

Forensic science – toxicology essay sample

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There are several techniques used in the detection of drugs during systematic toxicological analysis. These techniques are useful methods for the detection and identification of drugs that are valuable in a variety of contexts such as the criminal justice system, and pre-employment screening. The suitability and availability of each technique varies depending on the drug being studied. Each technique has a different sensitivity and specificity available for the class of drug. Gas Chromatography and Thin-Layer Chromatography Gas Chromatography (GC) is an instrument used to separate volatile components of a liquid sample.

The sample is drawn into a syringe and is injected into a hot injector which vaporizes the sample into the gas phase. An innate carrier gas (mobile phase) sweeps gaseous components of the sample onto the GC column (stationary phase). The components of the sample partition between the two phases and are individually recorded as they reach the detector at end of the column at different times. Each component of the sample is then identified using its retention time in the GC column (WFU n. d.).

Thin-Layer Chromatography (TLC) is a simple and inexpensive procedure that is often used to provide information on number of components in a compound or to indicate the extent of progress of a chemical reaction (WPI n. d.). In this technique, a small quantity of a sample is blotted on a TLC plate which moves up via capillary action of a solvent. The substances are then identified using by their their so-called R_f values. The R_f value for a substance is the ratio of the distance that the substance travels compared to the distance that the solvent travels up the plate (WPI n. d.). *Methadone* Methadone is a synthetic narcotic analgesic which is used in many countries

as substitution therapy for heroin addiction (Horakova and Valentova, 2004, p. 1).

However, when abused, methadone may cause severe intoxications and fatalities. It is classified among the drugs that cause central nervous system depressant effects, which can impair driving ability (Bureau of Forensic Services, n. d.). Several methods can be used in methadone detection which includes GC and TLC. In a study on the determination of methadone in urine (Horakova and Valentova 2004, p. 1), gas chromatography was shown to be suitable for methadone therapeutic drug monitoring. However, whereas the chromatographic separation was completed within 13 min, the whole procedure from the extraction to determination of methadone and EDDP in urine took 4 – 5 hours to complete.

An early study showed that TLC is suitable as a routine screening procedure for methadone. McIntyre et al (1975, p. 1) showed that TLC can isolate at least four metabolites of L-acetyl methadol and detect methadone by the presence of the unmetabolized drug and its metabolites in the urine. Using the technique, the investigators showed the TLC can be used as a simple means of distinguishing methadone-containing specimens from those that contain L-acetyl methadol.

Codeine

Codeine is used as a narcotic analgesic drug prescribed for pain relief and relief from coughing (Bureau of Forensic Services, n. d.). A study on the determination of codeine in blood and bile by GC showed that the method is highly sensitive to the drug (Lee, H. & Lee C. 1991 p. 1). An earlier study <https://assignbuster.com/forensic-science-toxicology-essay-sample/>

showed that urine sample can also be used to detect codeine using GC and TLC. Jain et al. (1975, p. 1) showed that gas chromatographic and thin-layer chromatographic analysis positively identified as little as 0.5 mg of codeine in urine.

Diazepam

Diazepam is a benzodiazepine-type drug which is prescribed for its anticonvulsant and muscle relaxing effects (Bureau of Forensic Services, n.d.). An early study on the use of electron-capture GC for the analysis for diazepam in serum showed a high chromatographic sensitivity and peak symmetry for the benzodiazepine (Wallace, Schwertner & Shimek 1979, p. 1296). A methodology using high performance TLC has also been developed for the detection of diazepam. Sarin et al. (1998, p. 332) conducted a study based on this method and found that TLC is a rapid and reliable qualitative and quantitative tool in the analysis of cold drinks adulterated with diazepam and can be used by law enforcement laboratories for routine analysis.

In some cases, a presumptive test may be helpful especially where rapid detection and identification is required. Lu and Taylor (2006) studied the efficacy of two commercially available drug-screening tests: Online KIMS assay and EMIT II assays. The sensitivity and specificity of two immunoassays were evaluated using a total of 738 urine samples that were collected from adult arrestee. The results showed that both the EMIT II and KIMS assays have strong capabilities to accurately detect the presence of methadone from urine samples (Lu & Taylor 2006, p. 116).

Gas Chromatography and Mass Spectrometry

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Gas chromatography (GC) coupled to mass spectrometry (MS) is routinely employed in forensic toxicological analysis. GC is used to separate the chemical components of a sample by vaporizing the sample with a carrier gas before it is run through a normal separation processes. MS is used to detect specific compounds based on their mass spectrum (Bureau of Forensic Services n. d.). The separation power of GC combined with the selectivity of the detection of MS make the use of GC-MS the technique of choice among other tools of drug detection (Paterson, Cordero & Burlinson 2004, pp. 323).

Barbituates

Barbiturates are prescription sedatives also known as depressants. Depressants act as “downers” which affect the central nervous system. They are often used to counteract the unpleasant effects of illicit stimulants or to reduce anxiety (GDCADA n. d.). GC-MS is commonly used with solid-phase microextraction (SPME) in the detection of barbiturates. A study on the simultaneous determination of seven barbiturates in human whole blood and urine showed the technique is simple and sensitive enough to be used in the fields of clinical and forensic toxicology (Iwai, M. et al. 2004).

Using the method, the investigators showed that the barbiturates could be rapidly and simultaneously determined even at the therapeutic levels. TLC can also be used as a presumptive test for barbiturates detection. The WHO suggests that the qualitative analysis of barbiturate is best performed by TLC using a solvent extract of urine, stomach contents or scene residues. TLC should also permit identification of the type of barbiturate present, if not the

actual compound ingested. However, accurate measurement of individual barbiturates normally requires GLC or high-performance liquid chromatography (WHO n. d.).

Solid Phase Extraction

Solid-phase extraction (SPE) is a method of extraction used to isolate and concentrate organic analytes from the sample matrix and to provide a suitable sample extract for instrumental analysis. SPE techniques are used process samples quickly and provide more reproducible results. Basically, the process of SPE involves the pumping a sample through a disk or cartridge in order to trap organic analytes and then eluting the organic analytes from the solid sorbent using an organic solvent.

Ketamine

Ketamine is a tranquilizer commonly used to sedate animals. Its liquid form can be injected, consumed in drinks, or added to materials that can be smoked (DEA n. d.). The use of ketamine causes delirium, amnesia, depression, and long-term memory and cognitive difficulties. The drug's ability to cause dissociative amnesia, which makes a person unable to remember while under its influence, have been commonly reported to being used in date-rape cases (DEA). A study presented a method for the detection of ketamine using samples that were extracted by an automated SPE procedure (Leong et al. 2005, p. 314). The extracts were subsequently analyzed using GC-MS. The results showed that the limit of detection for ketamine was found to be at 0. 4 ng/mg while the limit of quantitation was found to be 0. 6 ng/mg.

Gas-Liquid Chromatography

Gas-liquid chromatography (GLC) involves all methods used in gas chromatography using a liquid dispersed on a solid support as the stationary phase. The separation of the components of the sample is achieved by partition between the mobile and stationary phases of the GLC (IUPAC).

Alcohol

According to the Center for Disease Control, in 2004, about 1 in 3 adult drinkers in the U. S reported to have past-month binge drinking (Serdula cited by CDC 2004). Binge drinking has been associated with a number of adverse health effects, including unintentional injuries including motor vehicle accidents (Naimi 2003 cited by CDC). In a study conducted by the National Highway Traffic Safety Administration (NHTSA) in 2002, 41% of all traffic-related deaths in the U. S. were alcohol-related motor vehicle crashes (2003 cited by CDC).

Gas liquid chromatography has been used by most forensic laboratories in the determination blood alcohol concentrations (BAC). A study suggested that GLC is the most reliable method in BAC determination compared to enzymatic procedures often used in hospital laboratories, although no significant difference has been found in BAC values obtained using both methods (Wineka et al. 2004, p. 1). Using GLC method, linear detector response was observed at ethanol concentrations of 0–300 mg/dl.

HPLC and UV Spectrophotometry

High-performance liquid chromatography (HPLC) is a form of liquid chromatography that is used to separate compounds found in a solution. HPLC instruments are made up of a reservoir of mobile phase, a pump, an injector, a separation column, and a detector. The presence of analytes in the column effluent is recorded by several detection methods such as UV Spectrophotometry, which is the measurement of the wavelength and intensity of absorption of UV light by a sample.

Morphine, Codeine, Oxycodone, Hydrocodone

Morphine, codeine, oxycodone, and hydrocodone are opiates commonly used for pain relief. Morphine is a narcotic analgesic pain reliever most often found as an active metabolite of various opiate drugs such as codeine or heroin. Codeine, oxycodone, and hydrocodone are semisynthetic narcotic analgesic commonly prescribed as pain relievers and cough suppressants (Bureau of Forensic Services, n. d.). According to the DEA, aside from their medical use, these narcotics produce a general sense of well-being by reducing tension, anxiety, and aggression which may be helpful in a therapeutic setting but contribute to their abuse.

A method has been developed for the simultaneous determination of common drugs including morphine, codeine and hydrocodone using reversed-phase HPLC (Achilli et al. 1996, p. 273). It was shown that it was possible to identify and to determine these drugs in the same chromatographic run in just 50 minutes. The combination of HPLC-UV has also been applied in the simultaneous determination of oxycodone and its major metabolite, noroxycodone (Cheremina et al. 2000, p. 777). Another

study used UV detection in the simultaneous determination of codeine and its metabolites in plasma and urine samples after separation using HPLC (He et al. 1998). Investigators have shown that the method was highly sensitive and selective and showed good reproducibility and accuracy after external standardization (He et al. 1998).

Methamphetamine

Methamphetamine is a stimulant drug that causes increased heart rate and blood pressure and irreversible damage to blood vessels in the brain, producing strokes. Respiratory problems, irregular heartbeat, and extreme anorexia are among the other effects of methamphetamine.

Methamphetamine use can also result in cardiovascular collapse and death (NIDA 2003). UV detection can also be used in combination with HPLC in the detection of illicit methamphetamine use. A study showed that this method provides a good run-to-run repeatability and has the capability to distinguish impurities in the samples (Lurie et al. 2000, p. 53). However, the same study showed that HPLC with fluorescence (FL) detection gave more than 60x increase in sensitivity over UV detection for certain impurities in the study. Further, the use of FL detector was more rapid which make it an ideal presumptive test for methamphetamine detection.

Summary

Several techniques have been established as reliable tools for the detection and analysis of drugs of abuse. Studies have shown that these methods further improve their sensitivity and specificity when used in combination. Other studies have also demonstrated that some of these techniques are

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rapid enough to be used as presumptive test. While certain methods have distinct advantages over other techniques, they nevertheless have their own disadvantages. Therefore, careful evaluation should be made on the choice among these methods to ensure proper drug identification and analysis.

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