Laboratory Results Interpretation
Updated April 2025

Similarly Useful Documents:
Complementary 'Laboratory Results Interpretation' Canva Document
Quantitative Laboratory Results Interpretation
Complementary 'Quantitative Laboratory Results Interpretation' Canva Document
FTIR Component Designations Guidelines

Background on Laboratory Testing
Laboratories utilize various instruments to analyze drug samples sent in by community partners.

All instrumentation/testing techniques are complementary to one another as no one individual instrument can provide perfect drug checking results. The instruments used by the laboratory are more sensitive than point of care technologies and allow for identification of active substances at very low concentrations.

Some laboratories offering drug checking analysis for community programs include (list is not exhaustive):

U.S. based:
- CFSRE [Center for Forensic Science Research & Education]
- UNC [University of North Carolina]
- NIST [National Institute of Standards Technology]
- Notre Dame
- RIH [Rhode Island Hospital]
- CSL [Connecticut State Lab]
- UCSF [University of California - San Francisco]
- CDPH [California Department of Public Health]
- DrugsData

International:
- Substance (Vancouver)
- Health Canada (Ontario)
- Portugal/Europe laboratories (Kykeon)

There are many instruments used by these labs but most samples on StreetCheck are associated with either GC/MS or LC/QToF/MS.

Laboratory Results Reporting Summary
Laboratory results only report on the active components contained in a sample. They don't typically test for or report any sugars, fillers, binders (lactose, cellulose, etc) or other inactive components. The qualitative results and semi-quantitative ratios from labs therefore report the active components relative to each other and **do not** represent a quantification of the entire sample. The following are summaries of the types of results reported by the laboratories that conduct testing for drug checking programs.

Qual - Qualitative

Qualitative results indicate the relative presence of active components in a sample using qualitative descriptors without providing exact quantities. There are three ways qualitative results are reported. See Figure 1 for a table of this information.

1. Major, Minor, Trace Active Component
   - Commonly used by RIH and CSL
   - Major/Minor/Trace designations are with respect to the intensity of the most abundant active component. Major is considered 30% - 100% intensity of the most abundant active component peak. Minor is considered 10%-29% relative to the most intense active component peak. Trace is considered below 10% peak intensity of primary abundant active component peak.

2. Primary or Trace Active Component
   - Commonly used by UNC and CDPH
   - Primary indicates that the substance is the most abundant active component identified. Primary is considered 10-100% intensity of the most abundant active component peak. Trace is considered below 10% peak intensity of primary abundant active component peak.

3. Absence/Presence of Active Component
   - Commonly used by NIST
   - Confirms that active substances are present in a sample and does not give any indication of the relative presence of the substances with respect to one another.

Semi-Quant - Semi-Quantitative

Semi-Quant results assign a relative ratio to each active substance identified. The numbers/ratios from the semi-quant results **do not** indicate concentrations of active components and **do not** represent the entire makeup of the sample. The relative ratio assigned to the substance is derived from the relative peak height/intensity detected by the instrument and pertains to active components only. There are two options for reporting semi-quant results:

1) The smallest component is set to a ratio of 1. The relative abundance of each component is with relation to the smallest component.
   a) DrugsData has a great interpretation of results for semi-quantitative reporting/interpretation in this manner on their website.
   b) The recorded chromatogram of a sample measuring the abundance of the separated substances is reviewed and the heights and sizes of the peaks are estimated. The smallest component is identified and given a ratio designation of 1. The remaining active components are given ratios in relation to the smallest component (relative ratio of 1) based on intensity of the signals produced from the other components.
   c) A peak double the size of the smallest component will be assigned a relative ratio of 2. Substances that are less than 10% of the smallest component (ratio of 1) are reported as trace.

2) A ‘Primary Drug’ is identified and set to a relative ratio of 1
   a) CFSRE assigns relative ratio values to substances with respect to the ‘Primary Drug’ in a sample when reporting semi-quant results.
      i) The ‘Primary Drug’ is the most abundant active substance from the list in Figure 3.
      ii) The ‘Primary Drug’ is NOT always the most abundant active substance in a sample.

iii) Since the ‘Primary Drug’ is not always the most abundant active substance, other active components might have a ratio greater than, equal to, or less than 1.

iv) Please note that we have chosen to remove decimals for ease of reporting and interpretation of results. All results will be cleaned to remove any decimals to provide the smallest whole number values possible.

- Case Scenario 1:
  - Methamphetamine and caffeine are identified in a sample via laboratory testing. Methamphetamine is on the ‘Primary Drug’ list while Caffeine is not. Therefore, methamphetamine will have a relative ratio set to 1.
  - The relative ratio of Methamphetamine to Caffeine is determined as Methamphetamine (1) | Caffeine (2.5)
  - The result from above [Methamphetamine (1) | Caffeine (2.5)] will then be cleaned to appear as whole numbers only.
    - The reported laboratory values will appear on StreetCheck as: Methamphetamine (10) | Caffeine (25)
- Case Scenario 2:
  - Fentanyl, Heroin and Xylazine are identified in a sample via laboratory testing. Both Fentanyl and Heroin are on the ‘Primary Drug’ list while Xylazine is not. Therefore, whichever substance is more abundant (Fentanyl or Heroin) will have a relative ratio set to 1 and the less abundant substance will be set to a ratio less than 1.
  - The relative ratio of Fentanyl to Heroin to Xylazine is determined by the laboratory as: Fentanyl (1) | Heroin (0.7) | Xylazine (2.3)
  - The result from above [Fentanyl (1) | Heroin (0.7) | Xylazine (2.3)] will then be cleaned to appear as whole numbers only.
    - The reported laboratory values will appear on StreetCheck as: Fentanyl (10) | Heroin (7) | Xylazine (23)
- Case Scenario 3:
  - Fentanyl and Carfentanil are identified in a sample via laboratory testing. Both Fentanyl and Carfentanil are on the ‘Primary Drug’ list. Therefore, whichever substance is more abundant (Fentanyl or Carfentanil) will have a relative ratio set to 1 and the less abundant substance will be set to a ratio less than 1.
  - The relative ratio of Fentanyl to Carfentanil is determined as: Fentanyl (1) | Carfentanil (0.2)
  - The result from above [Fentanyl (1) | Carfentanil (0.2)] will then be cleaned to show whole numbers only.
  - The laboratory values will be cleaned to appear as whole values: Fentanyl (10) | Carfentanil (2)
    - The whole values are not the simplest whole values possible so the StreetCheck laboratory results will be cleaned and appear as: Fentanyl (5) | Carfentanil (1)

b) Please see Figure 2 for another example of the ‘Primary Drug’ reporting when multiple active components are present in a sample.

Quant - Quantitative

Quant results provide quantified results in the form of percentages of some of the active components identified in a sample relative to overall composition of the sample. Samples of enough substance are massed on an analytical balance to complete the calculation. These results are indicative of concentrations of an identified

substance within a sample. For example: “the sample submitted is 5% fentanyl.” Quant results will not report inactive components. Please refer to the Quantitative Laboratory Results Interpretation document for which substances are able to be quantified and more information related to this reporting method.

[QTOF]* - (Quadrupole time of flight)
In a set of sample results, “QTOF” as reported by CFSRE indicates that the active substance associated with this designation was only identified via their LC-QToF-MS. CFSRE tests all samples on both their GC/MS and their LC-QToF-MS. Occasionally, CFSRE will identify substances only via the more sensitive method (LC-QToF-MS) and not via their less sensitive instrument (GC/MS). If the substance is one of concern/interest (e.g. Carfentanil, Nitazene), then CFSRE will report it with the [QTOF] designation. The relative ratio/abundance of a [QTOF] active substance can be presumed to be an extremely small component in the sample.

The list of active substances for which a QTOF-only result would be listed in sample results includes:
- Nitazenes (Protonitazene, Metonitazene, N-Desethyl Etonitazene, etc.)
- Fentanyl and analogues (Fentanyl HCl, Carfentanil, etc.)
- Benzodiazepines (Alprazolam, Bromazolam, Clonazolam, Clonazepam, Flubromazepam, etc.)
- Synthetic Cannabinoids (MDMB-INACA, etc.)
- Heroin
- Xylazine

Suspect Peak - Tentative Nitazene*
“Suspect Peak - Tentative Nitazene” Reported by CFSRE means a peak appears on the spectrum of the lab instrument that is tricky to identify but could be indicating a nitazene is present. Further testing will be conducted by the lab to confidently differentiate between the potential nitazene analogues and lab results will be updated to reflect the final identification.

CFSRE Semi-Quant Discordant Results Reporting
Occasionally, the semi-quant results are discordant.

Case Scenario A:
Semi-Quant Results: Fentanyl (10) | Caffeine (4576)
CFSRE considers certain substances to be the “Primary Drug” in a sample. These active substances are assumed to be the main substance(s) that are intentionally being used/acquired (e.g. Cocaine, Fentanyl, Methamphetamine, etc., see figure 3)
In most cases, these substances are found in greater abundance than the more obscure contaminants or impurities. In a sample that is 4576 parts fentanyl to 10 parts caffeine, it would be listed as:
Fentanyl (10), caffeine (Trace)
But, in the example of semi-quant results above, fentanyl is the identified intended substance and so it is being listed as the smallest part (10) instead of being listed as trace.

Case Scenario B:
Semi-Quant Results: Fentanyl (10), Cocaine (5), Medetomidine (2337), Acetaminophen (983)
Fentanyl and Cocaine are both considered a ‘Primary Drug’, so the more abundant one will be set to a ratio of 1. If it had been flipped and there was 10 parts medetomidine to 2337 parts fentanyl, the medetomidine would actually not be listed because the ratio would be far too small and likely below the cutoff to be designated a

trace component. But since fentanyl is the “intended substance”, they do not omit it from the results like they otherwise would.

Chirality considerations

What is chirality? Chirality refers to a chemical molecule’s asymmetrical spatial structure. Molecules are chiral if their mirror image cannot be superimposed by any combination of rotation or translation. The mirror image form of the molecule is called an enantiomer. While the two chiral molecules are structurally similar and have similar physicochemical properties (boiling point, molecular weight, etc.) they may have different biological effects on the receptors or proteins including variations in potency, effects, and efficacy.

<u>An example of chiral molecules includes:</u>

D vs L Methamphetamine

D-methamphetamine is much more potent than L-methamphetamine

Medetomidine vs Dexmedetomidine

Medetomidine is faster active and more effective than dexmedetomidine, but both may result in similar adverse effects

Laboratories providing drug checking results will not typically specify the chirality of the substance. While this information may be helpful in understanding why someone experienced different effects or side effects, the process for determining chirality requires the use of a special chiral column, which is very expensive. CFSRE uses them only very sparingly.

Considerations of Toxicological effects

For MADDS samples, all lab results are reviewed by a medical toxicologist for guidance on a component’s health effects in humans. We update this information in the clinical advisory notes and other resources available to technicians within StreetCheck. When no information is available or it is unknown, we say this: Please reach out with any questions about effects in humans that are not clear in these resources, or if you have specific questions you’d like us to follow up on with a medical toxicologist.

<u>GC/MS (Gas Chromatography - Mass Spectrometry)</u>

- What is gas chromatography (GC)?
  - Chromatography is a process for separating components of a mixture.
  - A substance dissolved in an organic solvent is injected into the gas chromatography column where heat generates a vapor from the substance being analyzed. The vapors in the gas chromatography column are separated between two phases: mobile phase and stationary phase. An inert “carrier gas” (mobile phase) propels the vapors through the column chamber. The chromatograph column is coated with a solid stationary phase, which causes the vaporized components to slow down. Each active component reaches the end of the column at different times based on properties such as boiling point and polarity. A detector will create a chromatogram to measure the retention time. The separated active components are passed onto the mass spectrometer.
  - Gas Chromatography provides the retention time and peak intensity
- What is mass spectrometry (MS)?
  - Mass Spectrometry provides mass information
  - An ion source breaks up the vaporized particles which are deflected based on mass creating a pattern recorded by a detector which is highly specific for each active substance, such as a fingerprint, to identify the chemical.

LC/QToF/MS (Liquid Chromatography - Quadrupole Time-of-Flight - Mass spectrometry)
Commonly abbreviated from LC/QToF/MS to simply QTOF

- What is liquid chromatography (LC)?
    - Liquid chromatography separates active components of a mixture based on the components' affinity for the liquid mobile phase which slowly filters down through the solid phase and separates into distinct bands. Separated active components are passed to the quadrupole time of the flight chamber.
- What is Quadrupole Time-of-Flight (QTOF)?
    - The liquid sample is dispersed into a fine mist by a process known as electrospray. The ions are passed through the quadrupole, which is made of a set of four electromagnetic rods alternating the electric field allowing one specific mass to pass through at a time. The analyte ions enter a collision chamber where they are fragmented by a neutral gas (e.g. argon or nitrogen). Ions are propelled upward through the time of flight chamber in a vacuum by an electric field. At the top is a reflector which reverses the ions' direction towards the detector. Ions with a lighter mass will have a shorter time of flight while larger molecules will have a longer time of flight.

If you have any questions please contact the MADDS team: (madds@brandeis.edu)

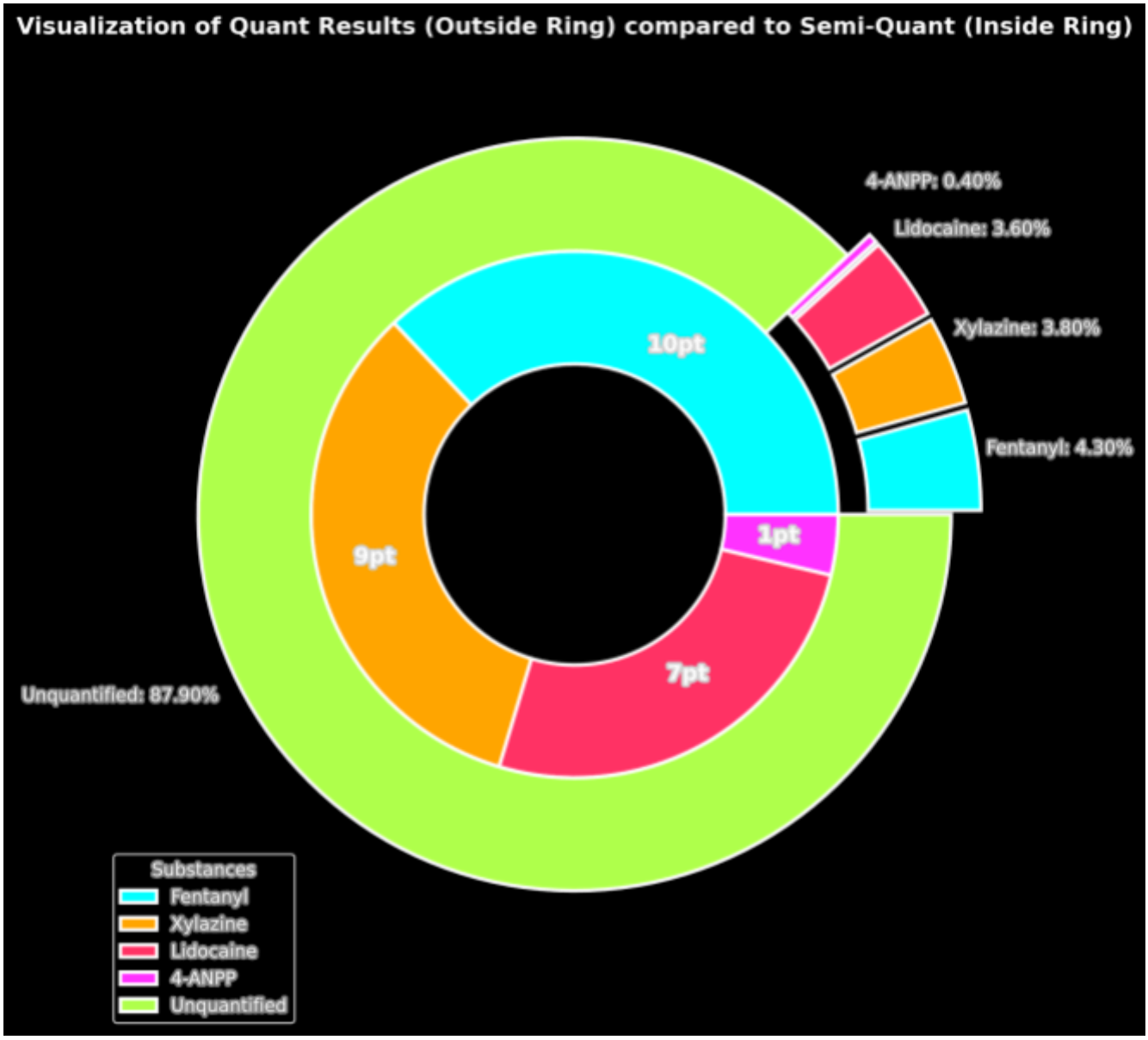
Figure 1

Qualitative Descriptor	Definition	Usage	Intensity/Percentage Range
Major	Relative presence of an active component in a sample.	Commonly used by RIH, CT State Lab.	100% - 30% intensity of the most abundant active component peak.
Minor	Relative presence of an active component in a sample.	Commonly used by RIH, CT State Lab.	10% - 29% intensity relative to the most intense active component peak.
Trace	Relative presence of an active component in a sample.	Commonly used by RIH, CT State Lab, UNC, CDPH (California DPH).	Below 10% peak intensity of the primary abundant active component peak.
Primary/Trace	Indicates the most abundant or least abundant active component identified in a sample.	Commonly used by UNC, CDPH (California DPH).	Primary - 100% - 10% intensity of the most abundant active component peak Trace - Below 10% peak intensity of active component
Absence/Presence	Confirms whether active substances are present in a sample without relative amounts.	Commonly used by NIST.	No intensity range provided; only confirms presence or absence of active substances in the sample.

- **Major/Minor/Trace**: Used to describe the relative abundance of active components based on peak intensity.
- **Primary/Trace**: Focuses on identifying the most abundant active component and traces of others.
- **Absence/Presence**: A simple yes/no confirmation of an active substance's presence in the sample.

Note that FTIR technicians may designate components in their reporting as major/minor/trace/unknown for ALL components, not just the active components. So, it is possible for an FTIR technician to indicate Lactose as Major and Fentanyl as Minor while the lab test results indicate Fentanyl Major. Once quantified by the lab, the same sample may have Fentanyl at 3%. This represents both the major active component noted by the lab but also a minor component of the overall sample's structure. This example demonstrates the importance of interpreting all test results, not just one data point to "see" a substance's composition.

Figure 2



This chart represents the relationship of Semi-Quant and Quant results for a potential CFSRE Sample

- Fentanyl, Xylazine, Lidocaine, and 4-ANPP are identified in a sample via laboratory testing.
- The relative ratio of Fentanyl to Xylazine to Lidocaine to 4-ANPP is determined by the laboratory as: Fentanyl (1) | Xylazine (0.9) | Lidocaine (0.7) | 4-ANPP (0.1)
- The result from above will then be cleaned to appear as whole numbers only. The reported laboratory values will appear on StreetCheck as:
  - Fentanyl (10) | Xylazine (9) | Lidocaine (7) | 4-ANPP (1)
- The quant results show Fentanyl (4.3%) | Xylazine (3.8%) | Lidocaine (3.6%) | 4-ANPP (0.4 %)
  - The remaining percent (87.9%) of the sample remains unknown to the quantitative results.

Figure 3 List of Primary Drugs per CFSRE 2/2025

- 1,4-Butanediol
- 2,5-Dimethoxy-4-bromoamphetamine
- 2CB
- 2C-B-fly
- 2C-C
- 2-Fluoro Deschloroketamine
- 2-fluoro-2-oxo-PCE
- 2-MMC (2-Methylmethcathinone)
- 3,4-Methylenedioxyphenylpropan-2-one (MDP2P or PMK)
- 3-MeO-PCP
- 4Cl-MDMB-BINACA
- 4-cyano CUMYL-BUT7AICA
- 4-cyano CUMYL-BUTINACA
- 4-fluoro MDMB-BUTICA
- 4-MMC (4-Methylmethcathinone)
- 5-Fluoro ADB
- 5-Fluoro MDMB-PICA
- 5-OH-DMT
- AB-CHMINACA
- AB-CHMINACA 2'-indazole isomer
- Acetyl Fentanyl
- ADB-4en-PINACA
- ADB-5'Br-BINACA
- ADB-BINACA/BUTINACA
- ADB-PINACA
- alpha-Pyrrolidinohexanophenone (a-PHP)
- alpha-Pyrrolidinoisohexanophenone (a-PiHP)
- Alprazolam
- Amitriptyline
- Amphetamine
- AP-238
- Arecoline
- Atorvastatin
- Benzylfentanyl
- Bromazolam
- Morphine
- Buprenorphine
- Bupropion
- Buspirone
- BZO-POXIZID
- Caccure 907
- Carfentanil
- Chloromethcathinone
- CH-PIATA
- Citalopram/Escitalopram
- Clonazepam
- Clonazolam
- Cocaine
- Codeine
- CUMYL-PINACA
- Cyclobenzaprine
- Delta-8 Tetrahydrocannabinol
- Delta-9 Tetrahydrocannabinol
- Delta-9 THC-P
- Desalkylflurazepam
- Desalkylgidazepam
- Desalkylflurazepam
- Desomorphine
- Diazepam
- Dimethocaine
- Dimethylamphetamine
- Dimethylpentylone
- Dimethyltryptamine (DMT)
- Doxepin
- Etaqualone
- Ethylamphetamine
- Etizolam
- Eutylone
- Fentanyl
- Flu Alprazolam
- Flubromazepam
- Fluorexetamine
- Fluoxetine
- gamma-Butyrolactone (GBL)
- Guvacoline
- Heroin
- Hexahydrocannabinol
- Hydromorphone
- Isotonitazene
- Ketamine
- Lamotrigine
- Letrozole
- Levetiracetam
- Lisdexamfetamine
- Loratadine
- Lorazepam
- LSD
- MDA
- MDMA
- MDMB-4en-PINACA
- MDMB-5Me-INACA
- MDMB-5-methyl INACA
- MDMB-BUTINACA
- MDMB-CHMINACA
- MDMB-INACA
- Methadone
- Methamphetamine
- Methandrostenolone
- Methaqualone
- Methylenedioxybenzene
- Methylmethaqualone
- Methylmethcathinone
- Methylone
- Methylphenidate
- Metonitazene
- Metoprolol
- Metronidazole
- Mirtazapine
- Mitragynine
- Morphine
- N,N-Dimethylpentylone
- Naloxone
- Naltrexone
- Nandrolone Decanoate
- N-Cyclohexyl Methylone
- N-Desethyl Etonitazene
- N-Desethyl Isotonitazene
- N-Desethyl Protonitazene
- N-Ethylpentylone
- Nicotine
- N-Propionitrile Chlorphine
- N-Pyrrolidino Etonitazene
- N-Pyrrolidinyl Metonitazene
- N-Pyrrolidino Protonitazene
- O-Desmethyltramadol
- Olanzapine
- Ondansetron
- ortho-Methylfentanyl
- Oxandrolone
- Oxycodone
- para-Fluoro Valeryl Fentanyl
- para-Fluorofentanyl
- PCP
- Pentobarbital
- Phenazone
- Phentermine
- Prednisone
- Promethazine
- Propranolol
- Protonitazene
- Psilocin (Psilocybin)
- Rilmazafone
- Sertraline
- SR-17018
- Testosterone Cypionate
- Tetrahydrocannabinol
- Tetrahydrocannabinolic acid
- Tetrahydropalmatine
- Theobromine
- threo-4-Methylmethylphenidate (4-MeTMP)
- Tianeptine
- Tiletamine
- Tramadol
- Trazodone
- Trenbolone Enanthate
- UR-144
- Valeryl fentanyl
- Venlafaxine
- Zolpidem