Drug Testing Technology

Drug testing is divided into a two-step process—the *screening* test and then the *confirmatory* test (Council on Scientific Affairs 1987). The former test is designed to maximise the likelihood of finding a drug, while sometimes sacrificing the ability to identify the specific drug (for example, identifies opiates that could be either codeine or morphine). The test is designed to ensure that few or no people are classified as not using a drug when in fact they have (for example, false negatives). Confirmatory tests, on the other hand, are designed to ensure that positive screens are, in fact, true positives while also enabling the identification of the specific drug or metabolite in the urine. Normally a confirmatory test is only done if the screening test indicates the presence of a drug. If there is a relatively high concentration of the drug, then both the screening and confirmatory tests will be more reliable. Toxicologists report that it is difficult to detect small amounts of the drug when the tests run close to the concentration limit of what can be reliably detected (Blanke 1986, p. 44).

What is certain is that the higher the dose of drug taken, and the greater the frequency of use, the more likely it is to be detected. Although drugs are excreted at varying lengths of time, they do accumulate in the body with continued use. This effectively means that the more often the drug is used, the more likely it is to be detected. Manno notes that "a single dose of cocaine, for example, may only be detectable in urine for 1 day or less. Continued use on a daily basis may cause the drug to be detectable for 2 to 3 days after cessation of use" (1986, p. 56). In comparing hair and urine tests, Mieczkowksi and Newel (1993, p. 63) found very high concordance for cocaine when the cocaine metabolite concentrations were high. They concluded that "individuals at low concentrations (levels 1, 2, and 3) are likely to evade detection by urine, since they use either small amounts of cocaine or avoid daily or near daily use".

Screening Tests

There are two primary screening methods for detecting drugs in urine: *immunoassay* and *chromatography*. Immunoassay is the method used in the US-ADAM and DUMA projects for initial screening of illicit drugs. Essentially, the process involves using antibodies to detect the presence or absence of drugs in the urine. The specimen is compared to a calibrator, which contains a known quantity of the drug being tested. If the sample specimen is higher than, or equal to, the calibrator, then the test is considered positive. If the specimen is lower than the calibrator, then the test is considered negative. The calibrator used in the DUMA context is based on the cutoffs set by Australian Standard 4308–1995 (Standards Australia 1995). Screening tests are relative cheap and usually the turn-around time on results is very quick. The downside is that they do not tend to be as accurate as a confirmation test. An *immunoassay* commonly used in the criminal justice system is EMIT (enzyme multiplied immunoassay technique). This is the technique used by DUMA and US-ADAM. Another technique is KIMS ("On-Line" Kinetic Interaction of Micro-Particles test), used by the UK-ADAM program.

The two limitations of screening tests are *specificity* and *cross-reactivity*. Specificity refers to the extent to which the test can discriminate between different drugs (Bigger 1979). In terms of specificity, screens can only identify groups of drugs and not the specific chemical component. Thus, a positive screen for opiates cannot distinguish whether the specific chemical component is codeine or morphine. This problem is of particular concern when attempting to identify the kinds of opiates, amphetamines, and benzodiazepines an individual has been using. In comparing various methods of drug analysis, EMIT is considered to have high sensitivity and moderate specificity (Ostrea 1999, p. 42).

Cross-reactivity occurs when the test is unable to distinguish between substances that are unrelated but chemically similar. For example, poppy seeds can cause detectable concentrations of morphine or codeine, or both, in urine (Normand et al. 1994, p. 194). In addition, over the counter prescriptions can result in positive amphetamine, benzodiazepines, and opiate screens. DUMA asks participants about their use of prescription and over the counter medications in the past week. When the urinalysis results are merged with the self-report data, it will be possible to further examine self-reported prescription use versus self-reported illegal use.

Confirmatory Tests

As screening tests have less specificity and a higher likelihood of false positives, scientists recommend that positive tests be viewed as presumptive and that a positive immunoassay be retested and confirmed. The confirmation should preferably use a different technique of equal or greater sensitivity, such as gas chromatography/mass spectrometry. *Chromatography* involves separating and identifying the components of a specimen; thus, identifying the actual drug (for example, codeine rather than morphine). Chromatography methods include thin layer chromatography (TLC), gas liquid chromatography (GLC), high performance liquid chromatography (HPLC), and gas chromatography/mass spectrometry (GC/MS). GC/MS testing, although more expensive, more time consuming, and more technically complex, is recommended by AS4308–1995 and is used by DUMA. Essentially, this process involves shattering the drug into pieces that form a fragmentation spectrum. Different compounds have different fragment patterns and like fingerprints; no two are alike (Council on Scientific Affairs 1987). This spectrum of unknowns is compared to the analytic standards for those drugs and metabolites enabling identification of the compound. In comparison with various other methods of confirmatory tests, GC/MS has both high sensitivity and specificity (Ostrea 1999, p. 42). Wish and Gropper (1990, p. 343) report that "GC/MS is considered to be the absolute standard for identifying drugs" (see also Jenny 1989, p. 16).

Analysis of the accuracy of the immunoassay screening tests (see Table 5) indicate very high positive predictive values for cocaine metabolites (99.2%) and marijuana metabolites (97.8%) while amphetamines (76.8%) and opiates (70.0%) are much lower (Stuck et al. 1998, see Table 5). Given the additional cost and the high accuracy of immunoassays for marijuana and cocaine,

Table 5: Cumulative Positive Predictive Values 1993 and 1994 (Percentages)

	1993		1994	
	Positive Predictive Values	95% Confidence Interval	Positive Predictive Values	95% Confidence Interval
Amphetamines	77.7	(77.3–78.1)	76.8	(76.4–77.2)
Cocaine Metabolite	95.2	(95.0–95.4)	99.2	(99.1–99.3)
Opiates	74.6	(74.1–75.1)	70.0	(69.5–70.5)
Marijuana Metabolite	97.7	(97.6–97.8)	97.8	(97.7–97.9)

Source: Stuck et al. 1998, Table 4.

confirmatory testing has been restricted to opiates, amphetamines, and benzodiazepines.[8]

Cutoff Levels

Cutoff levels are used to determine whether a screen and the confirmatory test result is positive or negative. These levels are usually the common agreed levels at which the drug or metabolite can be detected; it is often referred to as the sensitivity level. Different testing procedures have different levels of sensitivity in detecting "a drug when it is present at greater than or equal to its predetermined analytic cutoff point" (Ostrea 1999, p. 42). For screening purposes, it is important that the test has high sensitivity so that it initially picks up recent drug use. This can result in a high false-positive rate but it also minimises the number of people who use drugs that test negative. Then in the second stage, the detected drug is confirmed using a test which has high specificity.

Jenny (1989, p. 17) suggests that there are four major criteria that are appropriate when setting the cutoff value:

1. the level should enable the detection of recent, casual drug use;
2. the level should be high enough to rule out analytical noise;
3. the level of confirmations should be lower than the screening level so as to "minimize the number of unconfirmed presumptive positive tests"; and
4. the level should be high enough to eliminate positive results from inadvertent exposure to the drug.

The point at which the cutoff level is set will influence the number of false negatives and false positives. The cutoff levels set by AS4308–1995 are designed to minimise the number of false positives so as to withstand legal scrutiny. Table 4 indicates the cutoff levels for both the screen and confirmatory tests used by DUMA.

[8] Confirmatory testing of benzodiazepines is undertaken as it provides a more accurate report on what drugs detainees are using.

Concentration Levels

Concentration is a term that refers to the amount of a drug or its metabolite in a given volume, usually nanograms per millilitres (Bigger 1979, Visher and McFadden 1991). However, screen results are normally expressed in qualitative terms of positive or negative (Wilkins 1998, p. 235) based on the agreed minimal concentration of the substance that the test can detect. For DUMA, the minimal concentration is set to AS4308–1995.[9] As urinalysis results are usually expressed in this qualitative fashion, the quantitative levels have not been traditionally used to determine the frequency and amount of use. However, in the 1990s there has been some research using quantitative urine levels of drug use, including the tracking of sequences of poly drug use (Wilkins 1998, p. 240, Preston et al. 1998, Li et al. 1998). DUMA does record the amount of drug or its metabolite in a given volume (for example, the concentration levels) for both the screen and confirmatory tests. However, in both cases the data are treated qualitatively in terms of a positive or negative.

[9] Except for benzodiazepines where a hydrolised procedure is used and the cutoff level is set to 100.