Re-Evaluating the Prevalence of Drugged and Poly-Drug Driving in Washington State

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Understanding Drug Metabolites, Pharmaceutical and Over-the-Counter Drugs, and other Non-impairing Drugs and Substances

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Glossary

Blood Alcohol Concentration (BAC), Alcohol Greater Than/Equal to BAC 0.08 – The unit of measurement used to describe the level of alcohol contained in a person's blood; the measurement describes the percent of a person's blood that is alcohol. Alcohol greater than/equal to BAC 0.08 refers to a driver at or in excess of the per se limit.

Carboxy-THC – The metabolite of delta-9-THC; This metabolite may be detected for up to 30 days after consumption.

Cannabinoids – A class of chemical compounds contained in marijuana. For purposes of this report, cannabinoids are an encompassing term to include any toxicology outcome related to marijuana (THC or carboxy-THC undistinguished).

Coded Fatal Crash (CFC) files – Refers to the Washington Traffic Safety Commission's in-house dataset on all fatal crashes in the state of Washington. The dataset draws on information from police traffic collision reports, driver licensing and history from the Washington State Department of Licensing, death certificates, and toxicology results.

Drugged Driving – Similar to drunk driving but referring specifically to drivers that are driving while under the influence of drugs instead of alcohol.

Drug Metabolites – The byproduct of the body breaking down or metabolizing a drug into a different substance(s). Metabolites can be either active or nonactive, indicating whether they have an effect on the body.

Fatality Analysis Reporting System (FARS) – A national database funded by the National Highway Traffic Safety Administration containing a census of all fatal traffic crashes occurring in the U.S.

National Highway Traffic Safety Administration (NHTSA) – Federal U.S. agency, part of the U.S. Department of Transportation, tasked with transportation safety by providing grants to state governments so states can conduct effective highway safety programs to keep people safe on roadways.

Poly-Drug – Refers to people that are positive for two or more drugs, or a combination of one or more drugs and alcohol as confirmed by toxicology testing.

THC – Acronym for Tetrahydrocannabinols. For purposes of this report, the use of THC specifically refers to delta-9-THC, the psychoactive chemical entering the blood and brain immediately after cannabis smoking/consumption.

Report Summary

Over the past decade in Washington, the number of poly-drug-positive drivers involved in fatal crashes has steadily increased year-over-year. However, these poly-drug-positive cases can include non-impairing pharmaceutical medication, over-the-counter drugs, drug metabolites (both active and non-active), or other drugs and substances unrelated to the events of the fatal crash (such as drugs administered post-crash by emergency personnel). Therefore, the prevalence of poly-drug-positive drivers may be overestimated. The Washington Traffic Safety Commission (WTSC) aimed to reduce the risk of overestimating poly-drug-positive drivers by conducting a systematic review of drug-positive driver data to remove non-impairing and unrelated drugs, non-active drug metabolites, and unrelated substances. This report details the steps taken by the WTSC to update drug-positive driver data to improve the quality of the data. The outcome of the update and change in drug-positive driver data, along with the steps implemented to update the data, are summarized below.

- In 2021, before updating the drug-positive driver data:
    - The number of alcohol-positive only (BAC of 0.08 or greater) drivers involved in fatal crashes was 59.
    - The number of one-drug-positive only (including BAC less than 0.08) drivers involved in fatal crashes was 35.
    - The number of poly-drug-positive drivers involved in fatal crashes reached a ten-year high of 221.
    - Poly-drug was the most prevalent impairment category among drivers involved in fatal crashes.

- In 2021, after updating the drug-positive driver data:
    - The number of alcohol-positive only (BAC of 0.08 or greater) drivers involved in fatal crashes **changed by 14%** from 59 to 67.
    - The number of one-drug-positive only (including BAC less than 0.08) drivers involved in fatal crashes **changed by 100%** from 35 to 70.
    - The number of poly-drug-positive drivers involved in fatal crashes **changed by 30%** from 221 to 154.
    - Poly-drug remained the most prevalent impairment category among drivers involved in fatal crashes – more than either alcohol only or one drug only.
    - The increase among alcohol-positive only and one-drug-positive only drivers are the result of recategorizing poly-drug drivers following the data improvements to reconcile individual drug relationships, such as drug metabolites being matched with parent drugs.

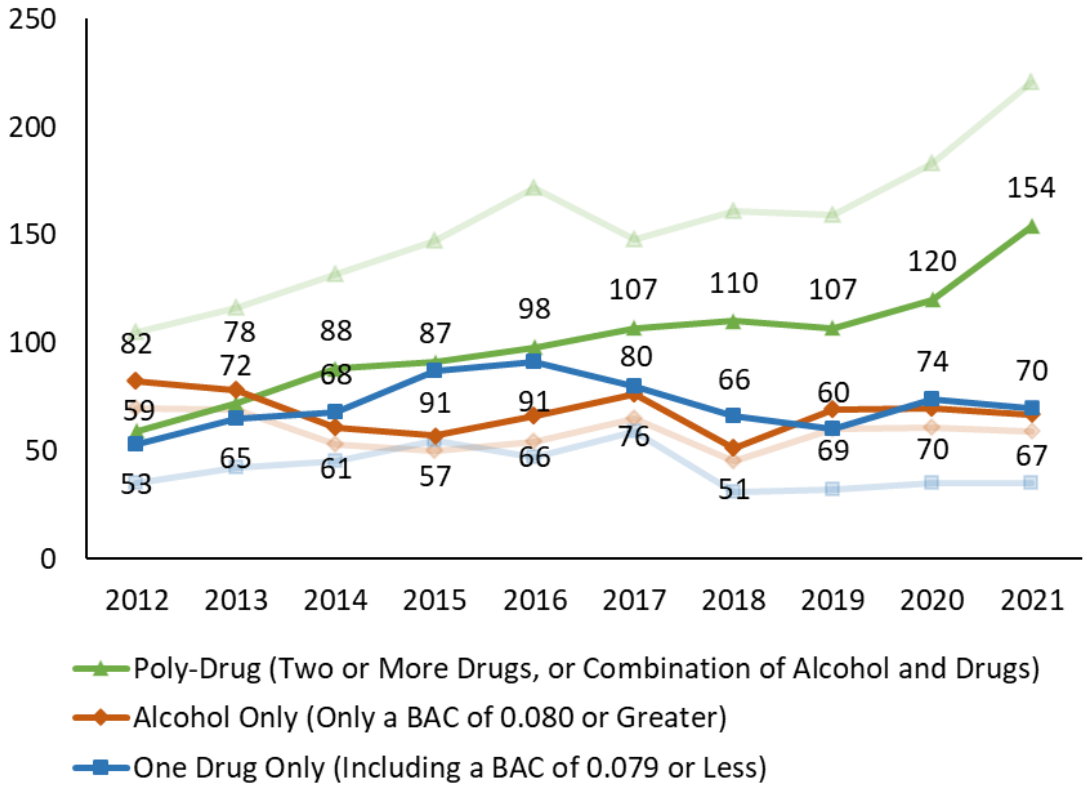

Figure 1: Number of Drivers in Fatal Crashes Positive for Alcohol and/or Drugs Before and After Data Updates

The following steps were implemented as part of the drug-positive driver data update.

- Identify a drug as impairing, potentially impairing, or non-impairing.
    - Classifications were based on current available research or, when lack thereof, best understanding of how a drug affects the body. This step aided in identifying non-impairing drugs that were subsequently removed from the data altogether.

- Remove non-impairing and unrelated drugs and substances.
    - Non-impairing refers to drugs and substances such as acetaminophen, caffeine, ibuprofen, and nicotine/cotinine. Unrelated refers to drugs and substances that were not related to the circumstances of the crash such as drugs administered post-crash by emergency personnel. This step indicates that drugs and substances determined to be non-impairing or unrelated to the circumstances of the fatal crash will no longer be counted as a positive drug result.

- Remove non-active metabolites when the parent drug is absent from toxicology results.
    - A non-active metabolite does not have impairing effects on the body. This step indicates that when a non-active metabolite was present without its parent drug, the non-active metabolite will no longer be counted as a positive drug result.

- Remove non-impairing pharmaceutical drugs when alcohol is not present.
    - It is common for drivers to take pharmaceutical medication and operate a vehicle. In many circumstances, medication helps them to carry out their regular activities in a healthy manner. There is the possibility for alcohol to interact with pharmaceutical medication to produce or exacerbate impairing effects. This step indicates that in the absence of alcohol, pharmaceutical medication determined to be non-impairing will no longer be counted as a positive drug result.

- Match parent drugs with their metabolites.
    - When a person tests positive for a parent drug and its metabolite, each would be counted as a separate drug when in fact only one drug was consumed. Matching parent drugs with their metabolites creates a parent/metabolite compound that becomes a single drug unit. This step indicates that parent drugs and their metabolites will no longer be treated as two or more separate drugs, but as a singular drug compound.

- Remove toxicology screening results when confirmatory results are present.
    - If a toxicology result shows a positive screening result – indicating that a drug family is present, and a confirmatory result – indicating that a specific drug is present, then each of these results are counted as separate drugs. This step indicates that when a confirmatory result is present, the screening result associated with it will no longer be counted as a positive drug result.

The drug-positive driver data updates listed above will provide more accurate data pertaining to driver impairment. These updates will prevent counting non-impairing or unrelated drugs and substances, non-active metabolites, or positive screening results when confirmatory is present as positive drug results. Additionally, these updates will stop parent drugs and their metabolites from being counted as multiple standalone drugs. Lastly, these updates will address non-impairing pharmaceuticals so that they are not counted as positive drug results. Drug impairment data is challenging as the landscape is quickly and constantly evolving with new drugs, testing protocols, and reporting procedures. With updated impairment data, we will be better informed as to the common drugs and drug combinations involved in fatal crashes. With better information, we can effectively guide program decisions to prevent impaired driving, improve roadway safety and save lives.

Background

Alcohol and/or drug positive (i.e., impaired) driving is the leading high-risk behavior involved in traffic fatalities in Washington – more than speeding, not wearing a seat belt, or distraction. More than half of all traffic fatalities in Washington involve an alcohol and/or drug positive driver or pedestrian/bicyclist. A concerning trend in the past decade is the increase in poly-drug-positive drivers. Poly-drug refers to testing positive for two or more drugs or a combination of alcohol and drugs. However, those drivers that are poly-drug positive may not actually be "impaired". This is because toxicology laboratories test for and report multiple different drugs including drug metabolites, pharmaceuticals, and over-the-counter drugs – including drugs which may be non-impairing, such as caffeine.

'Drug impaired' driving can be particularly challenging to define. With existing data and the limitations, it is more appropriate to classify it as 'drug-positive' driving. This is because drug presence does not necessarily imply impairment. The term 'drugs' is all encompassing from illicit such as methamphetamine, heroin, and cocaine, to over-the-counter such as diphenhydramine, pseudoephedrine, and acetaminophen, to pharmaceutical such as citalopram, warfarin, and oxycodone. While alcohol is well understood to affect driving by influencing reaction time, depth perception, judgement, motor skills, and blurred vision (Irwin, et. al., 2017), less is known about the effects of numerous drugs and the interacting effects of multiple drugs and/or alcohol on driving. Combining drugs or drugs with alcohol can increase their impairing effects or produce new effects that could increase crash risk (NTSB, 2022). For example, studies have shown that combining alcohol and benzodiazepines was associated with a seven-fold increase in crash risk compared to drivers without any drugs or alcohol (Dassanayake, et. al., 2011), while alcohol combined with amphetamines was associated with a five to 30-fold increase in crash risk compared to sober drivers (Hels, et. al., 2011).

Of particular concern for this report is the presence of drug metabolites, pharmaceuticals, over-the-counter drugs, or drugs and substances unrelated to the fatal crash. This report details the review process of existing drug-positive driver data in the WTSC's Coded Fatal Crash (CFC) files to identify impairing, potentially impairing, non-impairing, or unrelated drugs, followed by removal of non-impairing and unrelated drugs from the data. This report documents these changes to the data and presents them as guidelines to better report on drug-positive drivers with the intent of improving the quality of drug-positive and poly-drug-positive driver data.

Scenario

A 60-year-old male wakes up on a Sunday morning and prepares to go on a motorcycle ride. As part of his morning routine, he has two cups of coffee and

> takes his prescribed medication, diltiazem, for his high blood pressure. He woke up with some lower back pain, so he also took a recommended dose of ibuprofen. For the sake of example, let's say he is a chronic cannabis user, but *did not* consume any cannabis the day he was going for a motorcycle ride. He sets off on his ride and eventually gets into a crash where he sustains serious injuries. Emergency services transport him to a nearby hospital where they administer midazolam to sedate him prior to surgery. Unfortunately, he succumbs to his injuries and is declared deceased. Blood is drawn and submitted for a toxicology screening. The results conclude that he was positive for five substances. He tests positive for caffeine from the coffee he drank that morning, his pharmaceutical medication diltiazem, the ibuprofen he took for his back pain, carboxy-THC, the non-active metabolite of delta-9 THC due to his chronic use of cannabis, and lastly the midazolam administered by hospital staff.

This motorcycle rider would be deemed a poly-drug-positive driver, and one would likely conclude that it was drug impairment that contributed to the fatal crash. However, none of these drugs, substances, or drug metabolites were impairing or related to the circumstances of the fatal crash. In fact, if we were to remove the non-impairing caffeine, carboxy-THC, diltiazem, ibuprofen, and the unrelated midazolam, we would determine that this motorcycle driver was not positive for any impairing drugs. We could then conclude that neither drugs or impairment contributed to the fatal crash. This example showcases the complicated nature of drug-positive driver data and the efforts of this report to improve the quality of drug-positive driver data.

Types of Drugs

Illicit drugs are perhaps the first drugs to come to mind when we think about drug impaired driving. Illicit drugs are illegal to possess, generally lack any medicinal use, and pose a high-risk for abuse (NTSB, 2022). These include drugs such as cocaine, hallucinogens, heroin, 3,4-methyl enedioxymethamphetamine (MDMA), and methamphetamine. These drugs are well understood to impair driving by altering attention, balance, cognition, coordination, and other vital brain functions required to operate a vehicle safely (Lipari, Hughes, & Bose, 2017**;** Berning, Compton, & Wochinger, 2015; NCADD, 2015).

Pharmaceutical and over-the-counter drugs, on the other hand, are challenging to assess in toxicology results. Two-thirds of adults in the U.S. take pharmaceutical medication (Health Policy Institute, 2023). The 2013-2014 National Roadside Survey conducted by the National Highway Traffic Safety Administration (NHTSA) found that 10 percent of weekday, daytime drivers that were surveyed tested positive for pharmaceutical and/or over-the-counter drugs (Kelley-Baker, et. al., 2017). This means that pharmaceutical and over-the-counter drugs are prevalent among

drivers involved in fatal crashes – and some of these drugs have the potential to be impairing. While many pharmaceutical drugs can have impairing effects such as benzodiazepines and opioids (Cameron-Burr, et. al., 2021; van der Sluiszen, et. al., 2019), there are circumstances where pharmaceuticals may not impair one's ability to operate a vehicle safely. In some cases, pharmaceutical drugs are medically necessary and may make it safer for a person to operate a vehicle than if they did not take their prescribed medication (Berning, et. al., 2022; NTSB, 2022). These may include antidepressants, antipsychotics, and antiepileptics. It is possible that a person's underlying condition may increase crash risk without treatment, such as epilepsy or narcolepsy (Devlin, et. al., 2012; Donjacour, et. al., 2010).

Unfortunately with toxicology data, we are unable to determine if pharmaceutical drugs present in a drivers' system were prescribed to that individual, or if they were abusing the drugs or taking them recreationally. We are also unable to determine if the driver had taken the recommended dosage of the pharmaceutical drug as instructed by their doctor, or whether they were instructed by their doctor or pharmacist not to operate a vehicle while taking the drug. It is possible that prescribed medication can be impairing even when taking the recommended dose as prescribed by a doctor, and precautions must be taken in these circumstances.

Over-the-counter drugs in toxicology results share similar challenges. It is common for people to take a recommended dose of acetaminophen for pain management or cold medicine with dextromethorphan for cold symptoms and then drive a vehicle. However, we would not likely consider these people to be impaired. Certain over-the-counter drugs may cause drowsiness, affect judgement, slow reaction time, or blur vision, in which case a warning should be displayed to alert the user to avoid driving or operating heavy machinery when taking the drug or to avoid driving until they know how the drug will affect them (NTSB, 2022). Like pharmaceutical drugs, we are unable to determine if over-the-counter drugs were taken accordingly as directed on the packaging.

Drug Concentrations and Effects

Assessing drug levels or concentrations poses challenges as well. In Washington, there are per se limits for driving under the influence of alcohol and cannabis (see RCW 46.61.502). It is unlawful for a driver to operate a vehicle if their BAC is 0.08 or greater. Likewise, it is unlawful for a driver to operate a vehicle with a delta-9 THC concentration of 5 ng/ml or greater. With most drugs, except for alcohol, the drug concentration in the blood is not clearly correlated with level of impairment (NTSB, 2022). This means that for most drugs a measured concentration alone cannot be used to determine whether a driver was impaired by that drug at the time of the crash or traffic stop (Berning, et. al., 2022). One driver with a concentration of 50 ng/ml of

methamphetamine in their blood may not show any signs of impairment, whereas another driver with a concentration of 10 ng/ml of methamphetamine may show severe signs of impairment.

Drugs can affect people differently depending on the characteristics of the drug, the user, method of consumption, and circumstances around use (NTSB, 2022). User weight, size, tolerance, fat, and muscle composition can all influence the drug's effects. One person may be a chronic user of a drug, resulting in a high tolerance, whereas an acute user may be affected by the drug with a relatively low dose. Drugs are also metabolized at different rates across different people, resulting in varying lengths of time at which the drug affects or impairs an individual and exits the body. For example, cannabis can be detected for days or even weeks in blood samples from chronic users. This is problematic for determining if a driver is impaired as a positive drug test could mean that they had consumed cannabis at some point, but impairment at the time they were driving could not be concluded (Berning, et. al., 2022). As stated by the National Transportation Safety Board:

> "*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*." (NTSB, 2022)

For these reasons, drug impairment is particularly challenging to measure and standardize across all drivers. Overall, impairment is the physical and behavioral manifestation of a drug's effect, and there is no clear or consistent link with blood toxicology drug levels and the manifestation of impairment as exists for alcohol and BAC levels.

Other Toxicology Results

Drug metabolites are also included in toxicology results. A drug metabolite is the product of a drug being metabolized by the body. A drug metabolite can be either active, or non-active. An active metabolite begins or continues to have an effect on the body (Obach, 2013). For example, codeine is metabolized by the body into morphine, which offers pain relief for the user. A non-active metabolite does not have an effect on the body. For example, when a person smokes cannabis, they quickly become affected by delta-9 THC, which is the main psychoactive component of cannabis which causes the user to become "high". However, delta-9 THC is quickly

metabolized by the body into hydroxy-THC and quickly to carboxy-THC, which is the non-active metabolite of delta-9 THC. Although a non-active metabolite does not have impairing effects on the body, they are still counted as an independent drug in a toxicology panel – as demonstrated in the scenario provided earlier in this report. To someone unfamiliar with the relationships between parent drugs and metabolites, they may mistake these cases as poly-drug positive, when only one drug had been consumed by the user. This can contribute to overestimation of poly-drug drivers.

Toxicology results may also show both screening results and confirmatory results. A screening test can result in positive or negative, indicating whether a drug family/category is present in the blood sample. Typically, when a screening result is positive, confirmatory testing is performed to identify the specific drug within the drug family/category, and the corresponding drug level/concentration of that specific drug. Some toxicology reports provide both the screening result and the confirmatory result. This would result in two or more positive results present in the toxicology panel, even if the initial screening result was related to the confirmatory result of the same single drug. Like drug metabolites, these cases can lead to overestimation of poly-drug-drivers.

In serious crashes where a driver is transported to a hospital, it is common for emergency responders or hospital personnel to administer medically necessary drugs to the patient. This presents yet another challenge when interpreting toxicology results. It is possible for a toxicologist to determine if a drug was administered in a hospital setting based on the level of the drug in the body and whether metabolization has begun, but this is not always the case (Berning, et. al., 2022). For example, a patient may have already had hydrocodone (i.e., Vicodin) in their body when they crashed, then were given morphine by responding emergency personnel. These opioids would all appear in the patient's toxicology panel, but we would be unable to distinguish between which were in the driver's system prior to the crash, and which were administered afterwards. This raises the importance of documenting administration of drugs by emergency personnel and data sharing across hospitals, health departments, toxicologists, and law enforcement. Without the ability to distinguish these cases, we risk counting emergency administered drugs as drugs contributing to traffic crashes.

The contents above demonstrate and underscore the complexities of drug, poly-drug, and drug impairment involved in traffic crashes. It is critical that we have a clear understanding of the prevalence of drug and poly-drug driving on Washington roads to effectively invest and direct programs and resources to prevent impaired driving.

Limitations of National Fatal Crash Drug Data

NHTSA collects data from all 50 states and Puerto Rico on all police-reported fatal crashes on public roadways which is collectively reported in the Fatality Analysis Reporting System (FARS). National FARS data includes information on the fatal crashes, roadways, vehicles, drivers involved in fatal crashes, and toxicology reports (Berning, & Smither, 2014). FARS data is limited by the fact that there is a lack of standard practices when it comes to toxicology testing across and even within states. There are differences in who is tested, when they are tested, what drugs are tested for, what cut-off levels are used for reporting, how many drugs are tested, what equipment is used for testing, or what biological specimen is tested (Berning, & Smither, 2014). In Washington for example, RCW 46.52.065 states that a blood sample from all drivers and pedestrians killed in any traffic crash where the death occurred within four hours after the crash must be submitted to the state toxicologist. As noted in the previous section, many toxicology labs test for non-impairing drugs such as caffeine, nicotine, and acetaminophen. Without careful consideration of these cases, analysis of FARS data risk overestimating the prevalence of drug or poly-drug use among drivers (NTSB, 2022). Currently, FARS data does not differentiate between screening and confirmatory tests, which can also contribute to overestimation of drug use prevalence (Berning, et. al., 2022). NHTSA themselves have cautioned against using FARS drug and alcohol data to examine trends over time or make comparisons with alcohol use (Berning and Smither 2014; Berning and others 2022). NHTSA notes that:

> "*Currently, the data in FARS is insufficient to allow comparisons of drug use across years, or across States. In addition, in light of the limitations detailed above, it is also not possible to make inferences about impairment, crash causation, or comparisons to alcohol from this limited data. As more complete data becomes available, FARS data on drug-involved driving will be strengthened*." (Berning and Smither 2014)

These limitations still apply today as they did at the time of this publication. Therefore, it is important to be cautious when using FARS drug data. When possible, it may be advisable to use your own state's data directly.

Washington Traffic Safety Commission Coded Fatal Crash (CFC) Files

The Washington Traffic Safety Commission manages NHTSA's FARS and the Crash Report Sampling System (CRSS) for Washington state through a cooperative agreement. The WTSC works with our traffic safety partners in local and state agencies to gather all source documents involved in the investigation of fatal crashes. This information is used to code fatal crashes into the national FARS database. Using similar coding methods and the same FARS inclusion criteria, the WTSC also manages the Washington Coded Fatal Crash (CFC) analytical data files. The primary

source for both fatal crash data systems is the statewide crash database managed by the Washington State Department of Transportation. All three fatal crash databases share similarities, but each is distinctly different.

The CFC files are Washington state's official source for statewide fatal crash statistics. Information included in the CFC are composed of information reported by law enforcement on the police traffic collision report (PTCR), derived crash information from the statewide crash database, driver's license information and history, vehicle registrations, death certificates, EMS reports, and toxicology reports. As Washington was one of the first states to legalize the recreational use of cannabis and set a delta-9 THC per se limit, it was an immediate priority to address the FARS drug data limitations at the state level. Complete toxicology information was obtained through agreements with the WSP toxicology laboratory, Washington's central and single source of toxicology reports. With access to this information, the WTSC began including specified delta-9 THC and carboxy-THC results in the CFC files.

Up until now, the presence of other drugs besides alcohol or delta-9 THC was captured with FARS drug coding, and therefore subject to some of the same limitations described in the earlier section. The data updates described in this report address these remaining limitations and replaces the FARS drug coding with new reconciled data elements. These updates will provide more accurate analyses of drug and alcohol involvement in fatal crashes and enable further analysis of drug involvement that was not possible prior to these updates. With these improvements, we can move away from the term "drug-positive" and more confidently discuss impaired driving trends in the context of active drug influence.

Methodology to Update Drug-Positive Driver Data

In October 2023, the WTSC implemented data updates to improve drug-positive reporting among drivers involved in fatal crashes and provide data that better represents drug impairment. The methods were retroactively applied to data since 2012. The following steps of the methodology are described in detail in the sections that follow:

- Identify a drug as impairing, potentially impairing, or non-impairing.
- Remove non-impairing and unrelated drugs and substances.
- Remove non-active metabolites when the parent drug is absent from toxicology results.
- Remove non-impairing pharmaceutical drugs when alcohol is not present.
- Match parent drugs with their metabolites.
- Remove toxicology screening results when confirmatory results are present.

Identify a Drug as Impairing, Potentially Impairing, or Non-Impairing

The first step in the process of updating drug-positive driver data was identifying whether a drug was impairing, potentially impairing, or non-impairing (AKA 'potentially driver impairing' (PDI)). Nearly 150 unique drugs appeared in our drug-positive driver data from 2012-2021. This was a difficult task as conclusive scientific findings for the effects of *every* drug on driving abilities do not exist. Of the thousands of FDA-approved drugs and illicit drugs that exist, very few have been rigorously tested for driver impairment in driving simulation experiments. Moreover, there is not a standardized set of drugs that are understood to be impairing, non-impairing, or potentially impairing. As noted by the National Transportation Safety Board, "There is no universal method for classifying drugs, and numerous varying approaches exist in the traffic safety literature and field" (NTSB, 2022). The WTSC conducted a literature search of broad drug families/classes (e.g., antidepressants, benzodiazepines, cannabis, depressants, hallucinogens, inhalants, narcotic analgesics, opioids, sedatives, stimulants, etc.) and the terms 'driving', 'driving ability', 'driving while under the influence', 'under the influence', 'impairment', 'impairing', 'impaired driving', and 'impaired driver'. Where evidentiary studies were lacking, we searched for studies to explain the pharmacology of the drug to best understand how it affects the mind and body.

We deemed drugs to be non-impairing when there was evidence to suggest that the drug did not seriously impair driving abilities to the point that it could be a key contributing factor in a fatal crash. In the absence of evidence, we made determinations based on our best understanding of how the drug affects the mind and/or body. Non-impairing included drugs such as antibiotics, anticoagulants, caffeine, calcium-channel blockers, nasal decongestants, nicotine/cotinine, and nonsteroidal anti-inflammatory drugs (NSAIDs) (i.e., ibuprofen,). Caffeine has been recognized as an effective countermeasure for acute drowsy driving by the AAA Foundation for Traffic Safety (Bayne, et. Al., 2022). Calcium channel blockers work as a vasodilator and are frequently used to treat high-blood pressure, with side effects including peripheral edema, flushing and headaches (Sica, 2006). Nasal decongestants are used to treat symptoms of the common cold and act locally by stimulating alpha-adrenergic receptors reducing oedema and nasal secretions thereby improving breathing (Deckx, et. al., 2016). NSAIDs are not generally thought to impair driving abilities. While some studies have shown somewhat increased crash risk, the true association of NSAIDs and driver impairment have been found to be confounded by coadministration of other pain relief drugs (Hetland & Carr, 2014). See Appendix B for a complete list of drugs we determined are non-impairing.

We deemed drugs as potentially impairing when evidence was mixed on the drugs capacity to impair driving abilities, but the potential for impairment remained. In addition to our own research, we consulted with existing work by NHTSA and the NTSB on potentially impairing drugs and medications (see Figures 2 and 3 below). These included drugs such as anticonvulsants,

antihistamines, antitussives, muscle relaxants, narcotic and opioid analgesics, and selective serotonin reuptake inhibitor (SSRI) antidepressants. Research shows that a one-time recommended dose of an antitussive (i.e., cough suppressant) did not impair driving abilities, but that doses more than the maximum daily recommended dose were needed to show signs of impairment (Perry, et. Al., 2015). Muscle relaxants are associated with increased drowsiness, ataxia, and blurred visions, as well as significantly reduced coordination and reaction time (Hetland & Carr, 2014; LeRoy & Morse, 2008). Opioid analgesics have been shown to double crash risk, but there may be differences in outcomes based on acute versus chronic users (Hetland & Carr, 2014). The evidence for SSRI antidepressants and driving impairment is unclear and conflicting, suggesting crash risks increase only when high doses are taken, but caution should still be exercised when taking the drug (Hetland & Carr, 2014). See Appendix C for a complete list of potentially impairing drugs.

Lastly, we deemed drugs to be impairing when there was clear evidence and understanding of the drugs capacity to impair driving abilities. In compiling this list, we referred to the National Safety Council's list of Tier I and II drugs recommended for drug testing in driving under the influence of drug (DUID) cases and traffic fatalities (D'Orazio, et. al., 2021). Such drugs included benzodiazepines, cannabis, hallucinogens, sedatives, stimulants, and tricyclic antidepressants (TCA). Benzodiazepines may cause weakness, loss of balance, dizziness, and distorted vision (Hetland & Carr, 2014) and have been found to be associated with a 60-80 percent increase in crash risk and a 40 percent increase in 'accident responsibility' (Dassanayake, et. al., 2011). A rapidly growing body of work finds that cannabis intoxication is associated with statistically significant increases in crash risk (Pearlson, et., al., 2021; Rogeberg & Elvik, 2016). Tricyclic antidepressants have been found to increase crash likelihood by 41 percent (LeRoy & Morse, 2008). See Appendix D for a complete list of impairing drugs.

Drug Class	***Possible Effects***
Anti-Diabetic Drugs	Hypoglycemia
Anticholinergics	Blurred vision
Narcotic analgesics	Sedation
Anti-hypertensive drugs	Hypotension
Sedative/Hypnotics	Sedation
Antidepressants	Sedation, dizziness
Allergy drugs	Sedation, dizziness
Anti-arrhythmics	Fainting (syncope)
Anticonvulsants	Ataxia, dizziness, sedation
Skeletal Muscle Relaxants	Dizziness, sedation

Figure 2: NHTSA examples of "potentially driver impairing (PDI)" medications

Source: Multiple Medications and Vehicle Crashes: Analysis of Databases, NHTSA, 2008

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)

Figure 3: NTSB potentially impairing drug categories and subcategories used for drug classification and analysis

Source: Alcohol, Other Drug, and Multiple Drug Use Among Drivers, NTSB, 2022

Remove Non-Impairing and Unrelated Drugs and Substances

We removed 20 drugs and substances that were deemed non-impairing or unrelated to the events of the crash. A drug or substance was deemed to be non-impairing if they did not affect a person's ability to drive a vehicle based on available scientific evidence or method by which the drug affects the body. Examples of non-impairing drugs or substances included caffeine, nicotine, ibuprofen (e.g., Advil), and quinine (i.e., antimalarial treatment). Examples of unrelated drugs or substances included carboxyhemoglobin, which is present in cases of CO_2 inhalation from vehicle fires, naloxone (e.g., Narcan) which is used to treat narcotic overdoses, and midazolam (e.g., Versed) which is a sedative administered by emergency medical services (EMS) personnel. The drugs and substances we removed are listed in the table below.

Table 1: Non-impairing and unrelated drugs and substances removed from drug-positive driver data

1.	Acetaminophen	11.	Levamisole
2.	Amantadine	12.	Midazolam
3.	Benzene	13.	Naloxone
4.	Caffeine	14.	Nicotine/Cotinine
5.	Carboxyhemoglobin	15.	Quinine
6.	Etomidate	16.	Salicylate
7.	Glucose	17.	Tadalafil
8.	Ibuprofen	18.	Theobromine
9.	Ketones	19.	Trimethoprim
10.	Laudanosine	20.	Yohimbine

The figures below demonstrate how removing non-impairing drugs can change a person from being positive for three drugs to being positive for zero drugs. The upper Figure labeled 'Before' shows that the individual was positive for caffeine, ibuprofen, and nicotine. This could be a case of an individual who drank coffee, smoked a cigarette, and took a recommended dose of Advil for pain management. When we removed these three drugs from our drug-positive driver data, this individual was no longer positive for any drugs. As a result, this person no longer appeared in our drug-positive driver data.

Before			
	Result 1	Result 2	Result 3
Person 1	Caffeine	Ibuprofen	Nicotine

After			
	Result 1	Result 2	Result 3
Person 1			

Figure 4: Removal of non-impairing drugs from a drug-positive driver

Remove Non-Active Metabolites when the Parent Drug is Absent from Toxicology Results

When a drug is taken the body quickly begins to metabolize it. This metabolization process can produce active and/or non-active metabolites. An active metabolite begins or continues to have an effect on the body. This would be the case with a person taking codeine that is then metabolized by the body into morphine (i.e., pain reliever). Conversely, a non-active metabolite is one that does not produce any effects on the body. For example, delta-9 THC, the active component of cannabis, is metabolized in the body to carboxy-THC, a non-active metabolite of delta-9 THC.

We removed six different non-active metabolites but only if the parent drug was absent from the toxicology results. These non-active metabolites and their parent drugs are shown in the Table below.

Table 2: List of non-active metabolites removed if parent drug was absent from toxicology results

	Non-active metabolite	Parent drug
1.	Benzoylecgonine	(Cocaine)
2.	Carboxy-THC	(delta-9 THC)
3.	Desmethylloperamide	(Loperamide)
4.	Ecgonine methyl ester	(Cocaine)
5.	Norfentanyl	(Fentanyl)
6.	Ritalinic acid	(Methylphenidate)

Prior to the data updates, a person that tested positive for carboxy-THC and nothing else, would be flagged as being drug-positive, even though carboxy-THC is a non-active metabolite that does not have impairing effects on the body. By removing such instances, we eliminated drug-positive

cases where the driver was positive for non-active metabolites. This method is demonstrated in the Figure below.

Before			
	Result 1	Result 2	Result 3
Person 1	Carboxy-THC		

After			
	Result 1	Result 2	Result 3
Person 1			

Figure 5: Removal of non-active metabolites from a drug-positive driver when the parent drug is absent from the toxicology results

Remove Non-Impairing Pharmaceutical Drugs when Alcohol is not Present

We removed 18 pharmaceutical drugs that were deemed non-impairing, but only if alcohol was not present. This is because any amount of alcohol can interact with pharmaceutical drugs to enhance the effects of the drug or result in other impairing effects that might otherwise be absent if the drug were taken without alcohol and as prescribed by a doctor. The pharmaceutical drugs we removed included anticoagulants, anticonvulsants, antipsychotics, and calcium-channel blockers. These types of pharmaceuticals may improve one's ability to operate a vehicle or reduce crash risk if taken as prescribed by a doctor. The list of non-impairing pharmaceuticals removed are listed in the Table below.

Table 3: Non-impairing pharmaceutical drugs removed from drug-positive driver data when alcohol is absent

	Pharmaceutical drug	Pharmaceutical drug type
1.	Dextromorphan	Antitussive
2.	Diltiazem	Calcium-channel blocker
3.	Glipizide	Sulfonylureas
4.	Levetiracetam	Anticonvulsants
5.	Metformin	Biguanides
6.	Nifedipine	Calcium-channel blocker
7.	Olanzapine	Antipsychotic
8.	Phenytoin	Anticonvulsants
9.	Primidone	Anticonvulsants
10.	Pseudoephedrine	Alpha-adrenergic agonists
11.	Norpseudoephedrine	Alpha-adrenergic agonists
12.	Quetiapine	Antipsychotic
13.	Risperidone	Antipsychotic
14.	9-Hydroxyrisperidone	Antipsychotic
15.	Verapamil	Calcium-channel blocker
16.	Norverapamil	Calcium-channel blocker
17.	Warfarin	Anticoagulant
18.	Zonisamide	Antiepileptic

The Figure below show two different examples of pharmaceutical drugs in toxicology results. The top Figure shows an individual that was positive for warfarin (i.e., anticoagulant) and risperidone (i.e., antipsychotic). Because alcohol was not present along with these pharmaceutical drugs, both drugs were removed. This would result in the individual being positive for zero drugs instead of two.

Before			
	Result 1	Result 2	Result 3
Person 1	Warfarin	Risperidone	

After			
	Result 1	Result 2	Result 3
Person 1			

Figure 6: Removal of non-impairing pharmaceutical drugs when alcohol is absent

The next set of toxicology results shows an individual that tested positive for warfarin (i.e., anticoagulant) and alcohol (any positive BAC level). Because alcohol was present, there could be potential for interactions to occur with the pharmaceutical drug which could lead to enhanced effects of the drug or other impairing effects. Therefore, we would keep warfarin in the results, along with alcohol.

Before			
	Result 1	Result 2	Result 3
Person 1	Warfarin	Alcohol	

After			
	Result 1	Result 2	Result 3
Person 1	Warfarin	Alcohol	

Figure 7: Retention of non-impairing pharmaceuticals when alcohol is present

Match Parent Drugs with their Metabolites

In circumstances where both the parent drug and the metabolite were present, we combined them together to form a parent/metabolite compound. Prior to the data updates, if a driver tested positive for a parent drug and the metabolite of that parent drug, the driver would show as being positive for two separate drugs, when in fact they had only consumed one drug. This could result in inflated poly-drug-positive counts when drivers had only consumed a single drug. In total, we created 39 parent/metabolite compounds which are listed in the table that follows.

Table 4: List of parent/metabolite compounds created

1.	amitriptyline/nortriptyline
2.	alprazolam/alprazolam metabolite
3.	buprenorphine/norbuprenorphine
4.	bupropion/bupropion metabolite
5.	Delta-9 THC/carboxy-THC
6.	Delta-9 THC/11-hydroxy delta-9 THC
7.	Delta-9 THC/carboxy-THC/11-hydroxy delta-9 THC
8.	chlordiazepoxide/nordiazepam
9.	citalopram/desmethylcitalopram
10.	citalopram/norcitalopram
11.	clonazepam/7-aminoclonazepam
12.	cocaine/benzoylecgonine
13.	cocaine/benzoylecgonine/cocaethylene
14.	cocaine/benzoylecgonine/ecgonine methyl ester
15.	cocaine/benzoylecgonine/ecgonine methyl ester/cocaethylene
16.	codeine/morphine
17.	diazepam/nordiazepam
18.	doxepin/desmethyldoxepin
19.	fentanyl/norfentanyl
20.	fluoxetine/norfluoxetine
21.	hydrocodone/dihydrocodeine
22.	hydrocodone/hydromorphone
23.	hydrocodone/dihydrocodeine/hydromorphone
24.	isopropanol/acetone
25.	ketamine/norketamine
26.	lidocaine/monoethylglycinexylidide
27.	methadone/eddp
28.	methamphetamine/amphetamine
29.	oxycodone/oxymorphone
30.	propoxyphene/norpropoxyphene
31.	pseudoephedrine/norpseudoephedrine
32.	risperidone/9-hydroxyrisperidone
33.	sertraline/norsertraline
34.	sertraline/desmethylsertraline
35.	topiramatetopiramate metabolite
36.	tramadol/o-desmethyltramadol

37.	venlafaxine/norvenlafaxine
38.	venlafaxine/o-desmethylvenlafaxine
39.	verapamil/norverapamil

The Figure below shows a driver that was positive for both delta-9 THC and carboxy-THC. Prior to the data updates, this driver tested positive for two separate drugs. After the data updates, this driver was positive for only one parent/metabolite compound, delta-9 THC/carboxy-THC. This is an example of a driver shifting from poly-drug positive to positive for one drug only.

Before

	Result 1	Result 2	Result 3
Person 1	Delta-9 THC	Carboxy-THC	

After

	Result 1	Result 2	Result 3
Person 1	Delta-9 THC/Carboxy-THC		

Figure 8: Combining parent drugs and metabolites into parent/metabolite compounds

Remove Toxicology Screening Results when Confirmatory Results are Present

In a toxicology panel, there can be screening tests and confirmatory tests. Screening tests show whether a type/family of drug is present in the blood sample, whereas a confirmatory test can show the specific drug present, and its concentration in the blood sample. Periodically, screening results appeared throughout our drug-positive driver data. In total, six different screening results showed up in toxicology results. These included: amphetamines, barbiturates, benzodiazepines, cannabinoids, opiates, and tricyclic antidepressants. The Table below shows these screening results along with some examples of specific drugs within each drug category.

Table 5: Examples of screening result drug families and associated confirmatory result specific drugs

	Screening Results	Confirmatory Result Examples
1.	Amphetamines	methamphetamine
		3,4-methylenedioxy methamphetamine (MDMA)
2.	Barbiturates	phentermine
		butalbital
		phenobarbital
3.	Benzodiazepines	alprazolam
		clonazepam
		lorazepam
4.	Cannabinoids	11-hydroxy delta-9 THC
		carboxy-THC
		delta-9 THC
5.	Opiates	codeine
		fentanyl
		oxycodone
6.	Tricyclic antidepressants	amitriptyline
		cyclobenzaprine
		doxepin

The Figure below shows an example where a drug-positive driver was positive for both the screening result, cannabinoids, and the confirmatory results, delta-9 THC. Prior to the data updates, this driver tested positive for two drugs. After the data update, the screening results was removed because the confirmatory results, delta-9 THC, was present. This driver instead switched to being positive for only one drug.

Before

	Result 1	Result 2	Result 3
Person 1	Cannabinoids	Delta-9 THC	

After

	Result 1	Result 2	Result 3
Person 1	Delta-9 THC		

Figure 9: Removing screening results when confirmatory results are present

Alcohol and/or Drug-Positive Drivers Involved in Fatal Crashes after Data Updates

This section will note the changes in alcohol and/or drug positive driver data numbers and trends resulting from the data updates described above. The data in this section refers to drivers that were involved in a fatal crash and that tested positive for alcohol and/or drugs as determined by a toxicology test.

We created three different mutually exclusive alcohol and/or drug categories that a driver could fit into. The first was 'one drug only' which included drivers that were positive for only one drug or a BAC of less than 0.08 and no drugs. The second category was 'alcohol only' which included drivers without any drugs and a BAC of 0.08 or greater. The last category was 'poly-drug' which included drivers with two or more drugs or a combination of any alcohol and one or more drugs. Prior to updating drug-positive driver data, the number of poly-drug-positive drivers involved in fatal crashes had been increasing steadily since 2012. As shown below in Figure 11, the number of poly-drug-positive drivers reached a ten-year high of 221 in 2021. Meanwhile, the number of drivers involved in fatal crashes positive for alcohol only or one drug only remained relatively unchanged over time. In 2021, there were 59 alcohol only positive drivers involved in fatal crashes, and 35 one drug only positive drivers.

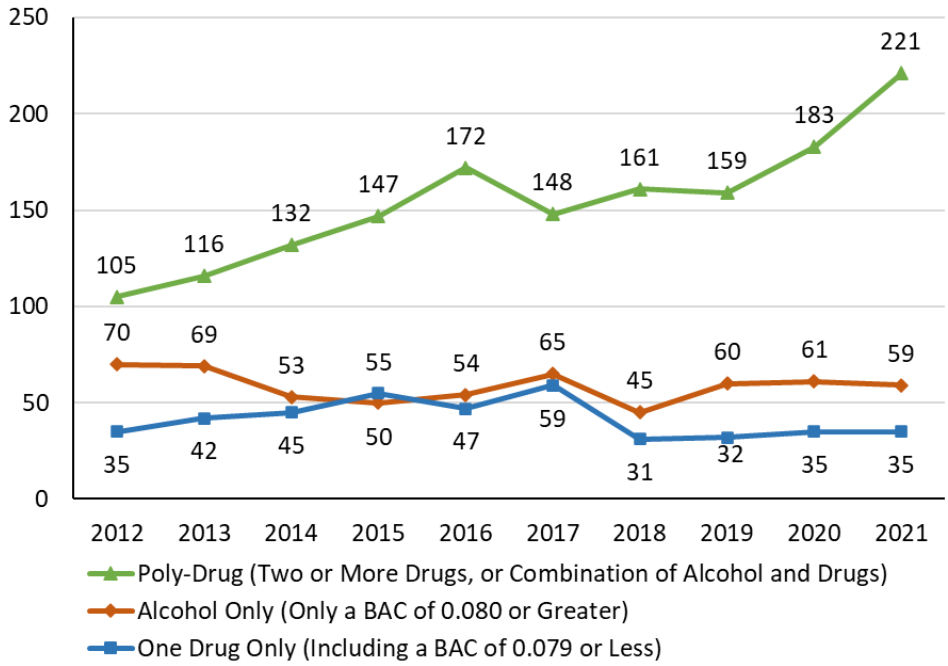

Figure 10: Number of Drivers in Fatal Crashes Positive for Alcohol and/or Drugs (before data updates)

After implementing the drug-positive driver data updates, these patterns shifted. Figure 12 below shows the number of alcohol and/or drug positive drivers involved in fatal crashes *after* the drug data was updated. The poly-drug pattern follows a similar trend to the original data – increasing steadily over time and reaching a ten-year high in 2021. However, in 2021, the number of poly-drug-positive drivers changed from the original data by 30 percent from 221 to 154. The pattern for alcohol only positive drivers remained generally unchanged, but the number changed from the original data by 14 percent in 2021 from 59 to 67. The most change was seen among one drug only positive drivers where the number in 2021 changed from 35 to 70. The decrease in poly-drug numbers and increase in one-drug only numbers reflects an exchange between drug categories as methods like combining parent and metabolite drugs into one drug or removing non-impairing or unrelated drugs reduced the overall number of drugs from multiple to only one. Despite these new findings, poly-drug remained the most prevalent alcohol and/or drug category among drivers in fatal crashes and is rapidly increasing.

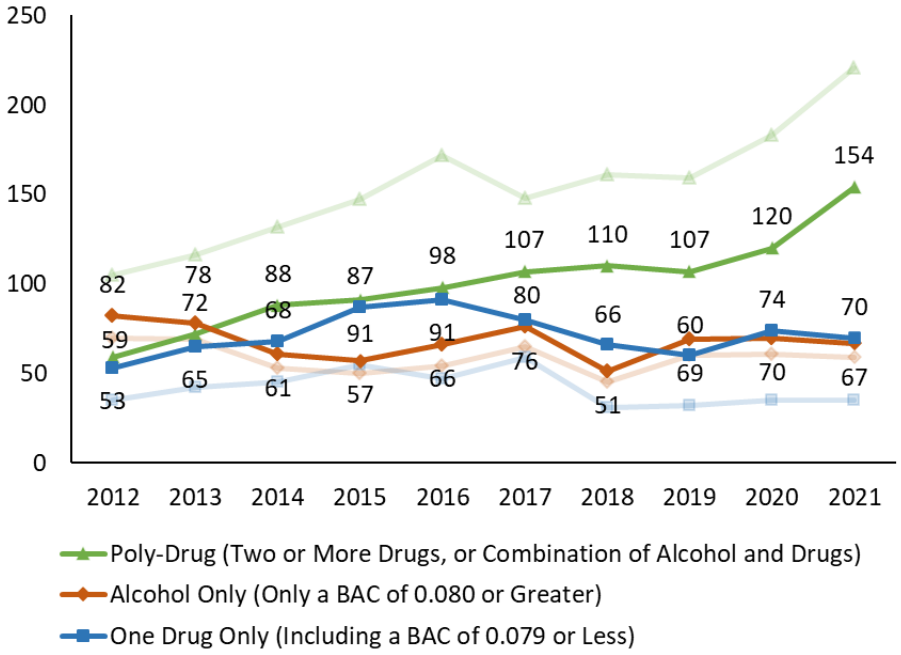

Figure 61: Number of Drivers in Fatal Crashes Positive for Alcohol and/or Drugs (after data updates)

In 2021, there were nearly twice as many poly-drug-positive drivers in fatal crashes than those that were only positive for one drug. Since 2013, the number of poly-drug drivers in fatal crashes has increased by 161 percent. Whereas the number of one-drug-positive drivers in fatal crashes has increased by 32 percent. The jump in poly-drug drivers in 2021 was notable as this number increased by 28 percent from 2020 – the largest year-over-year increase in the past ten years.

The overall number of drivers involved in fatal crashes has increased steadily since 2013, reaching a ten-year high of 952 in 2021. Although the number of drivers involved in fatal crashes has been increasing, the proportion of drivers tested for alcohol and/or drugs has been decreasing over time as shown below in Figure 13. In 2021, about 44 percent of drivers involved in fatal crashes were tested for alcohol and/or drugs. This was a notable decrease from a high of 64 percent in 2013. Despite a decrease in the proportion of drivers tested, the number of alcohol and/or drug-positive drivers has consistently increased, indicating that the increase in alcohol and/or drug-positive drivers is not due to increased testing efforts by law enforcement.

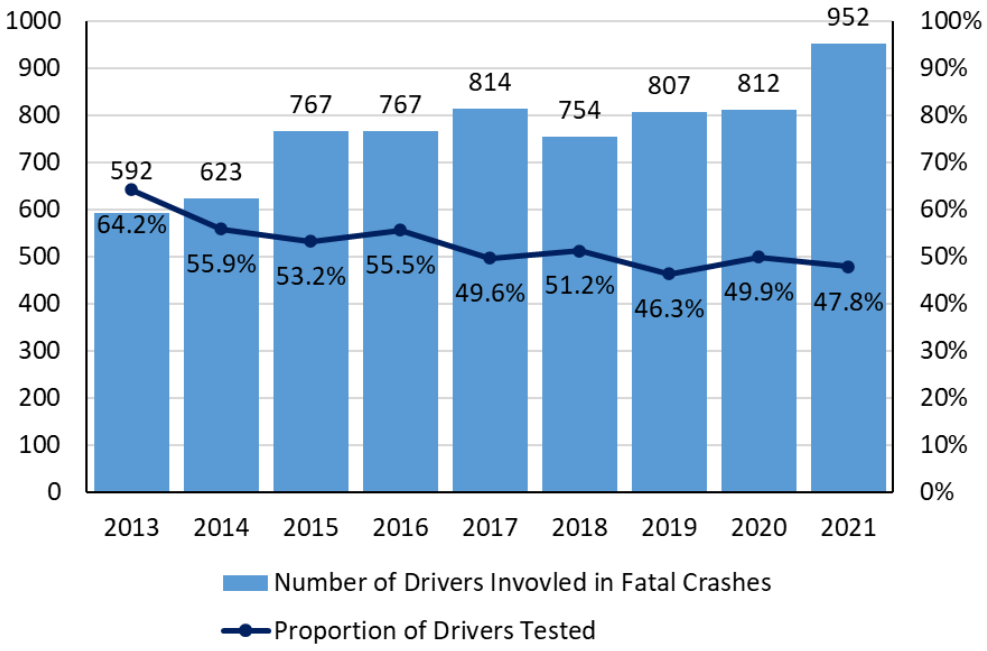

Figure 72: Drivers Involved in Fatal Crashes and Proportion of those Drivers Tested for Drugs and/or Alcohol

Prior to the drug data updates, the original data from 2012-2021 contained 1,875 drug-positive (one or multiple drugs) drivers involved in fatal crashes (see Table 6) and 147 unique drugs that appeared in toxicology results, lending to a total of 586 unique drug combinations observed among drivers. After implementing the updates, the number of drug-positive drivers changed from 1,875 to 1,605. These were likely drivers that were positive for non-impairing or unrelated drugs, or non-active drug metabolites.

Table 6: Descriptive Before and After Drug-Positive Driver Data Update, 2012-2021

	Before	After
Number of Drug-Positive Drivers	1,875	1,605
Number of Unique Drugs	147	127
Number of Unique Drug Combinations	586	428
Number of Drugs		
1	429 (23%)	1,074 (67%)
2	746 (40%)	343 (21%)
3	355 (19%)	117 (7%)
4	155 (8%)	46 (3%)
5	98 (5%)	13 (1%)
6	51 (3%)	5 (<1%)
7	15 (1%)	4 (<1%)
8+	26 (1%)	3 (<1%)

Out of the 1,875 drug-positive drivers in the original data, 40 percent tested positive for two drugs, while nearly one in four (23 percent) tested positive for only one drug, and nearly one in five (19 percent) tested positive for three drugs. The remaining ten percent tested positive for four or more drugs. After the data updates, the majority, or two-thirds of the 1,605 drug-positive drivers tested positive for one drug (67 percent). One in five (21 percent) tested positive for two drugs, seven percent tested positive for three drugs and less than three percent tested positive for four or more drugs.

Among the 1,605 drug-positive drivers in fatal crashes in the updated data, one-third (34 percent) had only forms of cannabis (e.g., delta-9 THC/carboxy-THC; 11-hydroxy delta-9 THC). That is to say that cannabis alone was the most prevalent drug combination among drug-positive drivers. The second most frequent drug combination was forms of methamphetamine alone (e.g., methamphetamine/amphetamine; methamphetamine) with about 13 percent of drug positive drivers testing positive for it. This means 47 percent of drug-positive drivers in fatal crashes were positive for forms of only cannabis or only methamphetamine. All other drugs in an assortment of combinations made up the remaining 53 percent. No other unique drug combination represented more than two percent of the total drug-positive drivers. Table 7 below displays the top 20 most frequent drug combinations among the updated drug-positive driver data.

Table 7: Most Frequent Drug Combinations among Updated Drug-Positive Drivers in Fatal Crashes, 2012-2021

Drug Combinations	Frequency	Percent
Delta-9 THC/carboxy-THC	477	29.72
methamphetamine/amphetamine	157	9.78
delta-9 THC/carboxy-THC/11-hydroxy delta-9 THC	61	3.8
methamphetamine	46	2.87
delta-9 THC/carboxy-THC & methamphetamine/amphetamine	37	2.31
citalopram	30	1.87
morphine	21	1.31
delta-9 THC/carboxy-THC & methamphetamine	18	1.12
diphenhydramine	16	1.00
methamphetamine/amphetamine & morphine	15	0.93
fluoxetine/norfluoxetine	14	0.87
amphetamine	12	0.75
oxycodone	12	0.75
cocaine/benzoylecgonine	11	0.69
hydromorphone	10	0.62
sertraline/desmethylsertraline	10	0.62
trazodone	10	0.62
hydrocodone	9	0.56
delta-9 THC/carboxy-THC & oxycodone	9	0.56
delta-9 THC/carboxy-THC/11-hydroxy delta-9 THC & methamphetamine/amphetamine	9	0.56
Total	1,605	100.00

This section now adds drivers positive for alcohol only into the drug-positive driver data, adding an additional 792 drivers. In total, there were 2,397 (792 alcohol only, 1,605 drug and/or alcohol) drivers in fatal crashes in the updated data that were positive for alcohol and/or drugs from 2012-2021. As shown below in Table 8, alcohol only ranked number one in the most frequent alcohol and drug combinations with one-third (33 percent) of alcohol and/or drug-positive drivers testing positive for alcohol only. This was followed by alcohol and delta-9 THC/carboxy-THC which 12 percent of drivers tested positive for, and then delta-9 THC/carboxy-THC alone with eight percent, and methamphetamine/amphetamine with five percent. See Appendix E for a complete list of the alcohol and drug combinations among drivers. This shows that among alcohol and/or drug positive drivers involved in fatal crashes, alcohol by far is the most prevalent drug followed by delta-9 THC, and the two combined are also highly prevalent compared to other drug combinations.

Table 8: Most Frequent Alcohol and Drug Combinations among Updated Drug-Positive Drivers in Fatal Crashes, 2012-2021

Alcohol and Drug Combinations	Frequency	Percent
alcohol	792	33.04
alcohol & delta-9 THC/carboxy-THC	278	11.6
delta-9 THC/carboxy-THC	199	8.3
methamphetamine/amphetamine	126	5.26
alcohol & delta-9 THC/carboxy-THC/11-hydroxy delta-9 THC	39	1.63
methamphetamine	36	1.5
alcohol & methamphetamine/amphetamine	31	1.29
delta-9 THC/carboxy-THC & methamphetamine/amphetamine	26	1.08
delta-9 THC/carboxy-THC/11-hydroxy delta-9 THC	22	0.92
alcohol & citalopram	15	0.63
citalopram	15	0.63
methamphetamine/amphetamine & morphine	15	0.63
morphine	14	0.58
alcohol & delta-9 THC/carboxy-THC & methamphetamine/amphetamine	11	0.46
diphenhydramine	11	0.46
delta-9 THC/carboxy-THC & methamphetamine	11	0.46
alcohol & methamphetamine	10	0.42
fluoxetine/norfluoxetine	10	0.42
trazodone	10	0.42
hydromorphone	9	0.38
Total	2,397	100.00

Limitations

Currently, about half of CFC fatal crashes are linked with EMS data which provides information on the drugs administered by emergency personnel. Efforts are underway to improve CFC linkages with EMS data. This will reduce the risk of misreporting emergency drugs as drugs influencing driving performance.

The body quickly begins metabolizing drugs in the body once they are consumed. Therefore, it is imperative to get a blood draw as soon as possible after a crash has occurred to get an accurate measurement of drug concentration in the blood sample. Otherwise, there is a risk of not detecting a certain drug at all, or not at its peak level when the driver was operating the vehicle.

For example, delta-9 THC is metabolized into carboxy-THC within a few hours or less (Sharma, et. al., 2012). If a delta-9 THC-positive driver does not get a blood draw until five hours after the crash, they may only test positive for the non-active metabolite carboxy-THC. Thus, there would not be evidence that the person was impaired by delta-9 THC at the time of the crash. For our drug-positive driver data update we elected to remove carboxy-THC from the data when it appeared alone without delta-9 THC present. While carboxy-THC may be our best evidence for recent delta-9 THC use, it does not guarantee it, and because carboxy-THC is non-active, we opted for the more conservative data approach to hamper over-estimation.

As noted by the NTSB, there is no standardized categorization of drugs in traffic safety. We recognize that our approach may differ from other agencies in attempting to categorize impairing, potentially impairing, and non-impairing drugs. This is particularly challenging given the limited and inconclusive evidence of the effects of various drugs on driving performance. We used what existing evidence we could find or otherwise determined a drug's potential for impairment based on our best understanding of how the drug affects the body. We consider our approach to be conservative, as we often aired on the side of caution and retained drugs that may not have carried a high risk of influencing driver performance but lacked evidence that they did not. For these reasons, we consider our work to be a novel approach and hope that others can use it as a foundation to make determinations at their own local levels.

Summary and Conclusions

Poly-drug-positive drivers are a serious and growing concern on Washington roadways. The recent surge in poly-drug drivers should be a call to action, and with that call comes a need for reliable, quality data to inform decisions. The contents of this report detail the WTSC's efforts to improve our drug-positive driver data to better understand the prevalence of and contributions to drug-positive driving. The WTSC has done this by:

- Removing non-impairing and unrelated drugs and substances.
- Removing non-active metabolites when the parent drug is absent from toxicology results.
- Removing non-impairing pharmaceutical drugs when alcohol is not present.
- Matching parent drugs with their metabolites.
- Removing toxicology screening results when confirmatory results are present.

These updates to our driver data have resulted in changes to drug, alcohol, and poly-drug driving numbers. Overall, the number of poly-drug drivers was reduced each year from 2012-2021 as non-impairing drugs were removed and drug metabolites were combined with their parent drugs, shifting drivers from poly-drug positive to being positive for one drug only. Among only alcohol-positive drivers, the number of drivers rose slightly each year, but generally did not

change substantially. Of particular concern was the rapid rise in poly-drug-positive drivers in 2021 – a ten-year high.

Improving our drug data helps us to better understand the prevalence of drug-positive driving to support enforcement of DUI laws, guide educational campaigns and educational materials, assist in crash investigations, and inform substance abuse professionals to help treat forms of substance abuse. The methods presented here for drivers will also be applied to all road user fatalities for whom toxicology information is available, which can contribute to larger conversations of substance abuse and misuse. New drugs are constantly emerging, whether pharmaceutical or illicit. For this reason, our work to re-evaluate drugged driving is ongoing. This will require constant identification and assessment of the impairing and influencing properties of new drugs as they appear in our toxicology data going forward.

While testing positive for drugs does not imply impairment, we have eliminated many non-impairing drugs and taken a step closer towards identifying those drivers that were likely influenced by drugs. This has been and continues to be a challenge for traffic safety professionals, law enforcement, prosecutors and communities. The NTSB recommends "standardized drug testing and reporting to improve our understanding of the prevalence of drug use among crash-involved drivers and drivers arrested for impaired driving" (NTSB, 2022). The WTSC hopes this novel approach contributes to foundational efforts to better understand drug-impaired driving by providing a roadmap to identify potentially impairing drugs while weeding out other non-impairing or unrelated drugs. More research is needed to better understand the prevalence of drugged and poly-drug driving in the U.S. and how different drugs and combinations of drugs can impair driving performance.

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Appendix A:

List of All Drugs Included in the Updated Driver Data

10-hydroxycarbazepine	hydroxyzine
11-hydroxy delta-9 THC	imipramine
4-anpp	isopropanol
6-acetylmorphine	ketamine
6-monoacetylmorphine	ketamine/norketamine
7-aminoclonazepam	lamotrigine
acetyl fentanyl	levetiracetam
alprazolam	lidocaine
alprazolam/alpha hydroxyalprazolam	lorazepam
alprazolam/alprazolam metabolite	lysergic acid diethylamide (LSD)
amitriptyline	Mcpp
amitriptyline/nortriptyline	3,4-Methylenedioxymethamphetamine (MDMA)
amlodipine	meperidine
amphetamine	meprobamate
aripiprazole	methadone
baclofen	methadone/eddp
benzodiazepines	methamphetamine
buprenorphine/norbuprenorphine	methamphetamine/amphetamine
bupropion	methanol
bupropion/hydroxybupropion	methocarbamol
butalbital	methylphenidate
cannabinoids	methylphenidate/ritalinic acid
carbamazepine	metoprolol
carisoprodol	mirtazapine
cetirizine	mitragynine
chlordiazepoxide/nordiazepam	morphine
chlorpheniramine	norbuprenorphine
citalopram	nordiazepam
clonazepam	norketamine
clonazepam/7-aminoclonazepam	norsertraline
clonidine	nortriptyline
cocaethylene	o-desmethylvenlafaxine
cocaine/benzoylecgonine	olanzapine
cocaine/benzoylecgonine/cocaethylene	opiates
codeine	oxazepam
codeine/morphine	oxycodone
cyanide	oxycodone/oxymorphone
cyclobenzaprine	paroxetine

desalkylflurazepam	phencyclidine
desipramine	phenobarbital
desmethylsertraline	phentermine
diazepam	phenylpropanolamine
diazepam/nordiazepam	primidone/plenylethylmalonamide
difluoroethane	promethazine
diphenhydramine	risperidone/9-hydroxyrisperidone
doxepin/desmethyldoxepin	sertraline/desmethylsertraline
doxylamine	sertraline/norsertraline
duloxetine	sevoflurane
ephedrine	synthetic cannabinoid
fentanyl	temazepam
fentanyl/norfentanyl	delta-9 THC/11-hydroxy delta-9 THC
flualprazolam	delta-9 THC/carboxy-THC
flubromazolam	delta-9 THC/carboxy-THC/11-hydroxy delta-9 THC
fluoxetine	topiramate
fluoxetine/norfluoxetine	topiramate/topiramate metabolite
gabapentin	tramadol
hydrocodone	tramadol/o-desmethyltramadol
hydrocodone/dihydrocodeine	trazodone
hydrocodone/dihydrocodeine/hydromorphone	venlafaxine
hydrocodone/hydromorphone	venlafaxine/o-desmethylvenlafaxine
hydromorphone	xylazine
hydroxybupropion	zolpidem

Appendix B:

List of Non-Impairing and Unrelated Drugs Removed from Drug-Positive Driver Data

acetaminophen
amantadine
benzene
caffeine
carboxyhemoglobin
etomidate
glucose
ibuprofen
ketones
laudanosine
levamisole
midazolam
naloxone
nicotine/cotinine
quinine
salicylate
tadalafil
theobromine
trimethoprim
yohimbine

Appendix C:

List of Potentially Impairing Drugs

4-anpp	meperidine
10-hydroxycarbazepine	meprobamate
acetyl fentanyl	methadone
acetone	methanol
amantadine	methocarbamol
baclofen	methylphenidate
buprenorphine	metoclopramide
norbuprenorphine	metoprolol
bupropion	mitragynine
bupropion metabolite	norcitalopram
buspirone	norfluoxetine
cetirizine	norketamine
chlorpheniramine	norpropoxyphene
citalopram	norsertraline
clonidine	norvenlafaxine
codeine	o-desmethyltramadol
cyanide	o-desmethylvenlafaxine
desipramine	olanzapine
desmethylcitalopram	orphenadrine
desmethylsertraline	oxcarbazepine
diphenhydramine	paroxetine
doxylamine	phentermine
duloxetine	phenylpropanolamine
eddp	phenytoin
ephedrine	promethazine
fluoxetine	propoxyphene
gabapentin	sertraline
guaifenesin	topiramate
hydrocodone	topiramate metabolite
hydromorphone	trazodone
hydroxyzine	tramadol
imipramine	valproic acid
isopropanol	venlafaxine
lamotrigine	zonisamide
lidocaine	
monoethylglycinexylidide	
mcpp	
meclizine	

Appendix D:

List of Impairing Drugs

11-hydroxy delta-9 THC	ketamine
6-acetylmorphine	ketamine/norketamine
6-monoacetylmorphine	levetiracetam
7-aminoclonazepam	lidocaine
alprazolam	lorazepam
alprazolam/alpha hydroxyalprazolam	lysergic acid diethylamide (LSD)
alprazolam/alprazolam metabolite	3,4-Methylenedioxymethamphetamine (MDMA)
amitriptyline	methamphetamine
amitriptyline/nortriptyline	methamphetamine/amphetamine
amlodipine	methylphenidate
amphetamine	methylphenidate/ritalinic acid
aripiprazole	mirtazapine
benzodiazepines	morphine
cannabinoids	norbuprenorphine
carbamazepine	nordiazepam
carisoprodol	nortriptyline
chlordiazepoxide/nordiazepam	opiates
clonazepam	oxazepam
clonazepam/7-aminoclonazepam	oxycodone
cocaethylene	oxycodone/oxymorphone
cocaine/benzoylecgonine	phencyclidine
cocaine/benzoylecgonine/cocaethylene	phenobarbital
codeine/morphine	primidone/plenylethylmalonamide
cyclobenzaprine	risperidone/9-hydroxyrisperidone
delta-9 THC	sevoflurane
desalkylflurazepam	synthetic cannabinoid
diazepam	tadalafil
diazepam/nordiazepam	temazepam
difluoroethane	delta-9 THC/11-hydroxy delta-9 THC
doxepin/desmethyldoxepin	delta-9 THC/carboxy-THC
fentanyl	delta-9 THC/carboxy-THC/11-hydroxy delta-9 THC
fentanyl/norfentanyl	tramadol/o-desmethyltramadol
flualprazolam	trazodone
flubromazolam	xylazine
hydroxybupropion	zolpidem

Appendix E:

List of Unique Alcohol and Drug Combinations among Drug-Positive Drivers in Fatal Crashes after Data Updates. 2012-2021

Unique Alcohol and Drug Combinations, 2012-2021	Frequency	Percent
alcohol	792	33.04
alcohol & delta-9 THC/carboxy-THC	278	11.60
delta -9 THC/carboxy-THC	199	8.30
methamphetamine/amphetamine	126	5.26
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC	39	1.63
methamphetamine	36	1.50
alcohol & methamphetamine/amphetamine	31	1.29
delta -9 THC/carboxy-THC & methamphetamine/amphetamine	26	1.08
delta -9 THC/carboxy-THC/11-hydroxy THC	22	0.92
alcohol & citalopram	15	0.63
citalopram	15	0.63
methamphetamine/amphetamine & morphine	15	0.63
morphine	14	0.58
alcohol & delta -9 THC/carboxy-THC & methamphetamine/amphetamine	11	0.46
diphenhydramine	11	0.46
delta -9 THC/carboxy-THC & methamphetamine	11	0.46
alcohol & methamphetamine	10	0.42
fluoxetine/norfluoxetine	10	0.42
trazodone	10	0.42
hydromorphone	9	0.38
alcohol & cocaine/benzoylecgonine/cocaethylene	8	0.33
amphetamine	8	0.33
hydrocodone	8	0.33
alcohol & morphine	7	0.29
alcohol & oxycodone	7	0.29
alcohol & delta -9 THC/carboxy-THC & methamphetamine	7	0.29
ketamine/norketamine	7	0.29
lidocaine	7	0.29
sertraline/desmethylsertraline	7	0.29
delta -9 THC/carboxy-THC/11-hydroxy THC & methamphetamine/amphetamine	7	0.29

tramadol	7	0.29
cocaine/benzoylecgonine	6	0.25
difluoroethane	6	0.25
methamphetamine/amphetamine & ephedrine & phenylpropanolamine	6	0.25
methamphetamine/amphetamine & phenylpropanolamine	6	0.25
delta -9 THC/carboxy-THC & oxycodone	6	0.25
alcohol & cocaethylene	5	0.21
alcohol & cocaine/benzoylecgonine	5	0.21
alcohol & diphenhydramine	5	0.21
alcohol & methamphetamine/amphetamine & delta -9 THC/carboxy-THC	5	0.21
codeine/morphine & methamphetamine/amphetamine	5	0.21
methamphetamine & morphine	5	0.21
oxycodone	5	0.21
alcohol & amphetamine	4	0.17
alcohol & diazepam/nordiazepam	4	0.17
alcohol & fluoxetine/norfluoxetine	4	0.17
alcohol & mdma	4	0.17
alcohol & delta -9 THC/carboxy-THC & cocaine/benzoylecgonine/cocaethylene	4	0.17
alcohol & delta -9 THC/carboxy-THC & morphine	4	0.17
diazepam	4	0.17
diazepam/nordiazepam	4	0.17
ketamine	4	0.17
delta-9 THC/carboxy-THC & methadone	4	0.17
delta-9 THC/carboxy-THC & morphine	4	0.17
zolpidem	4	0.17
alcohol & ketamine	3	0.13
alcohol & methadone	3	0.13
alcohol & methamphetamine & morphine	3	0.13
alcohol & sertraline/desmethylsertraline	3	0.13
alcohol & delta-9 THC/carboxy-THC & amphetamine	3	0.13
alcohol & delta-9 THC/carboxy-THC & citalopram	3	0.13
alcohol & delta-9 THC/carboxy-THC & mdma	3	0.13
alcohol & delta-9 THC/carboxy-THC & oxycodone	3	0.13
alcohol & venlafaxine	3	0.13
amitriptyline/nortriptyline	3	0.13
amlodipine	3	0.13

cocaine/benzoylecgonine & methamphetamine/amphetamine	3	0.13
fentanyl	3	0.13
fentanyl/norfentanyl & methamphetamine/amphetamine	3	0.13
fentanyl/norfentanyl & methamphetamine/amphetamine & 4-anpp	3	0.13
hydrocodone/hydromorphone	3	0.13
3,4-Methylenedioxymethamphetamine (MDMA)	3	0.13
methamphetamine/amphetamine & ephedrine & phenylpropanolamine & delta-9 THC/carboxy-THC	3	0.13
phentermine	3	0.13
delta -9 THC/carboxy-THC & amphetamine	3	0.13
delta -9 THC/carboxy-THC & citalopram	3	0.13
delta -9 THC/carboxy-THC & fluoxetine/norfluoxetine	3	0.13
delta -9 THC/carboxy-THC & methamphetamine/amphetamine & morphine	3	0.13
venlafaxine	3	0.13
11-hydroxy THC	2	0.08
alcohol & alprazolam	2	0.08
alcohol & buprenorphine/norbuprenorphine	2	0.08
alcohol & diazepam	2	0.08
alcohol & hydrocodone/dihydrocodeine	2	0.08
alcohol & methamphetamine/amphetamine & phenylpropanolamine	2	0.08
alcohol & delta -9 THC/11-hydroxy THC	2	0.08
alcohol & delta -9 THC/carboxy-THC & cocaine/benzoylecgonine	2	0.08
alcohol & delta -9 THC/carboxy-THC & methamphetamine/amphetamine & citalopram	2	0.08
alcohol & delta -9 THC/carboxy-THC & mitragynine	2	0.08
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & fentanyl	2	0.08
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & methamphetamine/amphetamine	2	0.08
alcohol & venlafaxine/o-desmethylvenlafaxine	2	0.08
alprazolam	2	0.08
bupropion	2	0.08
bupropion & citalopram	2	0.08

codeine/morphine & methamphetamine/amphetamine & 6-monoacetylmorphine	2	0.08
cyclobenzaprine	2	0.08
diazepam/nordiazepam & methamphetamine/amphetamine	2	0.08
diphenhydramine & hydrocodone	2	0.08
doxylamine	2	0.08
fluoxetine/norfluoxetine & trazodone	2	0.08
lamotrigine	2	0.08
lorazepam	2	0.08
lorazepam & morphine	2	0.08
methadone	2	0.08
methamphetamine/amphetamine & ketamine	2	0.08
metoprolol	2	0.08
oxycodone/oxymorphone	2	0.08
phencyclidine	2	0.08
phenobarbital	2	0.08
sertraline/desmethylsertraline & trazodone	2	0.08
delta -9 THC/carboxy-THC & cocaine/benzoylecgonine	2	0.08
delta -9 THC/carboxy-THC & codeine/morphine & methamphetamine/amphetamine	2	0.08
delta -9 THC/carboxy-THC & diazepam/nordiazepam & methamphetamine/amphetamine	2	0.08
delta -9 THC/carboxy-THC & lorazepam	2	0.08
delta -9 THC/carboxy-THC & methamphetamine/amphetamine & ephedrine & phenylpropanolamine	2	0.08
delta -9 THC/carboxy-THC & sertraline/desmethylsertraline	2	0.08
tramadol & zolpidem	2	0.08
10-hydroxycarbazepine	1	0.04
11-hydroxy THC & amlodipine & metoprolol	1	0.04
6-acetylmorphine & diphenhydramine & morphine	1	0.04
7-aminoclonazepam	1	0.04
7-aminoclonazepam & alprazolam	1	0.04
7-aminoclonazepam & alprazolam & mdma	1	0.04
7-aminoclonazepam & citalopram & methadone & morphine	1	0.04
7-aminoclonazepam & hydrocodone	1	0.04

7-aminoclonazepam & lamotrigine & venlafaxine	1	0.04
7-aminoclonazepam & nordiazepam	1	0.04
alcohol & 11-hydroxy THC	1	0.04
alcohol & 7-aminoclonazepam & amitriptyline & methamphetamine	1	0.04
alcohol & 7-aminoclonazepam & venlafaxine	1	0.04
alcohol & alprazolam & hydrocodone & zolpidem	1	0.04
alcohol & amitriptyline/nortriptyline & fluoxetine/norfluoxetine & oxycodone	1	0.04
alcohol & amitriptyline/nortriptyline & oxycodone	1	0.04
alcohol & amlodipine & citalopram	1	0.04
alcohol & amlodipine & metoprolol & phentermine	1	0.04
alcohol & amphetamine & benzodiazepines & methadone & delta -9 THC/carboxy-THC	1	0.04
alcohol & amphetamine & levetiracetam	1	0.04
alcohol & amphetamine & phenylpropanolamine	1	0.04
alcohol & buprenorphine/norbuprenorphine & levetiracetam	1	0.04
alcohol & buprenorphine/norbuprenorphine & delta -9 THC/carboxy-THC	1	0.04
alcohol & bupropion	1	0.04
alcohol & bupropion & citalopram	1	0.04
alcohol & bupropion/hydroxybupropion & fluoxetine/norfluoxetine	1	0.04
alcohol & bupropion/hydroxybupropion & delta -9 THC/carboxy-THC/11-hydroxy THC & amlodipine	1	0.04
alcohol & butalbital & promethazine	1	0.04
alcohol & cannabinoids	1	0.04
alcohol & chlordiazepoxide/nordiazepam	1	0.04
alcohol & chlordiazepoxide/nordiazepam & sertraline/norsertraline & 7-aminoclonazepam & citalopram	1	0.04
alcohol & chlorpheniramine	1	0.04
alcohol & citalopram & cyclobenzaprine & doxylamine	1	0.04
alcohol & citalopram & diphenhydramine	1	0.04
alcohol & citalopram & topiramate	1	0.04
alcohol & citalopram & tramadol	1	0.04
alcohol & clonazepam/7-aminoclonazepam & trazodone	1	0.04

alcohol & cocaine/benzoylecgonine & ketamine & mitragynine	1	0.04
alcohol & cocaine/benzoylecgonine/cocaethylene & citalopram	1	0.04
alcohol & cocaine/benzoylecgonine/cocaethylene & mdma	1	0.04
alcohol & cocaine/benzoylecgonine/cocaethylene & methadone & oxycodone	1	0.04
alcohol & cocaine/benzoylecgonine/cocaethylene & methamphetamine/amphetamine	1	0.04
alcohol & cyclobenzaprine & duloxetine	1	0.04
alcohol & desipramine & imipramine	1	0.04
alcohol & diazepam/nordiazepam & citalopram	1	0.04
alcohol & diazepam/nordiazepam & fluoxetine/norfluoxetine	1	0.04
alcohol & diazepam/nordiazepam & oxazepam & temazepam	1	0.04
alcohol & diazepam/nordiazepam & oxycodone	1	0.04
alcohol & diazepam/nordiazepam & venlafaxine	1	0.04
alcohol & diphenhydramine & doxylamine	1	0.04
alcohol & diphenhydramine & doxylamine & nordiazepam	1	0.04
alcohol & diphenhydramine & trazodone	1	0.04
alcohol & doxylamine	1	0.04
alcohol & doxylamine & metoprolol	1	0.04
alcohol & duloxetine & ketamine & delta -9 THC/carboxy-THC	1	0.04
alcohol & fentanyl	1	0.04
alcohol & fentanyl & delta -9 THC/carboxy-THC	1	0.04
alcohol & fluoxetine/norfluoxetine & bupropion & diazepam & lorazepam & morphine & oxazepam & temazepam & trazodone	1	0.04
alcohol & fluoxetine/norfluoxetine & methylphenidate	1	0.04
alcohol & gabapentin	1	0.04
alcohol & gabapentin & hydroxyzine	1	0.04
alcohol & hydrocodone	1	0.04
alcohol & hydrocodone & methadone	1	0.04
alcohol & hydrocodone & morphine & trazodone	1	0.04
alcohol & hydrocodone & delta -9 THC/carboxy-THC	1	0.04
alcohol & hydrocodone/hydromorphone	1	0.04

alcohol & hydromorphone	1	0.04
alcohol & hydromorphone & morphine	1	0.04
alcohol & hydroxyzine	1	0.04
alcohol & isopropanol	1	0.04
alcohol & ketamine & delta -9 THC/carboxy-THC	1	0.04
alcohol & ketamine/norketamine	1	0.04
alcohol & methamphetamine & oxazepam & temazepam & delta -9 THC/carboxy-THC	1	0.04
alcohol & methamphetamine & delta -9 THC/carboxy-THC	1	0.04
alcohol & methamphetamine/amphetamine & ephedrine	1	0.04
alcohol & methamphetamine/amphetamine & hydrocodone	1	0.04
alcohol & metoprolol	1	0.04
alcohol & mitragynine	1	0.04
alcohol & nordiazepam	1	0.04
alcohol & nortriptyline & phenobarbital	1	0.04
alcohol & oxycodone/oxymorphone	1	0.04
alcohol & paroxetine	1	0.04
alcohol & sertraline/desmethylsertraline & hydrocodone	1	0.04
alcohol & sertraline/desmethylsertraline & nortriptyline	1	0.04
alcohol & sertraline/desmethylsertraline & zolpidem	1	0.04
alcohol & sevoflurane	1	0.04
alcohol & delta -9 THC/carboxy-THC & 7-aminoclonazepam & amphetamine	1	0.04
alcohol & delta -9 THC/carboxy-THC & amphetamine & citalopram	1	0.04
alcohol & delta -9 THC/carboxy-THC & amphetamine & mdma	1	0.04
alcohol & delta -9 THC/carboxy-THC & bupropion & citalopram & diphenhydramine	1	0.04
alcohol & delta -9 THC/carboxy-THC & butalbital	1	0.04
alcohol & delta -9 THC/carboxy-THC & cetirizine & citalopram & hydroxyzine	1	0.04
alcohol & delta -9 THC/carboxy-THC & clonazepam/7-aminoclonazepam & alprazolam & zolpidem	1	0.04

alcohol & delta -9 THC/carboxy-THC & clonazepam/7-aminoclonazepam & diphenhydramine	1	0.04
alcohol & delta -9 THC/carboxy-THC & cocaine/benzoylecgonine & alprazolam	1	0.04
alcohol & delta -9 THC/carboxy-THC & cocaine/benzoylecgonine/cocaethylene & hydrocodone & oxycodone	1	0.04
alcohol & delta -9 THC/carboxy-THC & cocaine/benzoylecgonine/cocaethylene & methamphetamine	1	0.04
alcohol & delta -9 THC/carboxy-THC & codeine/morphine & 6-acetylmorphine & methadone	1	0.04
alcohol & delta -9 THC/carboxy-THC & desmethylsertraline	1	0.04
alcohol & delta -9 THC/carboxy-THC & diazepam/nordiazepam & alprazolam	1	0.04
alcohol & delta -9 THC/carboxy-THC & diazepam/nordiazepam & hydrocodone & oxazepam & temazepam & tramadol	1	0.04
alcohol & delta -9 THC/carboxy-THC & diazepam/nordiazepam & oxycodone	1	0.04
alcohol & delta -9 THC/carboxy-THC & diphenhydramine	1	0.04
alcohol & delta -9 THC/carboxy-THC & fluoxetine/norfluoxetine	1	0.04
alcohol & delta -9 THC/carboxy-THC & fluoxetine/norfluoxetine & amphetamine & olanzapine	1	0.04
alcohol & delta -9 THC/carboxy-THC & hydrocodone	1	0.04
alcohol & delta -9 THC/carboxy-THC & hydromorphone & morphine	1	0.04
alcohol & delta -9 THC/carboxy-THC & ketamine	1	0.04
alcohol & delta -9 THC/carboxy-THC & ketamine/norketamine	1	0.04
alcohol & delta -9 THC/carboxy-THC & ketamine/norketamine & oxycodone	1	0.04
alcohol & delta -9 THC/carboxy-THC & lorazepam	1	0.04
alcohol & delta -9 THC/carboxy-THC & lorazepam & oxycodone	1	0.04
alcohol & delta -9 THC/carboxy-THC & methadone	1	0.04

alcohol & delta -9 THC/carboxy-THC & methamphetamine/amphetamine & difluoroethane	1	0.04
alcohol & delta -9 THC/carboxy-THC & methamphetamine/amphetamine & ephedrine	1	0.04
alcohol & delta -9 THC/carboxy-THC & methamphetamine/amphetamine & nordiazepam	1	0.04
alcohol & delta -9 THC/carboxy-THC & methanol	1	0.04
alcohol & delta -9 THC/carboxy-THC & sertraline/desmethylsertraline	1	0.04
alcohol & delta -9 THC/carboxy-THC & topiramate/topiramate metabolite & amphetamine	1	0.04
alcohol & delta -9 THC/carboxy-THC & tramadol	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & amlodipine	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & aripiprazole & hydroxybupropion & hydroxyzine	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & cocaine/benzoylecgonine/cocaethylene	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & diazepam/nordiazepam	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & fentanyl/norfentanyl	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & hydrocodone & norbuprenorphine	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & ketamine	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & methamphetamine/amphetamine & phenylpropanolamine	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & risperidone/9-hydroxyrisperidone & fentanyl	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & sertraline/desmethylsertraline	1	0.04
alcohol & delta -9 THC/carboxy-THC/11-hydroxy THC & trazodone	1	0.04
alcohol & tramadol	1	0.04
alcohol & tramadol & venlafaxine	1	0.04
alcohol & tramadol/o-desmethyltramadol & citalopram & doxylamine & methamphetamine & trazodone	1	0.04

alcohol & venlafaxine/o-desmethylvenlafaxine & hydroxyzine	1	0.04
alcohol & zolpidem	1	0.04
alprazolam & cyclobenzaprine & hydrocodone & oxycodone	1	0.04
alprazolam & diphenhydramine	1	0.04
alprazolam & diphenhydramine & oxycodone	1	0.04
alprazolam & hydrocodone	1	0.04
alprazolam/alpha hydroxyalprazolam & delta -9 THC/carboxy-THC/11-hydroxy THC & chlorpheniramine	1	0.04
alprazolam/alprazolam metabolite & 7-aminoclonazepam & methadone	1	0.04
alprazolam/alprazolam metabolite & diazepam/nordiazepam & clonazepam & oxycodone	1	0.04
amantadine	1	0.04
amitriptyline	1	0.04
amitriptyline & lorazepam	1	0.04
amitriptyline/nortriptyline & diphenhydramine & topiramate	1	0.04
amitriptyline/nortriptyline & fluoxetine/norfluoxetine & zolpidem	1	0.04
amitriptyline/nortriptyline & hydrocodone	1	0.04
amitriptyline/nortriptyline & hydrocodone/dihydrocodeine/hydromorphone & gabapentin & methocarbamol & zolpidem	1	0.04
amitriptyline/nortriptyline & metoprolol	1	0.04
amitriptyline/nortriptyline & morphine & oxycodone & tramadol	1	0.04
amlodipine & metoprolol	1	0.04
amlodipine & delta -9 THC/carboxy-THC	1	0.04
baclofen	1	0.04
benzodiazepines	1	0.04
buprenorphine/norbuprenorphine	1	0.04
buprenorphine/norbuprenorphine & diazepam/nordiazepam & lorazepam & oxazepam	1	0.04
buprenorphine/norbuprenorphine & fentanyl/norfentanyl & morphine & delta -9 THC/carboxy-THC	1	0.04
buprenorphine/norbuprenorphine & ketamine	1	0.04

buprenorphine/norbuprenorphine & methamphetamine/amphetamine	1	0.04
buprenorphine/norbuprenorphine & methamphetamine/amphetamine & ephedrine & phenylpropanolamine	1	0.04
buprenorphine/norbuprenorphine & delta -9 THC/carboxy-THC	1	0.04
buprenorphine/norbuprenorphine & delta -9 THC/carboxy-THC & amphetamine	1	0.04
buprenorphine/norbuprenorphine & delta -9 THC/carboxy-THC & clonazepam/7-aminoclonazepam & methamphetamine/amphetamine & gabapentin	1	0.04
buprenorphine/norbuprenorphine & delta -9 THC/carboxy-THC & fentanyl/norfentanyl & methamphetamine/amphetamine & 4-anpp & hydromorphone & morphine	1	0.04
buprenorphine/norbuprenorphine & delta -9 THC/carboxy-THC & ketamine/norketamine & flualprazolam & nordiazepam	1	0.04
buprenorphine/norbuprenorphine & delta -9 THC/carboxy-THC/11-hydroxy THC	1	0.04
buprenorphine/norbuprenorphine & delta -9 THC/carboxy-THC/11-hydroxy THC & fentanyl/norfentanyl & 4-anpp & citalopram & clonidine & diphenhydramine & hydroxyzine	1	0.04
bupropion & cyclobenzaprine & tramadol	1	0.04
bupropion & morphine	1	0.04
bupropion & trazodone	1	0.04
bupropion & venlafaxine	1	0.04
bupropion/hydroxybupropion & trazodone	1	0.04
carbamazepine	1	0.04
carbamazepine & phenobarbital	1	0.04
carisoprodol & hydrocodone & meprobamate	1	0.04
chlordiazepoxide/nordiazepam & citalopram	1	0.04
chlordiazepoxide/nordiazepam & methamphetamine/amphetamine & morphine	1	0.04
citalopram & difluoroethane	1	0.04
citalopram & doxylamine	1	0.04
citalopram & ketamine	1	0.04
citalopram & methadone & oxycodone	1	0.04

citalopram & oxycodone	1	0.04
citalopram & trazodone	1	0.04
clonazepam/7-aminoclonazepam	1	0.04
clonazepam/7-aminoclonazepam & alprazolam & morphine	1	0.04
clonazepam/7-aminoclonazepam & diazepam/nordiazepam & oxycodone	1	0.04
clonazepam/7-aminoclonazepam & lorazepam & methamphetamine & morphine & nordiazepam	1	0.04
clonazepam/7-aminoclonazepam & paroxetine	1	0.04
cocaine/benzoylecgonine & diazepam/nordiazepam & oxycodone/oxymorphone	1	0.04
cocaine/benzoylecgonine & fentanyl/norfentanyl & 4-anpp & acetyl fentanyl & carisoprodol & meprobamate & methamphetamine	1	0.04
cocaine/benzoylecgonine & fentanyl/norfentanyl & 4-anpp & diphenhydramine	1	0.04
cocaine/benzoylecgonine & methadone	1	0.04
cocaine/benzoylecgonine & oxycodone & delta -9 THC/carboxy-THC	1	0.04
cocaine/benzoylecgonine & delta -9 THC/carboxy-THC	1	0.04
cocaine/benzoylecgonine/cocaethylene & ketamine	1	0.04
cocaine/benzoylecgonine/cocaethylene & delta -9 THC/carboxy-THC	1	0.04
codeine	1	0.04
codeine & hydrocodone	1	0.04
codeine & delta -9 THC/carboxy-THC & tramadol	1	0.04
codeine & venlafaxine	1	0.04
codeine/morphine	1	0.04
codeine/morphine & 6-acetylmorphine	1	0.04
codeine/morphine & 6-acetylmorphine & hydromorphone & methamphetamine	1	0.04
codeine/morphine & 6-acetylmorphine & methamphetamine	1	0.04
codeine/morphine & alprazolam & methamphetamine	1	0.04
codeine/morphine & diazepam/nordiazepam & methamphetamine/amphetamine & 6-monoacetylmorphine	1	0.04

codeine/morphine & fentanyl/norfentanyl & methamphetamine/amphetamine	1	0.04
codeine/morphine & methadone/eddp	1	0.04
codeine/morphine & methadone/eddp & methamphetamine/amphetamine & ephedrine & phenylpropanolamine	1	0.04
codeine/morphine & methamphetamine/amphetamine & 6-acetylmorphine	1	0.04
codeine/morphine & methamphetamine/amphetamine & 6-monoacetylmorphine & ephedrine & hydromorphone & norbuprenorphine & phenylpropanolamine	1	0.04
codeine/morphine & methamphetamine/amphetamine & ephedrine & hydromorphone & phenylpropanolamine	1	0.04
codeine/morphine & methamphetamine/amphetamine & hydromorphone	1	0.04
codeine/morphine & methamphetamine/amphetamine & hydromorphone & metoprolol	1	0.04
codeine/morphine & methamphetamine/amphetamine & methadone	1	0.04
codeine/morphine & methamphetamine/amphetamine & DELTA-9 THC/carboxy-THC	1	0.04
cyanide	1	0.04
cyclobenzaprine & difluoroethane & diphenhydramine	1	0.04
cyclobenzaprine & gabapentin & oxycodone	1	0.04
desalkylflurazepam	1	0.04
diazepam/nordiazepam & 7-aminoclonazepam & bupropion & citalopram & oxycodone & tramadol	1	0.04
diazepam/nordiazepam & alprazolam	1	0.04
diazepam/nordiazepam & alprazolam & methadone	1	0.04
diazepam/nordiazepam & carbamazepine & oxazepam & temazepam	1	0.04
diazepam/nordiazepam & citalopram & lorazepam & metoprolol	1	0.04

diazepam/nordiazepam & fluoxetine/norfluoxetine & meprobamate & morphine & oxycodone	1	0.04
diazepam/nordiazepam & gabapentin & hydromorphone & morphine & temazepam & trazodone & venlafaxine & zolpidem	1	0.04
diazepam/nordiazepam & hydrocodone/hydromorphone & cyclobenzaprine & lorazepam & oxycodone & temazepam	1	0.04
diazepam/nordiazepam & lamotrigine	1	0.04
diazepam/nordiazepam & phentermine	1	0.04
diphenhydramine & doxylamine	1	0.04
diphenhydramine & doxylamine & fentanyl & mitragynine	1	0.04
diphenhydramine & fentanyl & hydrocodone	1	0.04
diphenhydramine & hydrocodone & lorazepam	1	0.04
diphenhydramine & methamphetamine	1	0.04
diphenhydramine & temazepam	1	0.04
doxepin/desmethyldoxepin & methamphetamine/amphetamine & hydroxyzine	1	0.04
duloxetine	1	0.04
fentanyl & hydromorphone	1	0.04
fentanyl/norfentanyl	1	0.04
fentanyl/norfentanyl & 4-anpp & diazepam & fluoxetine	1	0.04
fentanyl/norfentanyl & methamphetamine/amphetamine & 4-anpp & ephedrine & flualprazolam & phenylpropanolamine	1	0.04
fentanyl/norfentanyl & methamphetamine/amphetamine & 4-anpp & morphine	1	0.04
fentanyl/norfentanyl & methamphetamine/amphetamine & 4-anpp & xylazine	1	0.04
fentanyl/norfentanyl & methamphetamine/amphetamine & 7-aminoclonazepam & alprazolam & flubromazolam & nordiazepam	1	0.04
fentanyl/norfentanyl & methamphetamine/amphetamine & butalbital	1	0.04

fentanyl/norfentanyl & methamphetamine/amphetamine & carisoprodol & hydrocodone & meprobamate	1	0.04
fentanyl/norfentanyl & methamphetamine/amphetamine & morphine	1	0.04
fentanyl/norfentanyl & delta -9 THC/carboxy-THC	1	0.04
fluoxetine & tramadol	1	0.04
fluoxetine/norfluoxetine & amphetamine & bupropion & lamotrigine	1	0.04
fluoxetine/norfluoxetine & bupropion	1	0.04
fluoxetine/norfluoxetine & doxylamine	1	0.04
fluoxetine/norfluoxetine & hydrocodone	1	0.04
fluoxetine/norfluoxetine & oxycodone	1	0.04
gabapentin	1	0.04
hydrocodone & meperidine	1	0.04
hydrocodone & methadone & methamphetamine	1	0.04
hydrocodone & morphine	1	0.04
hydrocodone & nordiazepam & zolpidem	1	0.04
hydrocodone/dihydrocodeine & diphenhydramine	1	0.04
hydrocodone/hydromorphone & carisoprodol & meprobamate & methadone & trazodone	1	0.04
hydrocodone/hydromorphone & zolpidem	1	0.04
hydromorphone & lidocaine & morphine	1	0.04
hydromorphone & lorazepam & phenobarbital & trazodone	1	0.04
hydromorphone & morphine	1	0.04
hydromorphone & morphine & oxazepam	1	0.04
ketamine & lamotrigine & mitragynine	1	0.04
ketamine/norketamine & diphenhydramine	1	0.04
lidocaine & phentermine	1	0.04
lidocaine & venlafaxine	1	0.04
lorazepam & mcpp & mitragynine & nordiazepam	1	0.04
lysergic acid diethylamide (LSD)	1	0.04
methadone & oxycodone	1	0.04
methamphetamine & opiates	1	0.04
methamphetamine/amphetamine & 7-aminoclonazepam & morphine	1	0.04
methamphetamine/amphetamine & amlodipine & ephedrine	1	0.04
methamphetamine/amphetamine & citalopram	1	0.04
methamphetamine/amphetamine & ephedrine	1	0.04

methamphetamine/amphetamine & fentanyl	1	0.04
methamphetamine/amphetamine & fentanyl & gabapentin & lorazepam	1	0.04
methamphetamine/amphetamine & hydrocodone	1	0.04
methamphetamine/amphetamine & isopropanol	1	0.04
methamphetamine/amphetamine & lamotrigine	1	0.04
methamphetamine/amphetamine & morphine & oxycodone	1	0.04
methamphetamine/amphetamine & morphine & phenylpropanolamine & delta -9 THC/carboxy-THC	1	0.04
methamphetamine/amphetamine & norketamine	1	0.04
methamphetamine/amphetamine & phencyclidine & delta -9 THC/carboxy-THC	1	0.04
methamphetamine/amphetamine & phenylpropanolamine & delta -9 THC/carboxy-THC	1	0.04
methamphetamine/amphetamine & delta -9 THC/carboxy-THC	1	0.04
methamphetamine/amphetamine & venlafaxine/o-desmethylvenlafaxine	1	0.04
methamphetamine/amphetamine & zolpidem	1	0.04
methanol	1	0.04
methylphenidate	1	0.04
methylphenidate/ritalinic acid	1	0.04
methylphenidate/ritalinic acid & venlafaxine/o-desmethylvenlafaxine & lamotrigine	1	0.04
metoprolol & mirtazapine	1	0.04
mitragynine	1	0.04
morphine & nordiazepam	1	0.04
morphine & nortriptyline & oxycodone	1	0.04
morphine & oxycodone & delta -9 THC/carboxy-THC	1	0.04
morphine & phencyclidine	1	0.04
nordiazepam	1	0.04
nordiazepam & zolpidem	1	0.04
norsertraline	1	0.04
nortriptyline	1	0.04
nortriptyline & trazodone	1	0.04
o-desmethylvenlafaxine	1	0.04
oxycodone & paroxetine & trazodone	1	0.04
oxycodone & tramadol	1	0.04
oxycodone & trazodone	1	0.04
oxycodone & zolpidem	1	0.04

oxycodone/oxymorphone & carisoprodol & meprobamate	1	0.04
phentermine & topiramate	1	0.04
primidone/plenylethylmalonamide & phenobarbital	1	0.04
sertraline/desmethylsertraline & hydrocodone	1	0.04
sertraline/desmethylsertraline & lorazepam & trazodone	1	0.04
sertraline/desmethylsertraline & methamphetamine & morphine	1	0.04
sertraline/desmethylsertraline & tramadol/o-desmethyltramadol & desipramine & imipramine	1	0.04
sevoflurane	1	0.04
synthetic cannabinoid	1	0.04
temazepam & tramadol	1	0.04
delta -9 THC/11-hydroxy THC & 7-aminoclonazepam & aripiprazole & cyclobenzaprine & carboxy-THC & gabapentin & lamotrigine	1	0.04
delta -9 THC/11-hydroxy THC & paroxetine	1	0.04
delta -9 THC/carboxy-THC & 7-aminoclonazepam & amphetamine & bupropion & oxycodone	1	0.04
delta -9 THC/carboxy-THC & 7-aminoclonazepam & morphine	1	0.04
delta -9 THC/carboxy-THC & alprazolam	1	0.04
delta -9 THC/carboxy-THC & alprazolam & methadone	1	0.04
delta -9 THC/carboxy-THC & alprazolam & methadone & methamphetamine	1	0.04
delta -9 THC/carboxy-THC & alprazolam & oxycodone	1	0.04
delta -9 THC/carboxy-THC & alprazolam & tramadol	1	0.04
delta -9 THC/carboxy-THC & aripiprazole	1	0.04
delta -9 THC/carboxy-THC & bupropion	1	0.04
delta -9 THC/carboxy-THC & butalbital	1	0.04
delta -9 THC/carboxy-THC & citalopram & gabapentin	1	0.04
delta -9 THC/carboxy-THC & cocaine/benzoylecgonine & methamphetamine	1	0.04
delta -9 THC/carboxy-THC & codeine/morphine & hydromorphone	1	0.04

delta -9 THC/carboxy-THC & diazepam/nordiazepam & fentanyl/norfentanyl & oxycodone/oxymorphone & alprazolam	1	0.04
delta -9 THC/carboxy-THC & diazepam/nordiazepam & oxycodone	1	0.04
delta -9 THC/carboxy-THC & difluoroethane & hydrocodone	1	0.04
delta -9 THC/carboxy-THC & diphenhydramine	1	0.04
delta -9 THC/carboxy-THC & diphenhydramine & lamotrigine & morphine	1	0.04
delta -9 THC/carboxy-THC & doxylamine	1	0.04
delta -9 THC/carboxy-THC & fentanyl	1	0.04
delta -9 THC/carboxy-THC & fentanyl/norfentanyl	1	0.04
delta -9 THC/carboxy-THC & gabapentin	1	0.04
delta -9 THC/carboxy-THC & lamotrigine & mirtazapine	1	0.04
delta -9 THC/carboxy-THC & lidocaine	1	0.04
delta -9 THC/carboxy-THC & lorazepam & morphine	1	0.04
delta -9 THC/carboxy-THC & mdma	1	0.04
delta -9 THC/carboxy-THC & methadone & morphine	1	0.04
delta -9 THC/carboxy-THC & methadone & zolpidem	1	0.04
delta -9 THC/carboxy-THC & methamphetamine/amphetamine & hydrocodone & oxycodone & phenylpropanolamine	1	0.04
delta -9 THC/carboxy-THC & methamphetamine/amphetamine & methadone	1	0.04
delta -9 THC/carboxy-THC & methamphetamine/amphetamine & phenylpropanolamine	1	0.04
delta -9 THC/carboxy-THC & methamphetamine/amphetamine & sertraline/desmethylsertraline & oxycodone	1	0.04
delta -9 THC/carboxy-THC & promethazine	1	0.04
delta -9 THC/carboxy-THC & trazodone	1	0.04
delta -9 THC/carboxy-THC & venlafaxine/o-desmethylvenlafaxine & bupropion & diphenhydramine	1	0.04
delta -9 THC/carboxy-THC & zolpidem	1	0.04
delta -9 THC/carboxy-THC/11-hydroxy THC & alprazolam	1	0.04

delta -9 THC/carboxy-THC/11-hydroxy THC & cocaine/benzoylecgonine & methamphetamine/amphetamine	1	0.04
delta -9 THC/carboxy-THC/11-hydroxy THC & codeine/morphine & methamphetamine/amphetamine & hydromorphone	1	0.04
delta -9 THC/carboxy-THC/11-hydroxy THC & duloxetine & gabapentin	1	0.04
delta -9 THC/carboxy-THC/11-hydroxy THC & fentanyl/norfentanyl & methamphetamine/amphetamine & 4-anpp	1	0.04
delta -9 THC/carboxy-THC/11-hydroxy THC & fentanyl/norfentanyl & methamphetamine/amphetamine & oxycodone/oxymorphone	1	0.04
delta -9 THC/carboxy-THC/11-hydroxy THC & lamotrigine	1	0.04
delta -9 THC/carboxy-THC/11-hydroxy THC & metoprolol	1	0.04
delta -9 THC/carboxy-THC/11-hydroxy THC & nordiazepam	1	0.04
delta -9 THC/carboxy-THC/11-hydroxy THC & venlafaxine/o-desmethylvenlafaxine	1	0.04
trazodone & venlafaxine	1	0.04
venlafaxine/o-desmethylvenlafaxine	1	0.04