayor and city council of the District of Columbia: Vigorously enforce the minimum drinking age laws by taking driver license action against underage purchasers and vendor license action against those who sell to person under the minimum purchase age.
H-93-3	Closed–Acceptable Action (overall)	November 4, 2003	To the 50 states, the Commonwealth of Puerto Rico, the territories, and the mayor and city council of the District of Columbia: Vigorously enforce youth drinking and driving laws to increases the percentage of alcohol-impaired drivers who are arrested.
H-93-2	Closed–Acceptable Action (overall)	November 4, 2003	To the 50 states, the Commonwealth of Puerto Rico, the territories, and the mayor and city council of the District of Columbia: Vigorously enforce the minimum drinking age laws to achieve a significant reduction in the rate of alcohol purchase by underage persons.
H-93-1	Closed–Acceptable Action (overall)	September 20, 2005	To the 50 states, the Commonwealth of Puerto Rico, the territories, and the mayor and city council of the District of Columbia: Review your drinking age (age 21) laws to determine if they prohibit persons under the age of 21 from attempting to purchase, purchasing, publicly possessing, or consuming alcoholic beverages and prohibits the sale of alcoholic beverages to persons under the age of 21. Enact laws to include these provision and to eliminate deficiencies that may exist.

Number	Classification	Date Closed	Recommendation
H-92-41	Closed–Acceptable Action	June 2, 2004	To the Federal Highway Administration: Conduct research to identify design changes in work zones that will aid drivers with degraded sensory perceptions resulting from aging, inattentiveness, or impairment. Use the results of this research to design better and more meaningful work zone traffic advisories and safety features. (Supersedes Safety Recommendations H-91-27, H-91-29, and H-91-30)
H-91-37	Closed–Acceptable Action (overall)	November 21, 2003	To the states, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, the U.S. territories: Require postaccident toxicological testing for alcohol and drug impairment of commercial vehicle operators involved with the intrastate transportation of hazardous materials in bulk.
H-91-32	Closed–Acceptable Action	August 3, 1994	To the Federal Highway Administration: Require postaccident toxicological testing for alcohol and drug impairment of commercial vehicle operators involved with the intrastate transportation of hazardous materials in bulk.
H-91-29	Closed–Acceptable Action/ Superseded	August 31, 1992	To the Federal Highway Administration: Encourage the use of the "design driver" concept, which assumes that some drivers are impaired or inattentive, in designing work zone safety features and signing. (Superseded by H-92-41)
H-90-55	Closed–Reconsidered (overall)	December 13, 2004	To the National Association of Trade and Technical Schools, National Home Study Council, and the Professional Truck Driver Institute of America: Encourage your membership to disseminate information to the commercial trucking industry and commercial vehicle operators regarding: The effects of fatigue, alcohol and other drug use; The interaction of alcohol, drugs and fatigue; The differences between truck driver perception of fatigue and actual onset of fatigue; Methods of minimizing conditions which lead to commercial vehicle operators driving while fatigued.

Number	Classification	Date Closed	Recommendation
H-90-54	Closed–Acceptable Action (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Enact legislation to establish 0.01 percent (the practical scientific level which allows for instrument sensitivity and individual differences) as the per se offense blood alcohol concentration for operators of commercial vehicles in your state.
H-90-53	Closed–Acceptable Action (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Enact legislation or adopt regulations, as appropriate, to define the alcohol concentration level that constitutes driving a commercial motor vehicle "under the influence" at the lowest possible level consistent with the capability of testing equipment to measure any ingested alcohol.
H-90-51	Closed–No Longer Applicable (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Develop a coordinated statewide program to conduct selective alcohol and other drug enforcement operations at times and locations of high levels of truck accidents- specifically at times of high incidence of commercial truck accidents involving alcohol and/or other drugs.
H-90-50	Closed–No Longer Applicable (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Provide drug recognition expert training to personnel in state and local police agencies and in other public safety/ law enforcement agencies who have commercial truck and truck driver enforcement and oversight responsibilities.
H-90-49	Closed–No Longer Applicable (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Disseminate safety information to commercial truck drivers in your state regarding the effects of fatigue, alcohol and other drug use, and the interaction of drugs and fatigue.

Number	Classification	Date Closed	Recommendation
H-90-47	Closed–No Longer Applicable (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Require intrastate motor carriers in your state to: require close supervision, including frequent unannounced drug testing, for an appropriate period, of commercial truck drivers with an identified alcohol or other drug abuse problem. Such testing should be sufficiently frequent to create the likelihood of detection if the person uses drugs of abuse.
H-90-46	Closed–No Longer Applicable (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Require intrastate motor carriers in your state to: obtain proof that applicants seeking work as commercial truck drivers, who have had a history of alcohol/drug abuse, have successfully completed a certified treatment program and obtained a physician's evaluation of substance abuse and dependency.
H-90-45	Closed–No Longer Applicable (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Require intrastate motor carriers in your state to: review the alcohol/drug abuse treatment history of all applicants seeking work as commercial truck drivers.
H-90-44	Closed–No Longer Applicable (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Require intrastate motor carriers in your state to: perform pre-employment alcohol and other drug tests for all applicants seeking to work as drivers of commercial trucks weighing over 10,000 pounds GVWR.
H-90-43	Closed–Unacceptable Action/No Response Received (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Report alcohol and other drug toxicological tests requested and results obtained in fatal accidents to the fatal accident reporting system operated by the National Highway Traffic Safety Administration.
H-90-42	Closed–Unacceptable Action (overall)	April 9, 2001	To the states, the Commonwealth of Puerto Rico, the Virgin Islands, and the territories: Enact legislation or issue regulations to require the collection of blood samples for alcohol and other drug toxicological testing from all vehicle operators involved in fatal commercial truck accidents.

Number	Classification	Date Closed	Recommendation
H-90-41	Closed–Unacceptable Action/No Response Received	March 6, 1995	To the National Governors' Association: Develop a program for the reporting of all accident toxicological results to the National Commercial Truck Database System.
H-90-40	Closed–Unacceptable Action/No Response Received (overall)	March 6, 1995	To the National Governors' Association: Coordinate development of national programs for state implementation of standardized testing for alcohol and other drugs.
H-90-39	Closed–Acceptable Action (overall)	March 18, 2004	To the International Association of Chiefs of Police, International Association of Directors of Law Enforcement Standards and Training, and the Commercial Vehicle Safety Alliance: Encourage your members to provide training in drug recognition for those personnel with commercial truck and truck driver enforcement and oversight responsibilities.
H-90-38	Closed–Acceptable Action (overall)	March 18, 2004	To the International Association of Chiefs of Police, International Association of Directors of Law Enforcement Standards and Training, and the Commercial Vehicle Safety Alliance: Disseminate to your members information regarding the prevalence of alcohol and other drug use/abuse and fatigue among professional commercial truck drivers.
H-90-37	Closed–No Longer Applicable (overall)	March 18, 2004	To the various trucking industry associations, drivers associations, the Teamsters Union, and the Commercial Vehicle Safety Alliance: Encourage your membership to participate in education and public information programs regarding: scheduling and its impact on driver fatigue; and the effects of alcohol and other drug use; and, the interaction of drugs and fatigue.
H-90-36	Closed–No Longer Applicable (overall)	March 18, 2004	To the various trucking industry associations, drivers associations, the Teamsters Union, and the Commercial Vehicle Safety Alliance: Encourage your membership to participate in alcohol and other drug education and information programs aimed at commercial drivers.
H-90-35	Closed–No Longer Applicable (overall)	March 18, 2004	To the various trucking industry associations, drivers associations, the Teamsters Union, and the Commercial Vehicle Safety Alliance: Actively promote and encourage your members to use or support: pre-employment tests for alcohol and other drugs; driver violation history checks; and alcohol or other drug abuse treatment history checks.

Number	Classification	Date Closed	Recommendation
H-90-34	Closed—No Longer Applicable	July 23, 2007	To the U.S. Department of Health and Human Services: Establish, with the Department of Transportation and other organizations as appropriate, a post accident alcohol and other drug analytic test plan for tests to be conducted on a wide range of impairing drugs with results reported at state-of-the-art sensitivity levels.
H-90-33	Closed—Acceptable Action	July 20, 2007	To the U.S. Department of Health and Human Services: Assist the Department of Transportation, the states, the American Academy of Forensic Sciences, the National Safety Council Committee on Alcohol and Drugs, and other organizations as appropriate, in standardizing procedures for postaccident toxicological specimen collection, chain of custody, testing, and reporting among the states for accidents involving medium and heavy trucks.
H-90-31	Closed—Unacceptable Action	August 3, 1994	To the Federal Highway Administration: Revise 49 *CFR* parts 391 and 392 to establish violation of the commercial vehicle operation alcohol offense (49 *CFR* 392.4, 392.5) as a reasonable cause requiring a drug test of the driver. Amend the regulations and provide notice to drivers of these revised regulations.
H-90-30	Closed—Unacceptable Action	August 3, 1994	To the Federal Highway Administration: Revise 49 *CFR* parts 391 and 395 to establish driver hours of service violations, logbook irregularities, or the presence of multiple logbooks as a reasonable cause requiring a drug test of the driver. Amend the regulations and provide notice to drivers of these revised regulations.
H-90-29	Closed—Unacceptable Action	July 7, 1998	To the Federal Highway Administration: As part of the FHWA on-going study of fatigue and loss of alertness among commercial vehicle operators, investigate the interactions of fatigue and drug usage.
H-90-23	Closed—Acceptable Alternate Action	April 29, 1996	To the Federal Highway Administration: Establish and fund a program to train instructors to provide drug recognition expert training to federal agency inspectors/investigators, police, and other public service personnel with commercial truck and truck driver oversight responsibilities.

Number	Classification	Date Closed	Recommendation
H-90-22	Closed–Acceptable Action	April 21, 1994	To the Federal Highway Administration: Establish a demonstration project(s) to deter the use of alcohol and other drugs by drivers of medium and heavy trucks that includes alcohol and other drug testing at special roadside sobriety checkpoints, truck inspection lanes, and truck weigh stations.
H-90-21	Closed–Acceptable Action	July 7, 1998	To the Federal Highway Administration: Disseminate safety information to national, state, and local police agencies, public service and safety agencies, professional truck driver groups and individual truck drivers, regarding: the effects of fatigue, alcohol and other drug use; the interaction of alcohol, drugs and fatigue; the prevalence of drug and alcohol abuse among professional commercial vehicle operators; and, methods of minimizing conditions which lead to commercial vehicle operators driving while fatigued.
H-90-20	Closed–Acceptable Action	August 3, 1994	To the Federal Highway Administration: Require close supervision, including frequent, unannounced drug testing, for an appropriate period, of commercial truck drivers with an identified alcohol or other drug abuse problem. Such testing should be sufficiently frequent to create the likelihood of detection if the person uses drugs of abuse.
H-90-19	Closed–Acceptable Alternate Action	August 3, 1994	To the Federal Highway Administration: Require commercial truck driver applicants with a prior history of drug and/or alcohol abuse to complete a certified treatment program and obtain a physician's evaluation of substance abuse and dependency.
H-90-18	Closed–Acceptable Action	August 3, 1994	To the Federal Highway Administration: Amend 49 CFR 391.21 "application for employment" and 391.23 investigations and inquiries to include a complete review of alcohol and other drug abuse treatment history prior to employment as a commercial truck driver.
H-90-17	Closed–Acceptable Alternate Action	August 2, 1994	To the Federal Highway Administration: Require pre-employment alcohol and other drug tests on all drivers of commercial trucks with a gross vehicle weight rating of 10,000 pounds and above as a condition of employment.

Number	Classification	Date Closed	Recommendation
H-90-16	Closed–Acceptable Action	November 24, 1998	To the National Highway Traffic Safety Administration: Revise the fatal accident reporting system to include standardized drug toxicological tests requested in each fatal accident and results, both single and multiple drug, which would include an estimating system similar to that now used to estimate national alcohol involvement in fatal accidents.
H-90-15	Closed–Unacceptable Action	April 1, 2005	To the United States Department of Transportation: Provide funding incentives, guidance and assistance to the states to obtain complete toxicological tests and report results (including drug tests requested) to DOT on all vehicle operators involved in fatal commercial vehicle accidents.
H-90-14	Closed–Unacceptable Action	April 1, 2005	To the United States Department of Transportation: Establish, with the Department of Health and Human Services and other organizations as appropriate, a postaccident alcohol and other drug analytic test plan for tests to be conducted on a wide range of impairing drugs with results reported at state-of-the-art sensitivity levels.
H-90-13	Closed–Acceptable Action	April 1, 2005	To the United States Department of Transportation: With the assistance of the Department of Health and Human Services, the states, the American Academy of Forensic Sciences, the National Safety Council Committee on Alcohol and Other Drugs, and other organizations as appropriate, standardize procedures for postaccident toxicological specimen collection, chain of custody, testing, and reporting among the states for accidents involving medium and heavy trucks.
H-90-12	Closed–Acceptable Action	April 1, 2005	To the United States Department of Transportation: Develop a program to merge elements concerning commercial vehicle operations of the separate DOT operated and supported highway accident databases. These elements should include, but not be limited to, driver history, carrier, vehicle and roadway characteristics, hazardous materials transportation, and alcohol and other drug involvement.

Number	Classification	Date Closed	Recommendation
H-90-11	Closed–Unacceptable Action	April 1, 2005	To the United States Department of Transportation: Assess and revise, as appropriate, the reporting and accuracy of existing database elements regarding toxicological tests for DOT operated and supported highway accident databases and trucking operations databases to provide complete and accurate reporting of toxicological tests requested and results obtained.
H-90-10	Closed–Acceptable Alternate Action	April 1, 2005	To the United States Department of Transportation: With the assistance of the Department of Labor, Occupational Safety and Health Administration and the Interstate Commerce Commission, conduct a detailed review of, and report on, trucking industry structure, operations, and conditions, especially shipping, dispatching, and receiving requirements, shipment broker operations, just-in-time shipments, and truckload/less-than-truckload operations which may create incentives for drivers to violate hours of service regulations and to use drugs of abuse.
H-89-14	Closed–Acceptable Action	August 20, 1990	To the Commonwealth of Kentucky: Expand efforts to make the public aware of increased emphasis on deterring impaired driving.
H-89-13	Closed–Acceptable Action	August 20, 1990	To the Commonwealth of Kentucky: Renew state efforts to publicize and encourage citizens to participate in the "Report a Problem Intoxicated Driver" program.
H-89-12	Closed–Acceptable Action	March 18, 2004	To the Commonwealth of Kentucky: Expand the use of sobriety checkpoints by the Kentucky State Police, and encourage and assist local law enforcement agencies to do the same.
H-89-11	Closed–Acceptable Action	August 20, 1990	To the Commonwealth of Kentucky: Expand the use by the Kentucky State Police of preliminary breath test devices and the three-part field sobriety test recommended by the National Highway Traffic Safety Administration, including the horizontal gaze nystagmus test, and urge and assist all other traffic law enforcement agencies in Kentucky to do the same.

Number	Classification	Date Closed	Recommendation
H-89-10	Closed–Acceptable Action	March 18, 2004	To the Commonwealth of Kentucky: Review all aspects of the plea bargaining prohibitions of the 1984 driving-under-the-influence law to determine if persons charged with alcohol-related offenses are being allowed to plea bargain the charge to a non-alcohol-related offense, and if so, take administrative or legislative action to correct the situation.
H-89-9	Closed–Acceptable Action	March 18, 2004	To the Commonwealth of Kentucky: Amend the current driving-under-the-influence laws to prohibit the reduction or elimination of a licensing penalty if a convicted offender enrolls in an education or treatment program. Participation in these programs should be required in addition to appropriate licensing or other penalties.
H-89-8	Closed–Acceptable Action	March 18, 2004	To the Commonwealth of Kentucky: Enact the recommendations made by the driving-under-the-influence (DUI) committee formed by the governor to assess the current DUI laws. These recommendations cover administrative license revocation, illegal per se, implied consent and testing, chemical analysis, suspended licenses, and alcohol driver education.
H-89-2	Closed–Acceptable Action (overall)	March 18, 2004	To all the states except Kentucky and the District of Columbia: Convene or reconvene a committee or task force to review your state's driving-under-the influence (DUI) legislation and its implementation, in light of the problems discussed in the accident report on the pickup truck/church activity bus head-on collision and fire near Carrollton, Kentucky, on May 14, 1988. Particular attention should be paid to implementation of administrative license revocation programs, improved evaluations of convicted DUI offenders, and enhanced public awareness and enforcement programs. Based on this review, take appropriate action to improve your state's DUI prevention program.

Number	Classification	Date Closed	Recommendation
H-85-50	Closed–Acceptable Action (overall)	February 14, 1994	To the governors and legislative leaders of the 50 states and Puerto Rico and the mayor and council chairman of the District of Columbia: Establish formal procedures to ensure that quantitative tests of the blood alcohol concentration of all drivers involved in fatal highway crashes are performed and reported to the state agency responsible for maintaining such records.
H-85-49	Closed–Acceptable Action (overall)	February 14, 1994	To the governors and legislative leaders of the 50 states and Puerto Rico and the mayor and council chairman of the District of Columbia: Initiate legislation or take the necessary administrative action to require alcohol testing of all drivers involved in fatal highway crashes.
H-85-48	Closed–Acceptable Action	June 7, 1993	To the National Highway Traffic Safety Administration: Urge states with deficient programs to increase the allocation of highway safety grant program funds and state matching funds to improve the measurement and reporting of alcohol involvement in fatal highway crashes.
H-85-47	Closed–Acceptable Action	June 7, 1993	To the National Highway Traffic Safety Administration: Undertake a more extensive and aggressive program to provide direct technical support to states to improve alcohol testing and reporting of all drivers involved in fatal highway crashes.
H-84-94	Closed–Acceptable Action (overall)	June 27, 2003	To the Arkansas State Police and the Arkansas State Crime Laboratory: Instruct state police officers to request that two separate vials of blood containing 5 ml each be collected for alcohol and drug analysis in serious and fatal accident investigations and that the samples be refrigerated until they can be transported to a laboratory for analysis and not be held in an officer's possession except for direct transportation to the laboratory.
H-84-92	Closed–Reconsidered	December 4, 2002	To the International Association of Chiefs of Police, Inc.: Develop a recommended policy to the states which will prompt law enforcement personnel to request medical testing for the presence of alcohol in the blood of all truck drivers involved in serious accidents.

Number	Classification	Date Closed	Recommendation
H-84-90	Closed–Acceptable Action (overall)	May 31, 1985	To the American Bar Association, the National Association of Judicial Educators, and the National Judicial State College: Work with state governments, state judicial organizations, and the National Highway Traffic Safety Administration to vigorously promote initial and recurrent training for judges in alcohol issues and DWI case adjudication and to develop more sources of funds for financing this training.
H-84-89	Closed–Unacceptable Action	November 19, 1985	To the Veterans Administration: Develop and implement a national policy making VA hospital alcohol dependence treatment programs more consistently available to local traffic court rehabilitation programs for convicted DWI defendants who are veterans.
H-84-88	Closed–Acceptable Alternate Action	September 23, 1993	To the National Highway Traffic Safety Administration: Incorporate the salient features of such court records systems as the court reporting network in Pennsylvania and the PROMIS System in Colorado in the Model Case Management Information System; ensure that the model system incorporates motor vehicle licensing records and court records of drunk driving-related violations and convictions.
H-84-87	Closed–Acceptable Action	September 23, 1993	To the National Highway Traffic Safety Administration: Evaluate the effectiveness of license actions against juveniles who violate alcohol laws, such as the laws recently enacted in Oregon, Washington, North Carolina, Maryland, and Maine.
H-84-86	Closed–Acceptable Action (overall)	March 18, 2004	To the governors of the 50 states and the mayor of the District of Columbia: Take action to increase the availability and quality of alcohol treatment services designed specifically for juvenile alcohol abusers, especially to provide services at low cost to the user.
H-84-85	Closed–Acceptable Action (overall)	March 18, 2004	To the governors of the 50 states and the mayor of the District of Columbia: Take steps to ensure that no diversion or supervision program in your state is used in place of license revocation/suspension and that court and DMV records reflect participation in diversion/ supervision programs.

Number	Classification	Date Closed	Recommendation
H-84-84	Closed–No Longer Applicable (overall)	November 2, 1995	To the governors of the 50 states and the mayor of the District of Columbia: Require that appropriate alcohol problem evaluations of persons charged with alcohol-related traffic offenses be conducted and made available to judges hearing these cases.
H-84-83	Closed–Acceptable Action (overall)	March 18, 2004	To the governors of the 50 states and the mayor of the District of Columbia: Take steps to require that law enforcement and judicial records systems in your state include complete records of DWI defendants' previous alcohol-related traffic offenses, including those committed as a juvenile, and that they are available to judges prior to sentencing.
H-84-82	Closed–Acceptable Action (overall)	March 18, 2004	To the governors of the 50 states and the mayor of the District of Columbia: Take steps to develop a records system that preserves records of alcohol related traffic offenses committed by a juvenile after the offender reaches adulthood.
H-84-81	Closed–Acceptable Action (overall)	March 18, 2004	To the governors of the 50 states and the mayor of the District of Columbia: Encourage and support initial and recurrent training on alcohol, problem drinking, and drunk driving case adjudication for all judges hearing DWI cases.
H-84-80	Closed–Unacceptable Action (overall)	March 18, 2004	To the 50 states and the mayor of the District of Columbia: Take steps to preclude reduction of an alcohol-related charge to a non-alcohol-related charge and to require in all cases that the defendant's driving record reflect the original charge.
H-84-79	Closed–Unacceptable Action (overall)	March 18, 2004	To the governors of the 50 states and the mayor of the District of Columbia: Encourage detention agencies in your state to adopt DWI holding and release policies that do not permit the release of alcohol offenders until after their blood alcohol concentration has dropped below the lowest level specified in state law as indicating alcohol impairment.
H-84-78	Closed–Acceptable Action (overall)	November 8, 1993	To the governors of the 50 states and the mayor of the District of Columbia: Propose legislation, if necessary, and/or take other appropriate action to facilitate the collection of DWI evidence based on the drawing of blood for BAC test purposes.

Number	Classification	Date Closed	Recommendation
H-84-77	Closed–Acceptable Action (overall)	December 10, 1993	To the governors of the 50 states and the mayor of the District of Columbia: Encourage the use, by all traffic law enforcement agencies in your state, of preliminary breath test devices and the NHTSA-recommended three-part field sobriety test, including the horizontal gaze nystagmus test.
H-84-27	Closed–Acceptable Alternate Action	October 26, 1987	To the mayor of the District of Columbia: Evaluate the effectiveness of sobriety check points and administrative license revocation procedures implemented.
H-84-26	Closed–Acceptable Action	October 26, 1987	To the mayor of the District of Columbia: Continue and expand the use of sobriety check points on a periodic and continuing basis by the appropriate enforcement agencies under your jurisdiction as part of a comprehensive driving while intoxicated enforcement program. These checkpoints should be conducted according to accepted procedures and constitutional safeguards.
H-84-25	Closed–Acceptable Alternate Action	November 21, 1990	To the National Highway Traffic Safety Administration: Evaluate the effectiveness of sobriety checkpoints and administrative revocation procedures.
H-84-24	Closed–Acceptable Alternate Action (overall)	August 24, 1993	To the governors of Alaska, Indiana, Iowa, Louisiana, Maine, Minnesota, Mississippi, Nevada, North Carolina, North Dakota, Ohio, Oklahoma, and West Virginia: Evaluate the effectiveness of sobriety check points and administrative license revocation procedures implemented.
H-84-23	Closed–Acceptable Action (overall)	December 10, 1993	To the governors of Alaska, Indiana, Iowa, Louisiana, Maine, Minnesota, Mississippi, Nevada, North Carolina, North Dakota, Ohio, Oklahoma, and West Virginia: Encourage local law enforcement agencies within your state to institute sobriety checkpoints on a similar basis.
H-84-22	Closed–Acceptable Action (overall)	December 10, 1993	To the governors of Alaska, Indiana, Iowa, Louisiana, Maine, Minnesota, Mississippi, Nevada, North Carolina, North Dakota, Ohio, Oklahoma, and West Virginia: Institute the use of sobriety checkpoints on a periodic and continuing basis by the appropriate enforcement agencies under your jurisdiction as part of a comprehensive driving while intoxicated enforcement program. These checkpoints should be conducted according to accepted procedures and constitutional safeguards.

Number	Classification	Date Closed	Recommendation
H-84-21	Closed–Acceptable Alternate Action (overall)	August 24, 1993	To the governors of Colorado, Delaware, Missouri, New Mexico, Oregon, Utah, and Washington: Evaluate the effectiveness of sobriety checkpoints and administrative license revocation procedures implemented.
H-84-20	Closed–Acceptable Action (overall)	December 10, 1993	To the governors of Colorado, Delaware, Missouri, New Mexico, Oregon, Utah, and Washington: Encourage local law enforcement agencies within your state to institute sobriety checkpoints on a similar basis.
H-84-19	Closed–Acceptable Action (overall)	December 10, 1993	To the governors of Colorado, Delaware, Missouri, New Mexico, Oregon, Utah, and Washington: Continue and expand the use of sobriety checkpoints on a periodic and continuing basis by the appropriate enforcement agencies under your jurisdiction as part of a comprehensive driving while intoxicated enforcement program. These checkpoints should be conducted according to accepted procedures and constitutional safeguards.
H-84-18	Closed–Acceptable Alternate Action (overall)	August 24, 1993	To the governors of Arizona, Arkansas, Florida, Georgia, Idaho, Maryland, Massachusetts, Nebraska, New Jersey, New York, South Dakota, Vermont, and Virginia: Evaluate the effectiveness of sobriety checkpoints and administrative license revocation procedures implemented.
H-84-17	Closed–Acceptable Action (overall)	October 13, 1993	To the governors of Arizona, Arkansas, Florida, Georgia, Idaho, Maryland, Massachusetts, Nebraska, New Jersey, New York, South Dakota, Vermont, and Virginia: Enact legislation or utilize existing authority to provide for administrative revocation of the licenses of drivers who refuse a chemical test for alcohol or who provide a result at or above the state presumptive limit.
H-84-16	Closed–Acceptable Action (overall)	December 10, 1993	To the governors of Arizona, Arkansas, Florida, Georgia, Idaho, Maryland, Massachusetts, Nebraska, New Jersey, New York, South Dakota, Vermont, and Virginia: Encourage local law enforcement agencies within your state to institute sobriety checkpoints on a similar basis.

Number	Classification	Date Closed	Recommendation
H-84-15	Closed–Acceptable Action (overall)	December 10, 1993	To the governors of Arizona, Arkansas, Florida, Georgia, Idaho, Maryland, Massachusetts, Nebraska, New Jersey, New York, South Dakota, Vermont, and Virginia: Continue and expand the use of sobriety checkpoints on a periodic and continuing basis by the appropriate enforcement agencies under your jurisdiction as part of a comprehensive driving while intoxicated enforcement program. These checkpoints should be conducted according to accepted procedures and constitutional safeguards.
H-84-14	Closed–Acceptable Alternate Action (overall)	August 24, 1993	To the governors of Alabama, California, Connecticut, Hawaii, Guam, Illinois, Kansas, Kentucky, Michigan, Montana, New Hampshire, Pennsylvania, Puerto Rico, Rhode Island, South Carolina, Tennessee, Texas, Virgin Islands, Wisconsin, and Wyoming: Evaluate the effectiveness of sobriety checkpoints and administrative license revocation procedures implemented.
H-84-13	Closed–Acceptable Action (overall)	October 13, 1993	To the governors of Alabama, California, Connecticut, Hawaii, Guam, Illinois, Kansas, Kentucky, Michigan, Montana, New Hampshire, Pennsylvania, Puerto Rico, Rhode Island, South Carolina, Tennessee, Texas, Virgin Islands, Wisconsin, and Wyoming: Enact legislation or utilize existing authority to provide for administrative revocation of the licenses of drivers who refuse a chemical test for alcohol or who provide a result at or above the state presumptive limit.
H-84-12	Closed–Acceptable Action (overall)	December 10, 1993	To the governors of Alabama, California, Connecticut, Hawaii, Guam, Illinois, Kansas, Kentucky, Michigan, Montana, New Hampshire, Pennsylvania, Puerto Rico, Rhode Island, South Carolina, Tennessee, Texas, Virgin Islands, Wisconsin, and Wyoming: Encourage local law enforcement agencies within your state to institute sobriety checkpoints on a similar basis.

Number	Classification	Date Closed	Recommendation
H-84-11	Closed–Acceptable Action (overall)	December 10, 1993	To the governors of Alabama, California, Connecticut, Hawaii, Guam, Illinois, Kansas, Kentucky, Michigan, Montana, New Hampshire, Pennsylvania, Puerto Rico, Rhode Island, South Carolina, Tennessee, Texas, Virgin Islands, Wisconsin, and Wyoming: Institute the use of sobriety checkpoints on a periodic and continuing basis by the appropriate enforcement agencies under your jurisdiction as part of a comprehensive driving while intoxicated enforcement program. These checkpoints should be conducted according to accepted procedures and constitutional safeguards.
H-82-36	Closed–Acceptable Action (overall)	April 17, 1983	To the International Association of Chiefs of Police and the National Safety Council: Collaborate and act as focal points for gathering information on reddi-type programs and provide information and assistance to the interested states and local communities.
H-82-35	Closed–Acceptable Action (overall)	July 25, 2002	To the mayor of District of Columbia and the governors of the states listed (50 states, excluding Colorado, Maryland, Nebraska, Utah, and Washington): Implement a citizen awareness and citizen drunk driver reporting program such as the reddi-type programs now used by Colorado, Maryland, Nebraska, Utah, and Washington.
H-82-18	Closed–Acceptable Action (overall)	August 9, 1993	To the states of Alabama, Alaska, Arizona, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Iowa, Kansas, Louisiana, Maine, Massachusetts, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming and the District of Columbia: Raise the minimum legal age for drinking or purchasing all alcoholic beverages to 21 years of age.
H-80-49	Closed–Acceptable Alternate Action	August 8, 1988	To the Oklahoma Department of Transportation: Seek the funds necessary to enable a renewed emphasis on alcohol safety especially in the rural areas and the less populated communities of the state.

Number	Classification	Date Closed	Recommendation
H-80-47	Closed–Acceptable Action	August 21, 1986	To the National Highway Traffic Safety Administration: Evaluate the effectiveness of current dram shop type laws in reducing the number of highway accidents involving drivers under the influence of alcohol in states having such laws. If the above evaluations prove to be positive, then incorporate the concepts of these laws into the existing Highway Safety Program Standard No. 8, alcohol in relation to highway safety.
H-80-27	Closed–Acceptable Alternate Action	August 5, 1980	To the Commonwealth of Pennsylvania: Provide increased emphasis on your statewide enforcement program directed toward reducing the number of persons driving on public roads while under the influence of alcohol. (Urgent)
H-80-1	Closed–Unacceptable Action	April 30, 1984	To the state of Maryland: Refer the following recommendation to the appropriate legislative committees: enact legislation that will redefine the terms "intoxicated" and "impaired by alcohol" to fit current nationally accepted standard definitions.
H-78-76	Closed–Acceptable Action	July 15, 1987	To the National Highway Traffic Safety Administration: Evaluate and report to the Safety Board those alcohol countermeasures that the NHTSA found to be practical and effective for the reduction in the number of alcohol-involved drivers.
H-78-75	Closed–Acceptable Alternate Action	June 13, 1983	To the city of Plant City, Florida: As part of its Operation Lifesaver program, emphasize in its selective traffic law enforcement program grade crossing warning signal violators and those who drive while under the influence of alcohol or drugs. (Urgent)
H-76-3	Closed–Acceptable Action	October 20, 1977	To the National Highway Traffic Safety Administration: Develop and report more effective systems and standards for conveying traffic information to impaired drivers at temporary traffic control sites (e.g., railroad crossings, construction sites, etc.) and protecting those persons controlling traffic.
H-76-2	Closed–Acceptable Action	October 20, 1977	To the National Highway Traffic Safety Administration: Determine and report the effectiveness of traffic information control systems currently in use at railroad crossings, considering in particular their ability to warn and achieve an appropriate reaction from impaired drivers.

Number	Classification	Date Closed	Recommendation
H-71-58	Closed–Acceptable Action	January 1, 1980	To the National Highway Traffic Safety Administration: Develop new and/or supplemental efforts in their alcohol safety action programs specifically designed for the young drinking driver, beyond those now contemplated or in use.
H-71-57	Closed–Acceptable Action	January 1, 1980	To the National Highway Traffic Safety Administration: Re-examine its highway safety program efforts with a view to focusing certain programs more sharply on the 15 to 24 year-old group of drivers as a means of reducing excess losses in this group. This would pertain especially to driver licensing, driver education, driver improvement, alcohol safety action programs, and vehicle inspection. A much more thorough set of examinations for initial licensing of young drivers appears highly desirable. A diagnostic approach to driver preparation, driver licensing, and driver improvement programs designed primarily for the new young driver appears highly justified by the disproportionate involvement and fatality rate of this age group.
H-69-5	Closed–Acceptable Action	June 27, 1975	To the United States Department of Transportation: The Board feels that alcohol problems in the different modes of transportation should be coordinated by the Department of Transportation. The role of such coordination would be (a) to give increased emphasis to study and program action with respect to the role of alcohol, extending coverage of the problem to all transportation modes, (b) to coordinate the DOT efforts with those of the health-oriented agencies and organizations, the various state and local transportation authorities, and the other federal efforts at public education and program action regarding alcohol problems, and (c) to provide a national focal point for information on alcohol in transportation safety. This coordination should be especially responsive to the large number of alcohol fatalities in highway transportation, the research capability in the Federal Highway Administration, and the need for transfer of techniques between the highway field, general aviation, and other modes. The vigorous educational effort with general aviation is worthy of careful study.

Number	Classification	Date Closed	Recommendation
H-68-27	Closed—Acceptable Action	June 27, 1975	To the Federal Highway Administration: Develop a program designed to produce a sense of individual responsibility in the general public to protect the nation's highways from drinking drivers, enlisting in such a program the aid of the news media, the producers of alcoholic beverages, private and public agencies concerned with highway safety, as well as religious, educational, and civic groups to (a) support law enforcement efforts against and the prosecution of drinking drivers; (b) impress upon the public individually, each person's serious social duty not to drive while under the influence of alcohol; and (c) individually to accept the responsibility of preventing other persons from driving while under the influence of alcohol.

Appendix B: Impairment-Related NTSB Investigations Since 2012

The NTSB has documented drug impairment from alcohol, other drugs, or a combination of drugs as a cause or contributing factor of several highway crash investigations over the past decade. Table B-1 provides links to the NTSB investigation reports, a list of drugs found in those investigations, and the probable cause of each crash.

Table B-1. NTSB-investigated highway crashes in which alcohol-, other drug-, or multiple-drug impairment was a cause or contributing factor since 2012.

Investigation Report	Drug(s) Found	Probable Cause
Box Truck Collision with Group of Bicyclists, Near Searchlight, Nevada, December 10, 2020. **HIR-22-07.**	Box truck driver: methamphetamine and amphetamine	The National Transportation Safety Board determines that the probable cause of the Searchlight, Nevada, crash was the box truck driver's impairment and fatigue stemming from his use of methamphetamine. Contributing to the crash was the decision made by the bicyclists to ride in the right travel lane of a 75-mph roadway.
Sport Utility Vehicle Centerline Crossover Collision With Pickup Truck on State Route 33, Avenal, California, January 1, 2021. **HIR-22/05.**	Sport utility vehicle driver: alcohol, cannabis Pickup truck driver: cannabis	The NTSB determines that the probable cause of the Avenal, California, crash was the failure of the sport utility vehicle (SUV) driver to control his vehicle due to a high level of alcohol impairment. Contributing to the severity of the crash was the SUV driver's excessive speed.
Collision Between Pickup Truck with Trailer and Group of Motorcycles, Randolph, New Hampshire, June 21, 2019. **HAR-20/04.**	Truck driver: benzoylecgonine, fentanyl, acetyl fentanyl, norfentanyl, morphine, 6-MAM	The NTSB determines that the probable cause of the Randolph, New Hampshire, crash was the pickup truck driver's crossing the centerline and encroaching into the oncoming lane of travel, which occurred because of his impairment from use of multiple drugs. Contributing to the crash was Westfield Transport's substantial disregard for and egregious noncompliance with safety regulations. Also contributing was the failure of the Massachusetts Registry of Motor Vehicles to revoke the pickup truck driver's Massachusetts driver's license when notified of his loss of driving privileges in another state.
Collision Between Passenger Train and Refuse Truck at Active Grade Crossing, Crozet, Virginia, January 31, 2018. **HAB-19/03.**	Truck driver: THC (6.6 ng/mL), THC carboxylic acid (59 ng/mL, gabapentin (2.2 mg/L)	The NTSB determines that the probable cause of the crash in Crozet, Virginia, was the truck driver's decision to enter an active grade crossing and his inaction when he encountered obstacles while attempting to cross the railroad tracks, most likely due to his impairment from the combined effects of the drugs marijuana and gabapentin. Contributing to the severity of the injuries was the lack of seat belt use by the truck occupants.

Investigation Report	Drug(s) Found	Probable Cause
Fatal Pedestrian Collision with Car, Washington, DC, August 18, 2016. **HAB-18/15.**	Pedestrian: alcohol (BAC 0.10 g/dL) Driver: alcohol (BAC 0.09 g/dL), MDMA, MDA, benzoylecgonine.	The NTSB determines that the probable cause of the crash in Washington, DC, was the pedestrian's decision to cross the street outside the crosswalk and against the traffic signal. Contributing to his poor decision-making was alcohol impairment. Further contributing to the crash was the driver's impairment from alcohol, which most likely diminished her ability to detect and avoid the pedestrian.
Fatal Pedestrian Collision with Sport Utility Vehicle, Town of Geneva, Wisconsin, August 16, 2016. **HAB-18/12.**	Pedestrian: alcohol (BAC 0.23 g/dL) Driver: 19 ng/ml of delta-9-THC, 8.2 ng/ml of 11-hydroxy-THC, 180 ng/ml of carboxy-THC, 24 ng/ml hydrocodone	The NTSB determines that the probable cause of the crash in the Town of Geneva, Wisconsin, was the pedestrian's decision to walk in the travel lane with her back to traffic. Contributing to her poor decision-making was impairment from the effects of alcohol intoxication.
Fatal Pedestrian Collision with Pickup Truck, Falls Church, Virginia, June 4, 2016. **HAB-18/04.**	Pedestrian: alcohol (BAC 0.22 g/dL), cocaine, benzoylecgonine (cocaine metabolite), cocaethylene	The NTSB determines that the probable cause of the crash in Falls Church, Virginia, was the pedestrian's decision to run across the multilane roadway in front of the oncoming car. Contributing to his poor decision-making was impairment from the effects of alcohol intoxication and recent use of cocaine.
Pickup Truck Centerline Crossover Collision With Medium-Size Bus on US Highway 83, Concan, Texas, March 29, 2017. **HAR-18/02.**	Truck driver: delta-9 THC and clonazepam	The NTSB determines that the probable cause of the Concan, Texas, crash was the failure of the pickup truck driver to control his vehicle due to impairment stemming from his use of marijuana in combination with misuse of a prescribed medication, clonazepam. Contributing to the severity of the injuries was the insufficient occupant protection provided by the lap belts worn by passengers seated in the rear of the medium-size bus.
Pickup Truck Collision With Multiple Bicycles, Cooper Township, Michigan, June 7, 2016. **HAB-17/01.**	Truck driver: THC-COOH, methamphetamine, amphetamine, hydrocodone,* tramadol O-desmethyltramadol, cyclobenzaprine,* ketamine, norketamine,* and lorazepam (* *means positive in 1 of 2 independent tests*)	The NTSB determines that the probable cause of the Cooper Township, Michigan, crash was the impairing effects of the driver's polysubstance abuse in the hours before the crash.
Multivehicle Work Zone Crash on Interstate 75, Chattanooga, Tennessee, June 25, 2015. **HAR-16/01.**	Truck driver: methamphetamine and amphetamine	The NTSB determines that the probable cause of the Chattanooga, Tennessee, crash was the truck driver's failure to respond to the slow-moving traffic within a work zone because of performance decrements likely associated with his fatigue and methamphetamine use. Contributing to the crash was the failure of the pre-employment screening process to identify driver risk factors. Contributing to the severity of the crash was the truck-tractor's high impact speed.

Investigation Report	Drug(s) Found	Probable Cause
***Truck-Tractor Semitrailer Median Crossover Collision With Medium-Size Bus on Interstate 35, Davis, Oklahoma, September 26, 2014.* HAR-15/03.**	Truck driver: Sertraline, trazodone; Test for 5-fluoro-AMB conducted, but neither presence nor absence could be confirmed.	The NTSB determines that the probable cause of the Davis, Oklahoma, crash was the failure of the truck-tractor driver to control his vehicle due to incapacitation likely stemming from his use of synthetic cannabinoids. Contributing to the severity of injuries were the lack of restraint use by the bus passengers and the lack of appropriate crashworthiness standards for medium-size buses.
***School Bus and Truck Collision at Intersection, Near Chesterfield, New Jersey, February 16, 2012.* HAR-13/01.**	Bus driver: 7-amino-clonazepam, desmethylvenlafaxine (O-), tramadol	The NTSB determines that the probable cause of the Chesterfield, New Jersey, crash was the school bus driver's failure to observe the Mack roll-off truck, which was approaching the intersection within a hazardous proximity. Contributing to the school bus driver's reduced vigilance were cognitive decrements due to fatigue as a result of acute sleep loss, chronic sleep debt, and poor sleep quality, in combination with, and exacerbated by, sedative side effects from his use of prescription medications. Contributing to the severity of the crash was the truck driver's operation of his vehicle in excess of the posted speed limit, in addition to his failure to ensure that the weight of the vehicle was within allowable operating restrictions. Further contributing to the severity of the crash were the defective brakes on the truck and its overweight condition due to poor vehicle oversight by Herman's Trucking, along with improper installation of the lift axle brake system by the final stage manufacturer—all of which degraded the truck's braking performance. Contributing to the severity of passenger injuries were the nonuse or misuse of school bus passenger lap belts; the lack of passenger protection from interior sidewalls, sidewall components, and seat frames; and the high lateral and rotational forces in the back portion of the bus.

Appendix C: NTSB Drug Category and Subcategory Descriptions

The NTSB created its own drug classification scheme organized by the likely effects of a drug or similarities in drug properties. A brief description of the NTSB drug categories and subcategories is provided below. It should be noted that these definitions reflect the specific definitions used by NTSB for this research and analysis, but other sources may define each category with slight differences. Additionally, each of these categories should be understood to only include potentially impairing drugs. For extra clarity due to the large number of drugs within the "neuropsychiatric medications" and the "other" categories that are non-impairing, the words "potentially impairing" were added to these category names. Here and throughout the report, chemical or generic drug names are not capitalized, and drug brand names are capitalized. Drug brand names are the names given by companies that sell the drugs.

Alcohol, the common name for ethanol or ethyl alcohol, is an intoxicant that is commonly found in beer, wine, and liquor. Alcohol is a psychoactive drug which produces depressant effects.

Non-Ethanol Alcohols are alcohols other than ethanol. Examples include isopropanol and methanol.

Cannabis, commonly referred to as marijuana, refers to the dried leaves, flowers, stems, seeds, and other derived products of the *Cannabis sativa* or *Cannabis indica* plant. Subcategories include the following:

- **THC** or tetrahydrocannabinol refers to the compounds that are primarily responsible for cannabis' psychoactive effects. This subcategory includes Δ9-THC and Δ8-THC and their metabolites or byproducts, including cannabinol, 11-nor-9-carboxy-THC, and 11-Hydroxy-THC.
- **Other cannabinoids** are all other chemicals derived from the cannabis plant which are not THC or the metabolites of THC but have psychoactive properties or alter the psychoactive properties or concentrations of other compounds. This includes cannabidiol.

Potentially Impairing Neuropsychiatric Medications include a wide variety of prescription drugs that have impairing side effects such as dizziness, drowsiness, and incoordination. The disorders these medications are treating may also have adverse effects on driving safety. Subcategories include the following:

- **Antidepressants** are drugs commonly prescribed for the treatment of depression. Examples include amitriptyline, bupropion (Wellbutrin), and doxepin.

- **Antiepileptics**, also referred to as anticonvulsants, are a broad group of drugs used to treat seizures or convulsions. They may also be used to treat nerve pain and psychiatric diseases, such as bipolar disease. Examples include carbamazepine (Tegretol), gabapentin, and oxcarbazepine.
- **Antipsychotics**, also known as neuroleptics, are used to treat or reduce symptoms of psychosis, a finding in schizophrenia and some other neuropsychiatric conditions. Examples include aripiprazole (Abilify), clozapine, risperidone, and ziprasidone.
- **Other Anxiolytics** are drugs used to treat anxiety. This subcategory included drugs used to treat anxiety where the mechanism of action was other than as a central nervous system depressant such as benzodiazepines and barbiturates. This category includes buspirone.
- **Other potentially impairing neuropsychiatric medications** includes all remaining medications used to treat neuropsychiatric disorders that are not included in this or other categories. Examples include ropinirole.

Hallucinogens are a diverse group of drugs that produce psychoactive effects which may alter perceptions, thoughts, and/or feelings. They are characterized by their tendency to produce hallucinations. Examples include LSD, mescaline, and psilocin.

Inhalants consist of a wide variety of vapors that are inhaled as their primary method of usage. This includes many common household products such as spray paint, paint thinners, glue, and cleaning fluids. Chemical examples include acetone, difluoroethane, and toluene.

Dissociative anesthetics create feelings of detachment or dissociation from a person's body or environment and may be used for general anesthesia during surgery. Dissociative anesthetics may produce visual and auditory distortions. Examples include ketamine, phencyclidine (PCP), and tenocyclidine.

Sedatives serve as central nervous system depressants. They produce sedating or relaxant effects which may be used to treat a variety of conditions. Subcategories include the following:

- **Barbiturates** are a group of depressants that are known as sedative-hypnotics because they are commonly used to induce sleep or reduce anxiety. Examples include butalbital and phenobarbital.
- **Benzodiazepines** are depressants primarily used to treat anxiety, seizures, and insomnia. Examples include alprazolam (Xanax), clonazepam (Klonopin), diazepam, and lorazepam.

- **Muscle relaxants** effect skeletal muscle function, decrease muscle tone, and may be used to treat muscle pain or spasms. Examples include baclofen, carisoprodol (Soma), and cyclobenzaprine.
- **Sedating antihistamines** are drugs used to treat allergic symptoms and also cause sleepiness. Examples include diphenhydramine (Benadryl), meclizine, and promethazine.
- **Sleep aids** are used to treat problems of falling and staying asleep. Examples include suborexant, zolpidem, and zopiclone.
- **Other sedatives** are all other drugs that act as central nervous system depressants, but do not have properties that fit into the above subcategories. An example is phenibut.

Stimulants serve as central nervous system stimulants and may improve alertness, create pleasure and invigoration, and produce sympathomimetic effects. Subcategories include the following:

- **Amphetamines** are strong central nervous system stimulants that may be used legally to treat attention deficit hyperactivity disorder, narcolepsy, and obesity or illicitly for its stimulant and mood-altering effects. Examples include amphetamine, MDA, MDMA, and phentermine.
- **Cocaine** is a highly addictive stimulant made from the leaves of the coca plant. Cocaine is a Schedule II drug under the Controlled Substances Act, meaning it has a high potential for abuse, but may also be used for medical treatment (primarily as a topical local anesthetic).[137] Examples include cocaine and its metabolites: benzoylecgonine, cocaethylene, EME, EEE, and AEME.
- **Methamphetamine** is a powerful central nervous system stimulant that is most commonly used illicitly but may also be used to treat attention deficit hyperactivity disorder and obesity. Methamphetamine metabolizes into amphetamine.
- **Piperazines** are a broad group of drugs that produce stimulant effects that may mimic amphetamine, specifically MDMA (ecstasy). Examples include mCPP, TFMPP, and benzylpiperazine (BZP).
- **Other stimulants** are drugs that act as central nervous system stimulants, but do not have properties that fit into any of the other subcategories. Examples include phenylpropanolamine and yohimbine.

[137] Controlled Substances Act, Public Law 91–513, 84 Stat. 1242 (1970).

Narcotic analgesics are potent drugs used primarily for pain management but have a high potential for addiction and abuse. Subcategories include the following:

- **Non-fentanyl opioids** include a class of drugs that are naturally found in the opium poppy plant for pain management, as well as synthetic drugs that act to mimic these effects. This subcategory includes all opioids with the exception of fentanyls. Examples include codeine, heroin, hydrocodone, oxycodone, and tramadol.
- **Fentanyls** are synthetic opioids that are characterized by their extreme potency. Fentanyl is 50-100 times stronger than morphine. Examples include fentanyl, 4-ANPP, and valerylfentanyl.

Novel psychoactive substances, sometimes referred to as "designer drugs," are drugs that are designed to mimic the effect of established illicit drugs, but the compounds are often created to avoid legal classification as an illicit drug. Subcategories include the following:

- **Synthetic cannabinoids** are designed to mimic the effects of cannabis, specifically Δ9-THC, by binding to the same cannabinoid receptors in the brain. Synthetic cannabinoids may be marketed as "K2" or "Spice."
- **Synthetic cathinones** are synthetic stimulants which may commonly be referred to as "bath salts." They most closely mimic the effects of amphetamine. Examples include 4-FMC, methcathinone, and mephedrone.

Other potentially impairing drugs represent a broad set of drugs that do not have characteristics that align with any of the categories listed above. Often this will be because the drug may produce impairment, but the impairment is not neuropsychiatric, or because the effects of the drug may fall into multiple categories (for example, hallucinogenic and depressant). Subcategories include the following:

- **Anticholinergics** are drugs that inhibit nerve impulses responsible for involuntary muscle movements. They may be used to treat chronic obstructive pulmonary disease (COPD), bladder conditions, gastrointestinal disorders, and symptoms of Parkinson's disease. Examples include benztropine (Cogentin) and dicyclomine.
- **Antiemetics** are drugs used for the prevention or treatment of nausea and vomiting. An example is metoclopramide (Reglan).
- **Blood pressure medications** are used to treat high blood pressure. The majority of these drugs are non-impairing but may be indicative of a potentially impairing medical condition.

- **Methorphan**, due to the similarities of the chemical compounds, refers to dextromethorphan, dextrorphan, levorphanol, and methorphan. These drugs are commonly used as a cough suppressant but may be abused in high doses which produces hallucinogenic effects.
- **Migraine medications** are used to treat severe headaches and migraines. An example is sumatriptan.
- **Mitragynine**, commonly referred to as Kratom by recreational users, is the primary alkaloid isolated from the leaves of a tropical plant–*Mitragyna speciosa*. It is often used for both its stimulant properties and opioid-like effects. Examples include mitragynine and its metabolite 7-hydroxymitragynine.
- **Other alkaloids** include any alkaloid that is not otherwise classified by its other properties into another category. Alkaloids are a large group of drugs that serve as anesthetics, cardioprotective, and anti-inflammatory agents.
- **Other** refers to any drug that could not be classified into other common categories. An example is butane.

Appendix D: Summary of the DRUID Meta-Analysis Results

The DRUID project, a 5-year effort involving 18 European countries, comprised numerous studies to assess the prevalence of use and risk of various drugs (Hels and others 2011). The project also conducted a meta-analysis on data from 605 publications to estimate the overall effects of different drugs and drug categories on performance. Using these analyses, the project was able to estimate the "degree of impairment" for different drugs and drug doses, which it characterized as, "capturing in a single parameter both the intensity (magnitude of impaired effects) and duration of impairment" (EMCDDA 2012). The report also acknowledged that there was not enough information to fully assess all drugs or drug combinations.

Table D-1 shows how various drugs within a certain drug class may be much more impairing than others. For example, within the anxiolytics drug class, lorazepam is much more impairing than other drugs in that class. The table also shows how different dosages and different routes of administration of the same drug can affect the degree of impairment.

Table D-1. Degree of impairment sorted in ascending order within different substance classes.

Class	Substance/Dose (mg)	Degree of Impairment
Anxiolytics	Buspirone (10)	0
	Buspirone (20)	0
	Clobazam (10)	0
	Clobazam (20)	0
	Meprobamate (400)	0
	Meprobamate (800)	0
	Diazepam (5)	17
	Diazepam (10)	57
	Lorazepam (1)	64
	Oxazepam (15)	104
	Diazepam (15)	112
	Oxazepam (30)	170
	Diazepam (20)	171
	Alprazolam (1)	369
	Lorazepam (2)	418
	Lorazepam (2.5)	571
Hypnotics and Sedatives	Temazepam (10)	0
	Zolpidem (5)	0
	Lormetazepam (1)	22
	Temazepam (20)	40
	Zaleplon (10)	40

Class	Substance/Dose (mg)	Degree of Impairment
Hypnotics and Sedatives (Continued)	Triazolam (0.25)	89
	Flunitrazepam (1)	115
	Zolpidem (10)	119
	Zolpidem (20)	214
	Zopiclone (7.5)	240
	Triazolam (0.5)	247
	Flunitrazepam (2)	461
Antipsychotics	Sulpiride (400)	0
	Haloperidol (3)	93
	Promethazine (27)	491
Antidepressants	Fluoxetine (60)	0
	Paroxetine (30)	0
	Imipramine (75)	32
	Trazodone (100)	87
	Mianserin (10)	185
	Amitriptyline (25)	327
	Amitriptyline (50)	380
Antihistamines	Fexofenadine	0
	Loratadine (10)	0
	Terfenadine (60)	0
	Diphenhydramine (25)	54
	Diphenhydramine (50)	92
Illicit Drugs	d-amphetamine (24.75)	0
	d-amphetamine (4.25)	0
	THC oral admin. (8.25)	0
	THC smoking (5)	66
	THC oral admin. (13.5)	68
	THC smoking (13.5)	70
	THC oral admin. (24.5)	215

Appendix E: List of Drug Compounds Tested by Laboratory

This table shows all of the substances that were included in this research as potentially impairing and which laboratories tested for which substances. Table E-1 shows that even in these exemplar laboratories, there are significant differences in the quantity of tested substances. This is a key reason why laboratory results cannot be aggregated into a single analysis. However, understanding which drugs were tested at each laboratory helps with interpreting each laboratory's results.

Table E-1. List of drug compounds tested by each of the four laboratories.

Drug Category	Drug Subcategory	Compound Tested	Orange County Laboratory	Wisconsin Laboratory	San Francisco Laboratory	New York Laboratory
Alcohol (Ethanol)	Alcohol (Ethanol)	Alcohol (Ethanol)	•	•	•	•
Non-Ethanol Alcohols	Non-Ethanol Alcohols	Isoproanol	•	•		
		Methanol	•			
Cannabis	THC	Cannabinol	•			
		Carboxy THC	•	•	•	•
		HydroxyTHC	•	•	•	•
		Delta-8-THC		•		
		Delta-9-THC	•	•	•	•
	Other Cannabinoids	Cannabidiol	•			
Potentially Impairing Neuropsychiatric Medications	Antidepressants	Amitriptyline	•	•		
		Bupropion	•	•		
		BupropionHydroxy	•			
		Bupropion Metabolites	•			
		Clomipramine	•			
		Desipramine	•	•		
		Doxepin	•	•		
		Duloxetine	•	•		
		Imipramine	•			
		Mirtazapine	•	•		
		Nefazodone	•			
		Norclomipramine	•			
		Nordesmethylmirtazapine	•			
		Nordoxepin	•	•		

Drug Category	Drug Subcategory	Compound Tested	Orange County Laboratory	Wisconsin Laboratory	San Francisco Laboratory	New York Laboratory
Potentially Impairing Neuropsychiatric Medications (Continued)	Antidepressants (Continued)	Nortriptyline	●	●		
		Protriptyline	●			
		Tianeptine	●	●		
		Trazodone	●	●		
		Vilazodone	●			
	Antiepileptics	Carbamazepine	●	●		
		Eslicarbazepine		●		
		Gabapentin	●	●		
		Hydroxycarbazepine			●	
		Lacosamide	●			
		Lamotrigine	●	●	●	
		Levetiracetam	●	●		
		Oxcarbazepine	●	●		
		Phenytoin	●	●		
		Pregabalin	●	●		
		Primidone	●	●		
		Topiramate	●	●		
		ValproicAcid	●	●	●	
		Zonisamide	●	●		
	Antipsychotics	Aripiprazole	●	●		
		Cariprazine		●		
		Chlorpromazine		●		
		Clozapine	●	●		
		Haloperidol	●	●	●	
		Hydroxyrisperidone	●	●		
		Loxapine		●		
		Lurasidone	●	●		
		Norclozapine	●			
		Norquetiapine	●			
		Olanzapine	●	●	●	
		Prochlorperazine	●			
		Quetiapine	●	●		
		Risperidone	●	●		
		Ziprasidone	●	●		

Drug Category	Drug Subcategory	Compound Tested	Orange County Laboratory	Wisconsin Laboratory	San Francisco Laboratory	New York Laboratory
Potentially Impairing Neuropsychiatric Medications (Continued)	Anxiolytics	Buspirone	●	●		
	Other Potentially Impairing Neuropsychiatric Medications	Ropinirole	●	●		
Narcotic Analgesics	Non-Fentanyl Opioids	Brorphine		●		
		Buprenorphine	●	●	●	●
		Buprenorphineglucuronide	●	●		
		Codeine	●	●	●	●
		Codeineglucuronide	●			
		Desmetramadol	●	●		●
		Dihydrocodeine	●		●	
		Dihydrocodeineglucuronide	●			
		Diphenoxylate	●			
		EDDP	●	●	●	
		EMDP	●			
		Heroin	●			
		Hydrocodone	●	●	●	●
		Hydromorphone	●	●	●	●
		Hydromorphoneglucuronide	●			
		Isotonitazene		●		
		Meperidine	●			
		Methadone	●	●	●	●
		Morphine	●	●	●	●
		Morphineglucuronide	●			
		Norbuprenorphine	●	●	●	●
		Norbuprenorphineglucuronide	●			
		Norcodeine	●			
		Norhydrocodone	●			
		Normeperidine	●			
		Noroxycodone	●			
		Norpropoxyphene		●		
		Nortramadol	●			
		Oxycodone	●	●	●	●
		Oxymorphone	●	●	●	●

Drug Category	Drug Subcategory	Compound Tested	Orange County Laboratory	Wisconsin Laboratory	San Francisco Laboratory	New York Laboratory
Narcotic Analgesics (Continued)	Non-Fentanyl Opioids (Continued)	Propoxyphene		●		
		6-Acetylcodeine	●			
		6-AM	●	●	●	
		Tapentadol	●			
		Tapentadolglucuronide	●			
		Tramadol	●	●	●	●
	Fentanyls	Acetylfentanyl		●	●	●
		Betahydroxyfentanyl	●	●		
		Carfentanil		●		
		Fentanyl	●	●	●	●
		4-ANPP	●	●		
		Methoxyacetylfentanyl	●			
		Norfentanyl	●	●	●	
		oFF		●		
		pFF		●		
		Valerylfentanyl	●	●		
Hallucinogens	Hallucinogens	LSD	●	●		
		Mescaline	●			
		Psilocin	●			
Inhalants	Inhalants	Acetone	●	●		●
		Difluoroethane	●	●		
		Toluene	●			
Dissociative Anesthetics	Dissociative Anesthetics	GHB	●	●	●	
		Ketamine	●	●		
		Norketamine	●	●		
		Phencyclidine	●	●	●	●
		Tenocyclidine	●			
Sedatives	Barbiturates	Butalbital	●	●	●	
		Phenobarbital	●	●	●	
	Benzodiazepines	Alprazolam	●	●	●	●
		Bromazepam	●			
		Bromazolam		●		
		Chlordiazepoxide	●	●	●	
		Clobazam		●		
		Clonazepam	●	●	●	●

Drug Category	Drug Subcategory	Compound Tested	Orange County Laboratory	Wisconsin Laboratory	San Francisco Laboratory	New York Laboratory
Sedatives (Continued)	Benzodiazepines (Continued)	Clonazolam	●	●		
		Delorazepam		●		
		Demoxepam	●	●		
		Diazepam	●	●	●	●
		Diclazepam	●			
		Etizolam	●	●		
		Flualprazolam	●	●		
		Flubromazolam	●	●		
		Flubromazepam		●		
		Hyd-Flurazepam	●			
		Hydroxyalprazolam	●	●	●	●
		Lorazepam	●	●	●	●
		Lorazepamglucuronide	●			
		Lormetazepam	●			
		Norchlordiazepoxide	●	●		
		Nordiazepam	●	●	●	●
		Oxazepam	●	●	●	●
		Oxazepamglucuronide	●			
		Phenazepam	●			
		7-Aminoclonazepam	●	●	●	●
		Temazepam	●	●	●	●
		Temazepamglucuronide	●			
		Triazolam	●			
	Muscle Relaxants	Baclofen	●	●		
		Carisoprodol	●	●	●	●
		Cyclobenzaprine	●	●		
		Meprobomate	●	●	●	●
		Metaxalone	●	●		
		Methocarbamol	●	●		
		Norcyclobenzaprine	●			
		Orphenadrine	●	●		
		Tizanidine	●	●		
	Sedating Antihistamines	Brompheniramine	●			
		Cetirizine	●			
		Chlorpheniramine	●	●		

Drug Category	Drug Subcategory	Compound Tested	Orange County Laboratory	Wisconsin Laboratory	San Francisco Laboratory	New York Laboratory
Sedatives (Continued)	Sedating Antihistamines (Continued)	Diphenhydramine	•	•		
		Doxylamine	•	•		
		Hydroxyzine	•	•		
		Meclizine	•	•		
		Norchlorcyclizine	•			
		Pheniramine	•	•		
		Promethazine	•	•		
	Sleep Aids	Suborexant	•			
		Zaleplon		•		
		Zolpidem	•	•	•	•
		Zopiclone	•	•	•	
	Other Sedatives (Phenibut)	Phenibut		•		
Stimulants	Amphetamines	Amphetamine	•	•	•	•
		Atomoxetine	•	•		
		MDA	•	•	•	•
		MDMA	•	•	•	•
		Methylphenidate	•	•		
		Phendimetrazine	•			
		Phenmetrazine			•	
		Phentermine	•	•	•	
	Cocaine	AEME	•			
		Benzoylecgonine	•	•	•	•
		Cocaethylene	•	•	•	•
		Cocaine	•	•	•	•
		EEE	•			
		EME	•			
	Methamphetamines	Methamphetamine	•	•	•	•
	Piperazines	Benzylipiperazine	•			
		mCPP	•	•		
		TFMPP	•			
	Other Stimulants	Modafinil		•		
		Phenylpropanolamine	•		•	
		Yohimbine	•	•		

Drug Category	Drug Subcategory	Compound Tested	Orange County Laboratory	Wisconsin Laboratory	San Francisco Laboratory	New York Laboratory
Novel Psychoactive Substances	Synthetic Cannabinoids	5F-MDMB-PICA		•		
		Synthetic Cannabinoids		•		
Other Potentially Impairing Drugs	Anticholinergics	Benztropine	•	•	•	
		Dicyclomine	•			
	Antiemetics	Metoclopramide	•	•		
	Methorphan	Dextromethorphan		•		
		Dextorphan/Levorphanol	•			
		Levorphanol	•			
		Methorphan	•			
	Migraine Medications	Sumatriptan	•			
	Mitragynine	Mitragynine	•	•		
		7-Hydroxymitragynine	•			

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