WHITE PAPER

The MX908 Advantage in the Presence of Cutting Agents

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Executive summary

The MX908 is a rapid and reliable field technology that provides first responders with the ability to detect drugs of abuse at trace levels in mixtures with minimal concern for false alarms due to the presence of cutting agents. 296 samples were analyzed with a combined false alarm rate of 1.4%. With Reachback analysis, or manual spectra review provided by 908 Devices, the false alarm rate was observed to be 0.0%.

Introduction

Street samples of drugs, such as cocaine, heroin, and fentanyl, almost always contain cutting agents which are additional chemical compounds meant to increase the bulk amount of sample sold (Figure 1). There are two main types of cutting agents defined by the effect the cutting agent has on the end user. Adulterants (i.e. lidocaine, phenacetin, and caffeine) are cutting agents that are biologically active, meaning they have a physiological effect upon the user. Diluents (i.e. mannitol, lactose, and inositol) are cutting agents that do not have any associated biological effects and are often chosen to replicate the physical appearance of a drug, such as bulking a cocaine sample with baby powder.

Adulterants include scheduled and non-scheduled drugs and can be tailored to either mimic the physiological effect of the drug or to counter a negative side effect, providing a seemingly more enjoyable user experience. For example, adding lidocaine to cocaine increases its numbing effect, adding diphenhydramine to cocaine reduces nasal discharge, and adding cocaine to fentanyl (referred to as a "speedball") allows a user to experience the high of an opioid while remaining awake and energized.

Common adulterants and diluents can have adverse effects on illicit drug users[2–6]. For example, phenacetin is commonly detected in cocaine samples, however, it was removed from the drug market by the FDA due to its carcinogenicity and damaging effects on users' kidneys[6].

The presence of the adulterant xylazine in seized drug samples, especially fentanyl samples, has become increasingly common over the past several years. While used to cut illicit drugs, xylazine transcends the properties of a traditional adulterant, and poses a higher threat to drug users and law enforcement, as it acts synergistically with fentanyl or heroin, increasing the overall effect when used together versus using individually. This increases the chance of an overdose, and between 2018 and 2021, there was a 3,300% increase in reported xylazine-involved drug overdose deaths in the United States[7]. The presence of cutting agents within street drugs is not a new occurrence, however, it is becoming more prevalent, and, in some cases, more dangerous. Figure 2 demonstrates the most common cutting agents in the United States and worldwide between 2018 and 2021.

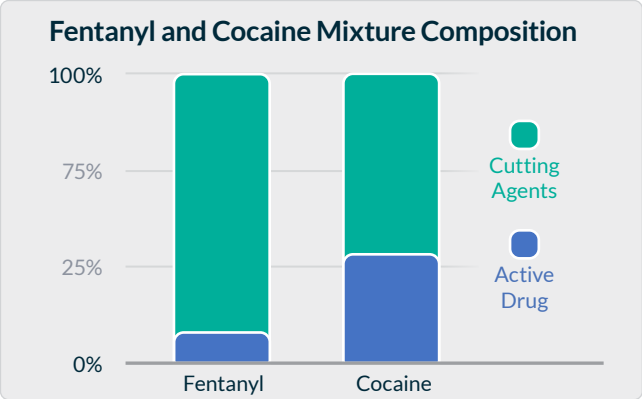

Figure 1. The average fentanyl purity of the 219 samples tested was 11.7%, and the average cocaine purity was 37.8%[1]

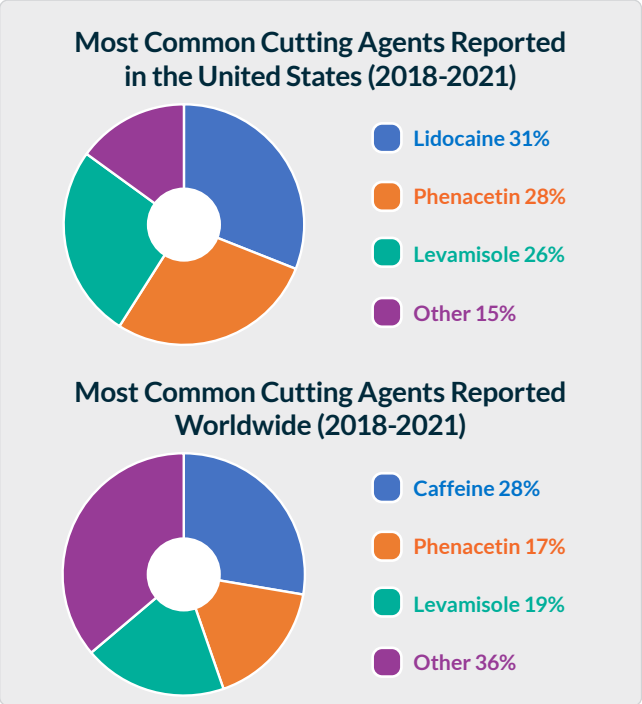

Figure 2. Most common cutting agents reported in the US and worldwide to The Center for Forensic Science Research and Education (CFSRE) between 2018 and 2021.[8]

Both in the field and in the laboratory, colorimetric tests are used to presumptively identify certain drug classes. However, the presence of cutting agents can cause false positives or false negatives with some colorimetric tests, affecting legal processes. False positives can occur because the tests lack the specificity necessary to distinguish between structurally related compounds. For example, cutting agents such as lidocaine, procaine, and quinine are known to cause false positives with the Scott reagent, which is commonly used in color tests to indicate the presence of cocaine[9-10]. False negatives can occur if too much sample is added to the test. For example, adding over the recommended amount of suspected cocaine to the reagent, even if cocaine is present, is known to cause false negatives[9-10]. Determination of color is also subjective, leading to differing assessments of colorimetric test kit results among users.

The high rate of false results on colorimetric test kits demonstrates the need for more accurate field testing technologies to provide higher confidence in results. The MX908 is a handheld chemical detector that leverages the specificity and sensitivity of high-pressure mass spectrometry to detect drugs, explosives, chemical warfare agents, and toxic industrial chemicals. It provides law enforcement officials worldwide with the ability to identify narcotics and other chemical compounds at trace (residues or low concentration samples) and bulk levels by comparing unknown samples to an on-device library of targets.

Methods

The cutting agents analyzed to assess the specificity of the MX908 are listed in Table 1. Testing was conducted using the "Drug Hunter" Mission Mode, which compares samples introduced into the MX908 to a library of only drug or drug-related targets. Preliminary testing of each compound at varying signal intensities was performed using manufacturer specified sampling techniques to reduce the possibility of contamination. Further testing involved collecting data in triplicate at low, medium, and high signal intensity ranges. A blank sample was run in-between different cutting agents to ensure the system was clean.

Table 1. Cutting agents analyzed with the MX908

Cutting Agents	Commonly Used to Cut
Acetaminophen	Fentanyl, heroin
Acetylsalicylic acid	Heroin
Atropine	Cocaine
Benzocaine	Cocaine
Caffeine	Heroin, cocaine, methamphetamine, MDMA
Diphenhydramine	Fentanyl, heroin
Hydroxyzine	Cocaine
Levamisole	Cocaine
Lidocaine	Cocaine
Procaine	Cocaine
Quinine	Fentanyl, heroin
Thiamine	Heroin
Xylazine	Fentanyl, cocaine

Results and Discussion

False alarm rates

As demonstrated in Figure 3, each compound was analyzed at least 12 times. Following each test, the MX908 provided an alarm and/or an alert for a drug

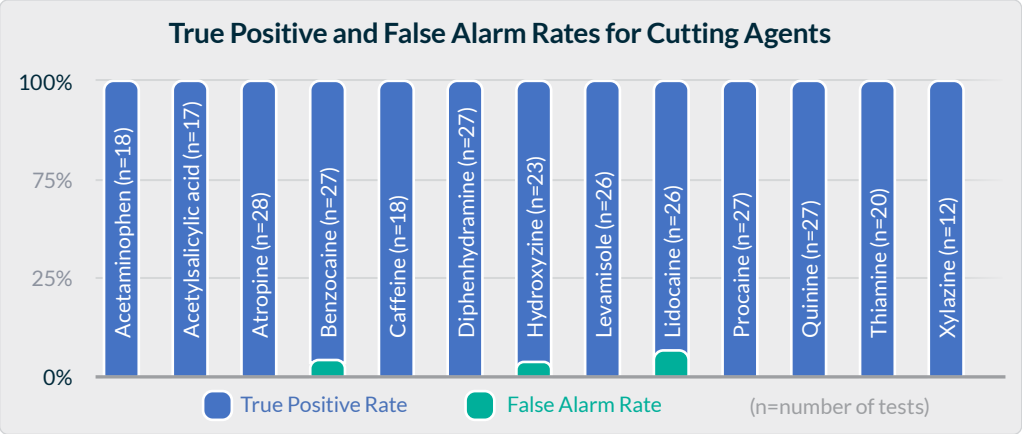

Figure 3. Each compound was tested at least 12 times on the MX908. 10 of the 13 tested compounds did not produce false alarms. The false alarm rates for benzocaine, hydroxyzine, and lidocaine were 3.7%, 4.3%, and 7.7%, respectively.

target or a "No Target Detected" result. Alarms indicate that the sample was consistent with a target at a high level of confidence, while alerts indicate that the sample was consistent with a target at a lower level of confidence. 10 of the 13 tested compounds did not produce any false alarms. The false alarm rate for each of the remaining three compounds—benzocaine, hydroxyzine, and lidocaine—was 3.7%, 4.3%, and 7.7%, respectively.

Spectral review

False alarms resulted from unidentified chemical components within the data and contamination. Multiple unidentified chemical components were observed in some tests of hydroxyzine and lidocaine and caused the false alarms noted in Figure 3. These components were not observed in the blanks prior to each cutting agent. Furthermore, these additional components were only observed on one MX908. One test for benzocaine produced a false alarm for caffeine. Upon review, two chemical components were observed in the data, consistent with benzocaine and caffeine. As the caffeine data set was analyzed prior to the benzocaine data set, it is likely that contamination was the source of the false alarm. While the false alarm rates for benzocaine, hydroxyzine, and lidocaine at time of analysis were 3.7%, 4.3%, and 7.7%, respectively, with Reachback analysis, the false alarm rates dropped to 0.0%.

Conclusions

Law enforcement encounters a variety of drug presentations: bulk drugs, trace residues, and low concentrations, but most drug samples will contain cutting agents. The MX908 is a rapid and reliable field technology that provides first responders with the ability to detect drugs of abuse at trace levels in mixtures with minimal concern for false alarms due to the presence of cutting agents. In addition to the high-confidence analysis of the MX908 in the field, the raw data collected by the MX908 allows 908 Devices' team of Forensic Chemists to greater distinguish between cutting agents and controlled substances on Reachback and provide valuable information regarding the composition of unknown samples.

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