

————— **Research Report** —————

**Use of Random Urinalysis to Deter
Drug Use in Prison:
A Review of the Issues**

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**Use of Random Urinalysis to Deter Drug Use in Prison:
A Review of the Issues**

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EXECUTIVE SUMMARY

A significant number of drug users have contact with the criminal justice system. Fully 80 percent of offenders admitted to federal corrections have substance abuse problems (Motiuk et al., 2003). It is important to identify who is using and abusing illegal substances for a variety of safety and treatment issues. While focusing on protecting society from the harms associated with drug abuse, the Correctional Service of Canada (CSC) is one of the key players in identifying the prevalence and extent of illicit drug use among offenders both in the community and in prison.

CSC and other partners in the criminal justice system are able to obtain an estimate of the extent of drug use by drug testing and self-report surveys of recent arrestees, incarcerated offenders, and offenders on conditional release in the community. This information has a profound effect on how CSC assigns programs and treatment services to those identified with drug abuse problems. The knowledge acquired will assist in the rehabilitation and supervision of offenders, which can contribute to the safety and security of institutions and to the protection of the public in communities to which offenders return.

Although urinalysis is a well-established technology, it is not without limitations. Results of urine tests must be interpreted with caution due to the myriad of possible factors that could influence the results. In addition to the technical challenges in interpretation of results, such as variability in clearance rates of drugs of abuse, differences in individual physiology, and cross-reactivity in urinalysis screening procedures, there are operational factors such as discernable patterns in sample collection that could potentially influence the accuracy of the results. These can pose serious challenges to effective implementation of a program of random urine testing.

This report outlines the major issues associated with urine testing in CSC, and provides background information on the rationale for implementing a program of random testing in institutions. Future research reports will examine a number of important topics related to CSC's experience with this program including:

- the impact of non-random request distribution on random urinalysis outcome;
- trends in urinalysis results;
- profiling offenders based on urinalysis outcome; and
- the consequences of testing positive and refusing to provide.

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INTRODUCTION

This paper provides an overview of urine testing for drugs of abuse, and discusses its use in the Correctional Service Canada's (CSC) random urinalysis program. Urine testing for illicit drugs such as cocaine, heroin, marijuana, amphetamines and others is a well-established technology and has been implemented in a wide variety of settings. Workplaces, in particular in the United States, have adopted urine testing to monitor and deter drug use among employees (ACLU, 1999). In Canada, use of workplace testing is restricted to professions whose employees are in safety-sensitive positions. For example, individuals employed by the Department of Transportation and members of the Canadian military are required to provide urinalysis samples upon request.

Urinalysis is also used extensively within criminal justice systems. The criminal justice system, and CSC, are able to obtain an estimate of the extent of drug use through the combined use of urinalysis and self-report surveys of arrestees, incarcerated offenders, and offenders on conditional releases in the community. This information has a profound effect on how CSC targets programs and treatment services to those identified with drug abuse problems.

Programs such as the Arrestee Drug Abuse Monitoring (ADAM) program in the United States (formerly the Drug Abuse Forecasting program) use urinalysis in combination with surveys of individuals who have been arrested and detained to gather information regarding the extent to which offending is associated with illegal drug use (Taylor & Bennett, 1999). Recently, the ADAM program has been expanded internationally, and sites in England, Scotland, Australia (Drug Use Monitoring in Australia or DUMA), Chile, Malaysia, Netherlands and South Africa have begun conducting similar testing of recent arrestees to determine the extent of their involvement with alcohol and drugs and the relationship to criminal behaviour (Makkai, 2000; Makkai, Fitzgerald & Doak, 2000; Bennett, Holloway & Williams, 2001; McKeganey, Connelly, Knepil, Norrie & Reid, 2000).

SUBSTANCE ABUSE AND CRIME

The link between substance abuse and crime is well documented. The relationship is complex, however, and is dependant on several factors such as type of drug consumed, level of dependence, level of income, and others (Brochu et al., 2001; Anglin and Perrochet, 1998; Hammersly, Forsyth, Morrison & Davies, 1989; Zhang, Wiczorek & Welte, 1997; Maden, Swinton & Gunn, 1992; Bennett, 1998, 2000; Walters, 1996; Greenfeld, 1998; Taylor & Bennett, 1999).

In Britain, Her Majesty's Prison Service has reported that dependency on illegal drugs is the single most serious risk for repeated offending (Home Affairs, 1999). In fact, it has been shown that those with the most serious problems with drug and alcohol are more likely to have had prior periods of incarceration (Nurco et al., 1991; McKeganey et al., 2000). Urinalysis results provide support for this conclusion, as it has been reported that arrestees who have had a prior arrest or who were incarcerated in the past 12 months were more likely to test positive for drug use (Makkai, 2000; ONDCP, 2000).

Prevalence rates of substance use and abuse for those involved in the criminal justice system are much higher than the general population. Household surveys on drug use in North America indicate that illicit drug use ranges from a high of 12.5% for THC to 0.1% for cocaine used in the past month (James, 2003; Poulin, Single & Fralick, 2002; Substance Abuse and Mental Health Services Administration, 2003). However, in Canada 80% of offenders entering the federal prison system are identified as having a substance abuse problem (Motiuk, Boe & Nafeck, 2003). Further, research in Scotland has demonstrated that 71% of arrestees (n=281) tested positive for drugs (McKeganey et.al., 2000).

Table 1 outlines several ways that behaviour linked to drugs and alcohol can intersect with the criminal justice system (ONDCP, 2000). In addition to crimes associated with the possession and use of illegal drugs, crimes related to drug use include theft motivated by the desire to fund a drug habit, crimes committed while under the influence, and smuggling and violence related to drug trafficking.

Table 1. Summary of the relationship between drugs and crime

Drug/Crime Relationship	Definition	Examples
Drug-defined offences	Violations of laws prohibiting or regulating the possession, use, distribution or manufacture of illegal drugs	Drug possession or use; Marijuana cultivation; Methamphetamine production; Cocaine, heroin or marijuana sales
Drug-related offences	Offences to which a drug's pharmacological effects contribute; Offences motivated by the user's need for money to support continued use; Offences connected to drug distribution itself	Violent behaviour resulting from drug effects; Stealing to get money for drugs; Violence against rival drug dealers
Drug-using lifestyle	A lifestyle in which the likelihood and frequency of involvement in illegal activity are increased because drug users may not participate in the legitimate economy and are exposed to situations that encourage crime	A life orientation with an emphasis on short-term goals supported by illegal activities; Opportunities to offend resulting from contacts with offenders and illegal markets; Criminal skills learned from other offenders

Source: ONDCP, 2000

Results from a 1997 survey of state and federal offenders in the United States suggested that over half (51%) of offenders were using alcohol and drugs while committing their offence. As many as 83% reported past drug use, and 57% were using drugs in the month before their offence. However, in this sample of offenders, only 20% of prisoners were incarcerated for crimes relating to the drug trade (Wilson, 2000).

Robinson, Porporino and Millson (1991) described drug use patterns among 503 male offenders from 3 institutions across Canada, using the results from the Computerized Lifestyle Screening Instrument. In the 6 months prior to arrest, 57% indicated that they had used drugs at least once, 10% said they used drugs every day, and more than 30% used drugs a few times each week. Eighty-five percent reported alcohol use in the 6 months prior to arrest. A more recent picture of the link between substance abuse and crime in Canada, reported that 54% of offenders were under the influence of alcohol and/or drugs at the time of the most serious offence for which they were currently serving a sentence (Pernanen et al. 2002).

In a sample of 133 inmates in Massachusetts, 95% had a diagnosis of dependence on drugs or alcohol, and 53% reported that drug use played a major role in the commission of the crime for which they were incarcerated (Kouri, Pope Jr., Powell, Olivia & Campbell, 1997). Bennett (1998) reported that 61% of arrestees tested positive for drug use, and 46% of arrestees stated that their drug use and crime were related. In Australia, surveys of arrestees revealed that 41% were using drugs prior to their arrest (Makkai, 2000).

The above research suggests that arrestees and offenders have a great deal of involvement, both in the recent and distant past, with drugs and alcohol (Taylor & Benett, 1999; Benett, 2000). This relationship could explain why drug use in prisons has been identified as a problem by correctional systems worldwide (Keene, 1997; Home Affairs, 1999; Wish & Gropper, 1990; Plourde and Brochu, 2002).

DRUG USE IN PRISON

Since offenders are highly likely to have involvement with substances, much effort has been expended on the part of CSC and other jurisdictions to combat the introduction of drugs into prisons. Inmates currently involved in a drug treatment program in a Delaware state prison reported on methods used to smuggle drugs into the facility (Inciardi & Lockwood, 1993). Inmates reported that visitors and correctional staff brought most drugs into the prison. Visitors were reported to have concealed drugs in clothing, in cellophane packages hidden in their mouths, or in ballpoint pens with the ink cartridge removed. Correctional staff were reported to smuggle drugs and drug paraphernalia into the prison in sports equipment, hollowed-out books, garment linings and photographic equipment. Offenders themselves reported being able to smuggle drugs into prisons. One method reported was to hide cocaine in the tongues of the shoes worn to sentencing, in order to enter the prison with a supply of drugs.

Offender surveys also reveal the prevalence of drug use in prison. A report prepared by the University of Oxford Center for Criminological Research in 1996 revealed that 51% of the offenders claimed to have used drugs in prison in the past month (Edgar & O'Donnell, 1998). Seventy-six percent of the sample claimed to have used drugs at some point during their period of incarceration. A similar survey conducted in 1997 revealed that around 50% of the male prison population, and 34% of the female prison population reported using drugs at some time during their current sentence (Home Affairs, 1999).

CSC conducted a national inmate survey in 1995 (n=4285) in which 38% of inmates reported to have used an illegal substance during their current sentence. Fifty-nine percent of offenders believed that marijuana was used often or daily, while 19% believed that heroin and 17% believed that crack/cocaine were used regularly (Robinson & Mirabelli, 1996). A study of randomly selected inmates (n=317) from 10 federal institutions in Quebec in 1999 revealed that 29% of inmates had used one or more substances during the three months of incarceration prior to their interview (Plourde & Brochu, 2002).

In the US, Inciardi and Lockwood (1993) reported that 60% of survey respondents admitted to drug and alcohol use in prison prior to their entry into a

treatment program, while in a sample of offenders on probation in England, the percentage who reported any drug use while in prison was as high as 75% (Keene, 1997).

High-Risk Behaviour

Due to the high proportion of offenders who report having used drugs while incarcerated, there is a concern that intravenous drug use in particular will lead to the spread of communicable diseases such as HIV/AIDS and hepatitis C. Surveys of offender intravenous drug use have attempted to shed some light on the prevalence of this type of drug use behaviour.

An offender survey conducted at a male federal institution in Ontario revealed that of a sample of 350 offenders, 24% ($n=84$) reported intravenous drug use while incarcerated (CSC, 1998). A national survey of incarcerated offenders in England and Wales in 1995 revealed that of the 3142 prisoners interviewed, 4% ($n=130$) had injected drugs during incarceration (Boys, Farrell, Bebbington, Brugha, Coid, Jenkins et al., 2002). In Greece, offender surveys revealed that out of 544 inmates incarcerated for drug related offences, 35% ($n=190$) had injected drugs during their current sentence (Malliori, Sypsa, Psychogiou, Touloumi, Skoutelis, Tassopoulos et al., 1998).

Of particular concern to prison officials is the likelihood that offenders will begin to inject drugs while incarcerated. Boys et al. (2002) reported that 4% of offenders surveyed had injected while in prison, and 25% of those offenders had injected for the first time while in prison.

Surveys from 5 prisons in England in 1995 reported that 6% of the sample tried using heroin for the first time while in prison. Although these offenders had injected while incarcerated, all had discontinued use by the time the survey was administered (Edgar and O'Donnell, 1998). In Canada, CSC reported that, of those offenders admitting to injection drug use in an offender survey in Ontario, 6% reported using intravenous drugs for the first time after entering prison (CSC, 1998).

ASSESSING THE LEVEL OF DRUG USE

Urinalysis

In an attempt to combat the use of drugs by inmates, urinalysis has been adopted as policy in several prison systems. For example, England has a program of mandatory drug testing in place, and randomly tests 10% of the prison population each month (Home Affairs, 1999). The Federal Bureau of Prisons in the US also tests inmates on a random basis, with the proportion of offenders required to submit varying by institutional security level (Pellisier & Gaes, 2001). In the US, 10% of offenders in maximum security institutions are chosen each month to provide a random sample, 3% are chosen in minimum security institutions, and 5% in all other institutions. In Canada, 5% of the federal inmate population is chosen randomly each month to provide a urine sample in all security levels (MacPherson, 2001). In these systems, and others, the goal is to reduce the use of and demand for drugs in prison.

Results from random testing in institutions have been reported for several jurisdictions. In 2000, the national positive rate in Canadian federal institutions from all random testing was 12% (MacPherson, 2001). Of the 12% who tested positive, 77% of tests were positive for cannabis, 9.8% for opiates and 1.9% for cocaine.

The results of the mandatory urinalysis program in England were recorded at one prison (HMP Lindholme) from the inception of the program in November 1995 to July 1996 (Brookes & Scott, 1997). The mean number of tests given per month was 69 with a mean positive result of 34%. Of those who tested positive, cannabis was the most prevalent at 70% followed by opiates at 47%, while the rate of cocaine was minimal at 3%. In 1999, reported positive rates from mandatory random drug testing in Her Majesty's Prison Service reported a positive rate for all drugs of 18.3% (Home Affairs, 1999).

In 1998, US state prisons with a random urinalysis program reported an average positive rate of 7% (Wilson, 2000). In a report by Pelissier and Gaes (2001), random testing in the Federal Bureau of Prisons resulted in positive rates between 1-2%, even though 57% of offenders entering their correctional system were reported to have used drugs regularly.

Urinalysis vs. Self-Report

Prior to implementation of urinalysis, the vast majority of information on the relationship between substance abuse and criminal activity came from survey and self-report data (Madden, Swinton & Gunn, 1992; Nurco, Hanlon & Kinlock, 1991). Although survey data and self-report have been generally considered valid, special populations, including incarcerated offenders, provide unique challenges (Davidson & Gossop, 1996).

Since offenders are not always truthful in admitting drug use during an interview, the use of urinalysis has been introduced to provide a more objective measure of recent drug use (Bennett, 1998; DeJong & Wish, 2000, Harrison, 1997). For example, recent arrestees may feel intimidated and fearful of further punishment or reprisals as a consequence of reporting behaviour known to be illegal. DeJong and Wish (2000) compared the results of urinalysis and self-reported drug use using the ADAM database and found significant underreporting of recent drug use. Of those offenders identified as having a positive urinalysis result for cocaine, less than half reported using the drug. Only 62% of offenders testing positive for heroin reported recent use. Similar results were found by Bennet (1998). In a study of 5 sites in England, it was found that arrestees consistently underreported recent use of THC, heroin, methadone, cocaine and amphetamines.

Interestingly, surveys of drug use behaviour of inmates find that urinalysis underestimates self-reported drug use while incarcerated. Compared to the underreporting of drug use by arrestees, inmates are more likely to report drug use in prison as compared to rates of detection by urinalysis (Edgar & O'Donnell, 1998; MacPherson 2001; Plourde & Brochu, 2002). Reasons for this could reflect different motivations of the two populations; arrestees may try to skew their answers to portray themselves in a more favorable light, even though assurances of confidentiality are given prior to an interview. In contrast, offenders serving prison sentences may not have the same motivation.

The discrepancy may also in part be due to the differences in research methodology. The ADAM program and others like it compare urine tests and survey information within individuals, gathering both measures for one arrestee and making direct comparisons. Research on incidence of drug use in prison compares random urine

test results and survey information between two separate groups of offenders. The groups are composed of different offenders, however are comparable on relevant characteristics such as being a resident in the same institution or residing within the same prison service (Edgar & O'Donnell, 1998). Random urinalysis protocols in prisons face several challenges to accurate estimation of drug use, and it is possible that within this study method, offender self-reported use may provide a more accurate description of prevalence of drug use.

IMPACT ON INSTITUTIONAL ENVIRONMENT

Underground Economy

Some correctional officials believe that drug use creates a prison atmosphere charged with violence mainly caused by the underground economy related to the drug trade (McVie, 2001; Home Affairs, 1999). Common objectives for implementation of random urinalysis programs include a desire to reduce the demand for drugs and increase the safety and security of the institutional environment (MacDonald, 1997; CCRA, 1992). It has been reported that trafficking in drugs can lead to significant threats to the security of the institutions, for both offenders and staff. Often offenders will need to seek protection from dealers in the institution due to the pressure and physical threat for non-payment of drug debts, dealers intimidate and place pressure on offenders returning from temporary release programs to bring drugs back into the institution, and threaten staff and families of offenders to carry drugs inside to maintain a supply (Home Affairs, 1999; McVie, 2001).

Violence and Intoxication

Often the effects of intoxication are cited as contributing to an environment charged with tension, aggression and violence. However, the psychopharmacological effects of the most common drugs of abuse detected through urinalysis do not invoke violent reactions. For example, marijuana, which is the most commonly detected drug of abuse in prisons, has little or no effect on aggression at low doses, and moderate to high doses tend to inhibit aggression (Grilley, 1998). In fact, the most common effects of marijuana are euphoria and relaxation (Adams & Martin, 1996). Self-report surveys of inmates reveal that the main reason offenders use drugs in prison is to relax (Cope, 2000; Plourde & Brochu, 2002).

Other drugs that have been found through the use of urinalysis and self-report are the benzodiazepines, such as Valium, which reduce aggressive tendencies and are traditionally used for anti-anxiety medications (Longo & Johnson, 2000). Heroin and other opiates also have primarily analgesic and sedative effects.

The potential for violent behaviour due to intoxication does exist with stimulant drugs, such as amphetamines and cocaine, as high doses can lead to suicidal thoughts, irritability, anxiety and paranoia (Grilley, 1998). It has been suggested, however, that the ability for these drugs to lead to violent outbursts only exists in a minority of individuals, those already exhibiting other signs of psychosis (Pernanen et al., 2002). In addition, cocaine has not been found to be a common drug of choice in prison, as reported by offenders (Plourde & Brochu, 2002; Keene, 1997). In support of this, cocaine and amphetamines are found in less than 1% of all random urinalysis samples in Canadian federal institutions (MacPherson, 2001).

Alcohol has traditionally been associated with acts of violence and aggression and is the substance used most often during the commission of violent crimes (Pernanen et al., 2002, Fagan, 1990). Cocaine, amphetamines and alcohol are difficult to detect using urinalysis, however, due to the rapid clearance rate in urine. This has the potential to limit the ability of random urinalysis to effectively deter the use of these substances and others with rapid clearance rates in urine.

Withdrawal from drugs is often associated with things like irritability, depression, insomnia, and hostility towards others (Giannini, 2000). It is possible that when drug supply is low, increased hostility and tension could result due to associated withdrawal and cravings. It is also possible that through effective strategies to reduce the supply of drugs in the institutions, violence and tensions increase as drug prices may be driven higher, and increased pressure may be placed on individuals to carry drugs (McVie, 2001).

Physiological Correlates of Substance Abuse and Aggression

It has been shown that substance abusers exhibit reduced glucose metabolism in an area of the brain known as the prefrontal cortex (Giancola et al., 1996; Meek, Clark, & Solana, 1989). Reduced glucose metabolism is an indication of reduced activity in this area of the brain, which is involved in higher intellectual functions such as forethought, behavioural inhibition, and capacity to learn from experience (Pincus, 1999). Individuals who are drug abusers and those who are predisposed to violence have similar patterns of activity in the prefrontal cortex. (Bechara, Damasio, Damasio & Anderson, 1994). Abnormal functioning in this area of the brain has also been shown to impair the ability

to assess consequences and act on that assessment, resulting in increased impulsivity (Barratt & Patton, 1983), characteristics which also have been linked to criminal offending. It has been suggested that a subset of the population of drug abusing offenders may have a neurological predisposition to violence and impulsivity that contributes to the overall level of tension in the institutional environment (Fishbein, 2000). However, it has also been suggested that the neurological consequences of drug abuse itself contributes to the deterioration of brain areas involved in executive functioning (Vecellio, 2003; Vanderschuren et al., 2001; Zakzanis & Young, 2001). It is important to note that the causal links among these variables are unclear. Nevertheless, these similarities provide interesting links between substance abuse, aggressive behaviour and criminality.

URINALYSIS AS A DETERRENT

There is some evidence that implementing a random urinalysis program may contribute to reducing the demand for and use of drugs in prisons. Surveys of offenders have revealed that 52% of the survey sample had altered their pattern of drug use in some way in response to Mandatory Drug Testing (MDT). Twenty-seven percent had stopped using, 15% had reduced consumption, 6% changed their pattern of use from cannabis to heroin, and 4% had experimented with heroin. Just over one third of prisoners who stopped or reduced consumption stated that they did not want to stop, but did so in response to MDT.

When HM Prison Service introduced their program of MDT in England the positive rate in institutions was shown to have dropped from 34% in 1995 to 25% in 1996. Edgar and O'Donnell (1998) compared the percentage of negative tests in the first two months after the introduction of MDT with the results a year later. The percentage of negative tests had increased in almost all sites examined, which suggests a reduction in drug use. Brookes and Scott (1997) examined urinalysis results at one site (HMP Lindholme) from the inception of the program in November 1995 to June 1996. The mean number of tests given per month was 69 with a mean positive result of 34%. There was a general downward trend in the amount of positive results from 55% in November to 19% in June.

An offender survey conducted across federal institutions in Canada reported that 32% believed that the urinalysis program had resulted in a slight decrease in drug use (Robinson & Mirabelli, 1996). In fact, a drop in the positive rate has also been reported in Canada, where an initial rate of 34% was found during the pilot phase of random testing in 1995, with a subsequent reduction in positive samples to around 11% following nationwide implementation (McVie, 2001).

PHYSIOLOGY AND PHARMACOLOGY

Principles of Drug Elimination

To have a comprehensive understanding of how urinalysis works, why it is effective in detecting drug use, along with some of its limitations, it is helpful to understand how drugs are handled by the body once they are introduced. The amount of drug in the body and the length of time it stays there depends on characteristics specific to that particular drug. Each drug has its own pharmacological profile for the rate and method of absorption, distribution, metabolism and elimination. Absorption describes the process whereby a drug passes into the bloodstream. Once there, the drug is distributed to various tissues, organs and to the site of action where it exerts the desired pharmacological effects. Drugs are then eliminated from the body through metabolism and excretion. Each of these characteristics influences the ability of urinalysis to detect drug use, and how the results can be interpreted. Appendix A provides a detailed description of the pharmacological basis for urine testing, including principles of drug absorption, distribution, metabolism and excretion.

Laboratory Analysis

Because urinalysis is a well-established technology, several methods exist to detect drugs and metabolites in samples. Although there are limitations associated with most methods, properly trained technicians are able to interpret the results with a high degree of accuracy. In most urinalysis programs, including the urinalysis program of CSC, samples are tested twice: an initial screening test and a subsequent confirmation test with a highly sensitive and specific detection technique. The purpose of preliminary screening is to simply determine whether a sample is positive or negative, and eliminate negative samples from further confirmatory testing.

Immunoassay

Each urine sample must undergo a separate immunoassay for each of the selected drug groups. Portions (aliquots) of urine are taken from the original container for initial immunoassay drug screening. Immunoassays are based on principles of competition between labeled and unlabelled antigen (drug/metabolite) for binding sites on a specific

antibody. Antibodies are specific proteins with sites on their surface to which specific drugs or metabolites will bind. Cloned Enzyme Donor Immunoassay (CEDIA) is the immunoassay method employed by CSC contract laboratory.

Gas Chromatography / Mass Spectrometry

Gas chromatography/mass spectrometry (GC/MS) is considered the most accurate and precise confirmation test for drug detection, and is the method used by the CSC contract laboratory. GC/MS permits highly efficient separation of components in the capillary column of the chromatograph, followed by extremely selective detection in the mass spectrometer. Chromatography separates the various components in a specimen through a partitioning process. The time it takes for the drugs and metabolites to separate from the gas is used for identification of the drug, as this property differs for the various drugs and metabolites in urine. Mass spectrometry then takes the identified molecules and breaks them down into fragments, which results in a unique "fingerprint" of the particular drug or metabolite present. The intensity of the fragments is directly related to the amount of drug or metabolite present in the sample.

Cut-off limits have been established for both initial and confirmatory drug testing. These limits are similar to those used in workplace testing, however the opiate cut-off value is lower and a broader range of drugs are tested for in the CSC program. Appendix B describes CSC collection and lab processing procedures and contains a list of drugs included in the CSC urine testing program and the cut-off levels associated with each.

INTERPRETING URINALYSIS RESULTS

Cross-Reactivity

There are four possible interpretations of urinalysis results (Table 2). The two true test results correctly reflect the condition of the sample. However, false positives and negatives can occur occasionally for several reasons. False positives occur as a result of antibodies in immunoassay tests cross-reacting with related drugs, and sometimes even with unrelated compounds, resulting in incorrect identification of drugs in urine. For example, the presence of morphine in urine is often assumed to be indicative of heroin use, however, the presence of urinary morphine can also result from the consumption of codeine, other analgesic medications, or from the consumption of poppy seeds (Wolff et al., 1999). The presence of codeine alone in urine may also be indicative of illicit drug use, however, its use in cough medications and in analgesic preparations makes such an interpretation difficult (Popa, Beck & Brodin, 1998). Similarly, pseudoephedrine in common cough medications will cross-react with immunoassays for amphetamine (Morgan, 1984). This characteristic of immunoassay tests illustrates the importance of confirmation testing of presumptively positive samples.

Table 2. Possible outcomes of urinalysis

Test Result	Person has taken the drug	Person has not taken the drug
Positive	True Positive	False Positive
Negative	False Negative	True Negative

A negative sample, meaning the drug is not contained in the urine, also has limitations of interpretation. Since drugs have different clearance rates in urine, it is possible that a negative test could result from not sampling soon enough after drug consumption. It is also possible that the dose of the drug taken was not large enough to result in sufficient quantities of drug metabolites to be detected with the current cut-off levels of the laboratory tests. It could also be that the drugs were not used chronically. Intermittent drug use will result in periods of time where no drug or metabolite is

contained in the sample. When a test result is negative, there is also the possibility that the drug was in the sample, and attempts had been made to mask its presence. Addition of adulterants such as bleach or vinegar directly to the sample, or diluting or flushing the system by drinking large amounts of liquids prior to sample collection are two methods used to evade detection. Monitoring pH and visual inspection of the sample at the laboratory will identify the majority of samples where an adulterant was added. There are also procedures in place at the laboratory that are able to identify diluted samples.

Dilution

Offenders dilute their urine by consuming various amounts of liquid before they are tested for illegal drug use. Dilution forces the kidney to rapidly eliminate excess liquid, which results in reduced drug concentrations in urine. It is possible to reduce the concentration of a drug in urine below the established cut-off levels, resulting in a false-negative sample. However, there are ways for the laboratory to identify dilute urine samples. Initial screening includes an assay for creatinine levels. Creatinine is produced by the metabolism of creatine and creatine phosphate in skeletal muscle (Elbert, 1997). The rate of metabolism of creatine and the concentration of creatinine in urine is constant in healthy individuals. A creatinine value of below 20 mg/dL indicates that a sample is dilute, and is subjected to follow-up testing for specific gravity. Specific gravity measures the total solids content of a urine sample and reflects its degree of concentration or dilution. This is done by comparing the weight of a drop of water (1.000 g/L) to the weight of a drop of urine. A specific gravity less than 1.003 g/L is considered to be dilute.

Further Cautions

A negative urine sample alone cannot be taken as proof that that individual has not used drugs such as cocaine or opiates, which have relatively fast clearance rates in urine. It can only be stated that this individual has not used in the past 1-3 days. On the other hand, for chronic users of THC whose detection time in urine is much longer, a positive urinalysis for THC is not conclusive evidence of recent use. Chronic users who have discontinued use will still test positive for THC in urine for quite some time, due to the highly-lipid soluble nature of the drug and metabolites and to the storage and slow

release from adipose tissue (Hawkes & Chiang, 1986). In addition, there are individual differences in physiological characteristics that can influence interpretation of urinalysis tests. For example, there are a small number of individuals who are unable to convert codeine into morphine due to an absence of the necessary metabolic enzyme (Hedenmalm et al., 1997).

The individual goals regarding the type of information desired of urinalysis testing programs must be considered when interpreting the results. Issues specific to the drug use episode itself cannot be determined by urinalysis testing. Specifically, urinalysis cannot determine when the drug was used, the specific dose of the drug used, or the degree of impairment associated with the drug use. In addition, urinalysis cannot determine whether the substance detected was from a legitimate (such as a prescription) or illegitimate source, or how it was administered. For example, urinalysis cannot tell whether the drug taken was consumed orally, smoked or injected. (Manno, 1986).

CORRECTIONAL SERVICE CANADA URINALYSIS PROGRAM

History of Urinalysis in CSC

In 1985, CSC regulations were amended to make the act of using an intoxicant a disciplinary offence. It was also amended to allow for a member of CSC to require an offender to provide a urine sample. Before this, the National Parole Board sometimes imposed urinalysis as a special condition of release. Ensuing operational issues and offender court challenges delayed the implementation of urinalysis nationally (for a historical account of urinalysis implementation in CSC, see CCRA Review, 1995). Urinalysis testing was re-introduced following the Corrections and Conditional Release Act (CCRA) and related Corrections and Conditional Release Regulations (CCRR), which came in effect in November of 1992. The legal requirements and guidelines are now clearly outlined in policy, which gives CSC the necessary authority to require offenders to provide urinalysis samples.

Urinalysis in federal institutions can be requested for several reasons. Offenders can be asked to provide a sample when there are reasonable grounds to suspect the offender is using or has used in the recent past. If offenders are participating in a program or activity involving community contact, and this contact may provide the offenders with access to intoxicants, they may be required to provide a sample as a condition for participation. Urinalysis may be required as part of a condition of participation in a substance abuse treatment program. Finally, offenders are required to provide a sample if their name has been chosen to participate in the random testing program.

Random Urinalysis Program

In 1993, three pilot sites were chosen for the random urinalysis program, Leclerc, Kent and Rockwood Institutions. Preliminary results showed a positive rate of 37.4% from these institutions (CSC, 1998). CSC expanded the random selection program to remaining institutions across the rest of the country in April 1994. Random urinalysis became mandatory April 1, 1995.

Initially, institutions were asked to randomly select 0% to 5% of their monthly populations, and the average requested was 3%. This practice changed late in 1996,

when it became mandatory that institutions request a minimum of 5% and maximum of 10% each month. Random selection is carried out at National Headquarters, where a list of offenders, based on the total on-count institutional population, is generated each month using a random selection computer program. The list is then forwarded to the Institutional Urinalysis Program Coordinator, who has 30 days from receipt of the list to complete testing. All lists are now sent on the first working day of the month, however, in 1995 until about the fall of 1998, a few institutions received their lists mid-month. The rank order of the list must be followed. If an offender is not available when his or her name is reached, that offender's name falls to the bottom of the list and a demand cannot be made to provide a sample until all other offenders on the list have been requested to provide a sample. Once the Urinalysis Program Co-ordinator receives a new monthly list, the previous list is discarded.¹

Consequences

If offenders test positive, they can be charged with the disciplinary offence of taking an intoxicant. An offender who is found guilty of this offence faces one or more of the following consequences: a warning or reprimand, a loss of privileges, an order to make restitution, a fine, performance of extra duties, or segregation from other offenders for a maximum of thirty days. Administrative sanctions that can be ordered as a consequence of a positive urinalysis include transfer to a higher security environment, withholding or refusing recommendations for temporary absence, or referral to a substance abuse program. An offender also has the option to refuse a request to submit a urine sample. If this occurs, staff may attempt to resolve the matter informally, where possible. However, the offender can be charged with the disciplinary offence of failing or refusing to provide a urine sample. The possible consequences of being charged with refusing to provide a sample are the same as for a positive sample. If an offender does refuse, however, CSC is not able to infer that the reason for refusal is due to the fear of a positive test result (Roy, 1990). If there are a large number of refusals, there are implications for the results of the random urinalysis program. The data collected on institutional drug use may provide an underestimate of drug use in institutions, if

¹ A more detailed description of the procedures for urinalysis testing may be found in Appendix B: Collection Procedures.

offenders who refuse would have otherwise tested positive. Refusals also result in a reduction in the proportion of offenders tested to less than the minimum 5% required by CSC, thereby further reducing the ability to generalize the results to the greater offender population. In addition, if offenders perceive a benefit to refusing to provide a sample, the number of offenders refusing may increase to the point that the results of random testing have no practical utility in a correctional setting.

DISCUSSION

ISSUES AND CHALLENGES TO RANDOM URINALYSIS PROGRAMS IN CORRECTIONAL INSTITUTIONS

To act as an effective deterrent, random urinalysis programs in correctional institutions require that all offenders, regardless of suspicion of drug use, be equally likely to be chosen to provide a sample. In this way, a random testing program actually presumes guilt without setting any criterion of reasonable suspicion of use. Urinalysis is also an intrusive process, as direct observation of an individual during sample collection is necessary to prevent tampering of samples. However, it has been demonstrated that the majority of offenders asked to provide a urine sample will test negative for drug use (MacPherson, 2001, Gaes et al., 2001, Edgar and O'Donnell, 1998). To protect individuals from being unduly subjected to this intrusive process, the Office of the Privacy Commissioner of Canada outlined three criteria which justify targeting a group of individuals for random testing (Government of Canada, 1990).

Criteria for Random Urinalysis

Prevalence of Substance Use

One criterion set out by the Privacy Commissioner states that random testing may be justified if there are reasonable grounds to believe that there is a significant prevalence of drug use or impairment within the group. In the case of offender populations, this condition is met. As has been described here and elsewhere, substance abuse problems occur with greater frequency within the offender population than with members of society in general. There is also substantial anecdotal and empirical evidence of drug use in institutions.

Safety of Individuals

A random testing program may also be justified if drug use or impairment poses a substantial threat to the safety of the public or other members of the group, and if there are reasonable grounds to believe that drug testing can significantly reduce the risk to safety. In an institutional environment, the drug trade can contribute to increased risk of

violence towards offenders, visitors and staff through intimidation techniques and threats. Intoxication may also lead to an unsafe environment if offenders are in an altered or dissociative state. In addition, institutional drug use by offenders undermines the rehabilitative goals of treatment, and reduces the effectiveness of programming designed to increase successful reintegration, reduce re-offending, and improve the safety of the communities to which the offenders return.

It has been reported, however, that implementation of a random testing program itself may contribute to increased tensions between offenders and staff. Edgar and O'Donnell (1998) revealed that the majority of adult offenders believed that random testing was not truly random and that staff used random testing to target or harass particular offenders. In addition, there was the perception that random testing was used solely for punitive or deterrent purposes, without any use of test results to benefit the offender. Possible benefits included gaining privileges or increasing the number of home leaves for evidence of abstinence. The perception of the unbalanced nature of random testing was reported to have resulted in an increase in the overall tension within the prison and increased resentment of staff. Two-thirds of the offenders surveyed agreed that random testing had increased staff-offender tensions.

A report prepared by the University of Central England in Birmingham revealed similar attitudes of offenders towards mandatory drug testing by both offenders and correctional staff (MacDonald, 1997). Both groups reported that mandatory drug testing had increased violent incidents and had increased tensions in the institution. Sixty-four percent of staff respondents felt that offenders perceived the selection procedure to be unfair, and 65% reported that offenders believed the consequences for positive tests and refusals to be too harsh.

Attitudes such as these have the potential to undermine goals of the random testing program. This issue is a complex one and requires further research based on empirical data, rather than reliance on offender and staff reporting, to determine if the implementation of a program of random urinalysis decreases incidents of violence in prison. Future research should also examine the more subtle fluctuations in institutional environment, with the goal of determining if a correlation exists between prevalence of drug use assessed by positive urinalysis results and acts of violence and aggression in prison.

Providing Adequate Supervision

Finally, a random testing program may be justified if the use of less intrusive alternatives such as regular medical exams, education, counselling or some combination of these cannot adequately supervise the behaviour of individuals in the group. Again, CSC has demonstrated that it meets this criterion. Nevertheless, CSC has put in place a comprehensive strategy to reduce drug use among offenders and to prevent the introduction of drugs into institutions. Canadian federal institutions currently are equipped with ion scanners used to check individuals on entry into the institution, and drug dogs who routinely conduct searches of visitors and of institutional living units. With just cause, correctional staff conduct searches of offenders, visitors, and regularly patrol institutional grounds and perimeter searching for drugs. In addition, CSC offers a wide variety of substance abuse treatment programming for offenders with an identified substance abuse problem, and each institution offers offenders the opportunity to live in intensive support units, drug-free units where offenders agree to increased searching and voluntary urine testing. Even with all these security and rehabilitative measures in place, drugs still enter institutions. Random urinalysis is often seen as an additional tool, used by security, to combat drug use and identify those offenders using drugs.

Treatment

One objective often stated for random testing in institutions is to identify offenders in need of treatment. Random testing alone cannot be used to assess an offender's long-term drug use, the existence of a chronic problem or the need for treatment. Random urinalysis will detect occasions of drug use, however, as we have seen, the interpretations must be made with caution given variable detection for different types of drugs, individual physiology, frequency of use and dose of drug consumed.

Until 2003, CSC had the ability to impose, as an administrative consequence for providing a positive sample, the requirement to provide monthly samples until the offender provided three consecutive negative samples. This would allow the offender to demonstrate abstinence from drug use over a significant period of time. It also provided an objective measure of drug use that could be used in determining need for treatment. However, a court ruled in 2003 that CSC could no longer request urinalysis samples for this purpose.

Currently, when offenders test positive under random urinalysis, the vast majority are charged with an offence and sent to disciplinary court. One option open to CSC is to refer offenders for treatment. However, not all offenders who test positive for drug use in prison require substance abuse treatment. Although 80% of offenders entering the Canadian federal correctional system have some type of substance abuse problem (CSC, 2003), PERNANEN et al. (2002) reports that only 47% were shown to be dependent on alcohol or drugs as assessed using the Drug Addiction Severity Test (DAST) and the Alcohol Dependence Scale (ADS), and only 54% had consumed drugs or alcohol just prior to committing their current offence.

Offenders entering the federal correctional system in Canada undergo extensive assessment of criminogenic factors during the Offender Intake Assessment process. Dynamic risk factors (factors subject to change in response to intervention) are identified using an assessment of the offender's employment, marital/family, associates/social interaction, substance abuse, community functioning, personal/emotional orientation, and attitudes. A comprehensive evaluation of the offender's need for treatment also uses supplementary assessment results and collateral information regarding the relationship between the offender's drug or alcohol use and the crime for which he has been sentenced (CSC, 2003). Through this evaluation, treatment needs are identified and a correctional plan generated prior to placing an offender in an institution. Current inclusion criteria for CSC's substance abuse programs require evidence that the offender's current crimes were directly related to substance abuse. However, a positive urinalysis result could be used to identify individuals not previously found to have a significant dependence on drugs or alcohol. CSC policy guidelines for monitoring offender progress in institutions allows for a reassessment of substance abuse treatment needs upon receipt of new information relating to the offender's potential for reintegration into the community (CSC, 2003). However, a single positive result on random urinalysis alone cannot provide sufficient justification for a reassessment of an offender's need for substance abuse treatment.

Changing Drug of Choice

An often-stated claim is that implementation of a random urinalysis program will result in offenders changing their use of drugs by switching from cannabis, which has a relatively long detection time in urine, to heroin and cocaine, drugs which are cleared

more rapidly and are far more difficult to detect. The belief that offenders 'switch' their drug of choice to avoid detection has been reported in narrative reviews, and surveys of offenders and correctional staff often reveal similar attitudes (Robinson & Mirabelli, 1996; MacDonald, 1997). However, the data does not support this idea.

A study conducted by the National Addiction Centre in London on mandatory drug testing of incarcerated offenders in England and Wales reported that there was no evidence for switching from cannabis to opiate use based on an analysis of the trends in positive test results (Farrell, Macauley & Taylor, 1998). Since mandatory testing was introduced, there has been a decrease in positive cannabis tests, but no increase in positive opiate tests. Edgar and O'Donnell (1998) asked inmates about their drug use patterns and found very little evidence of switching to harder drugs. Only four percent of their sample reported experimenting with heroin for the first time in prison, and none had persisted in their use. Six percent of offenders who used drugs in prison reported altering the balance of their use from cannabis to heroin. Similarly in Canada, examination of the random urinalysis data did not show any increase in positive tests for opiates or cocaine since the program's inception (MacPherson, 2001). The empirical data does not support the widely held belief that random testing contributes to significant changes in the types of drugs used by offenders.

FUTURE DIRECTIONS

It is clear that much research needs to be done to determine if CSC's random urinalysis program is meeting the stated objectives of reducing the demand for drugs and contributing to a safer institutional environment. Although urinalysis is a well-established technology, it is not without limitations. Results of urine tests must be interpreted with caution due to the myriad of possible factors that could influence the results. Because all drugs have unique pharmacological properties that influence the half-life, the amount of time it takes for drug to be eliminated from the body is variable. The rate of elimination of the drug in urine can vary from 1-2 days for heroin and morphine, and up to 21 days for chronic users of marijuana.

In addition to the technical challenges that urinalysis presents, there are also operational, or institutional, factors that can influence the accuracy of the results. These can pose serious challenges to effective implementation of a program of random urine testing. It is possible for urine tests to be contaminated or diluted, either by adding a substance to the sample such as bleach, or by drinking large amounts of fluids prior to testing. There is also the possibility that the inmate will refuse to be tested, which can bias results. In particular with a program of random testing, prior knowledge of when the tests will occur could make it possible to evade detection by discontinuing use for a period of time before the test. This depends again on the type of drug used and the rate the drug is cleared from the urine. Discontinuing use will most effect testing for drugs that have short half-lives, and could lead to an underestimation of the prevalence of use for those particular drugs.

Distribution of Testing

For random urinalysis programs to be most effective, the element of unpredictability in the testing schedule must be adhered to. Operational issues such as availability of offenders to be tested when their name is reached on the random list, and availability of trained urinalysis collectors at all times in the institution have the potential to restrict urinalysis schedules to the point where they are no longer random. In a report released by the National Addiction Centre in London (Farrel et al.,1998), it was shown that random tests were not being conducted on weekends, which could lead to increased drug use late in the week if offenders determined the collection schedule. While the

patterns of refusals and positive tests examined in the data did not reflect this trend, this area requires further study. Future research reports using the results from CSC's random urinalysis program will address the issue of testing distribution and its impact on the results of random testing.

Trends

Future research will also describe the results of random testing, focusing on institutional positive rates, types of drugs found, refusal rates, and incidence of dilution and adulteration of samples. Trends will be outlined in each of the above areas, examining the results over time, between regions of Canada, and between institutional security levels.

Profiling

Other initiatives currently underway include the construction of profiles of offenders testing positive and offenders refusing to be tested, using demographic information as well as information gathered through the Offender Intake Assessment process, the offenders' level of substance abuse problem, and a review of the offender's criminal history. Since refusal rates for random urinalysis testing are increasing in CSC (MacPherson, 2001), it is important to identify not only those offenders who test positive for drug use, but also those offenders most likely to refuse. It is of interest to determine whether the profile offenders who refuse is similar to the profile of offenders using drugs. This will provide CSC with valuable information for developing effective strategies for dealing with offender refusals.

Consequences

Increases in refusals to be tested by CSC have also prompted an examination of the consequences of testing positive as compared to the consequences for refusing to be tested. There exists within CSC policy a potential explanation of why refusing to be tested and being charged in disciplinary court is preferred to submitting a positive sample and being charged with taking an intoxicant. In CSC, if an offender is convicted in disciplinary court of taking an intoxicant, a record of substance abuse is placed on the offender's file. When the National Parole Board examines the offender's case to

determine the need for special conditions of release, a record of substance abuse may result in the imposition of an order of abstinence from all substances. As a method of monitoring abstinence conditions, parole officers are required to devise a schedule of urinalysis testing for the offender that occurs with a prescribed frequency but at irregular intervals. Therefore if offenders in the institution know that conviction of taking an intoxicant as a result of submitting a positive sample will likely lead to the requirement of providing urinalysis samples in the community, they might be more likely to refuse. Current research into the consequences of testing positive and refusing is focusing on the outcomes of disciplinary court charges for both groups, along with a review of parole officer reports used by the National Parole Board and others to make decisions regarding offenders' liberties.

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APPENDIX A

PHARMACOLOGICAL BASIS FOR URINE TESTING

Absorption

Drug absorption is dependent on the chemical properties of the drug and on the method for introducing the drug into the body, also known as the route of administration. The main routes of administration for the drugs of abuse are intravenous, oral, inhalation and intranasal; they are described more fully in Table 3. For each route of administration the rate at which the drug will be absorbed differs. For example, the onset of pharmacological effect is much slower for a drug taken by the oral route than for one taken intravenously because it has to first pass through the lining of the intestine into the bloodstream before it is distributed throughout the body. In comparison, intravenous injection puts the drug immediately into the bloodstream. Drugs are rapidly absorbed from the lungs due to the large alveolar surface area and extensive regional blood flow. Drugs absorbed from the mouth are rapidly absorbed into the bloodstream, which also results in a faster onset of pharmacological effect. Subcutaneous and intramuscular injection result in a slower onset of effect depending on the blood flow to the local injection site and the solution in which the drug is dissolved in the syringe. Application of a drug intranasally will result in a slower onset of effect, however still more rapid than the oral, subcutaneous or intramuscular routes. The drug is absorbed into the bloodstream through the nasal mucosa, although some will be ingested and absorbed orally.

The rate of drug absorption depends on the chemical properties of the drug itself, in particular the drug's lipid solubility, or how well the drug can pass through cell membranes. In general, there are three main ways in which small molecules cross cell membranes: 1) Cell membranes are made up of a lipid bilayer, and highly lipid soluble drugs diffuse easily through cell membranes to reach target tissues; 2) Smaller molecules can diffuse through aqueous pores or channels in the membrane, however, most drug molecules are too large to pass through these pores; and 3) Specialized transport mechanisms located in cell membranes regulate entry and exit of molecules. These

generally involve a carrier protein, which binds the transported molecule and deposits it on the other side of the membrane.

Distribution

Once the drug is absorbed into the bloodstream, it is rapidly distributed throughout the body. Depending on the lipid solubility of the drug, it can be deposited in tissue reservoirs such as adipose (fat) tissue, which may act as a storage depot for the drug. For example, THC is very lipid soluble, and is readily distributed to tissues, including adipose tissue. It has been suggested that the slow release of THC from adipose tissue is the reason for the slow elimination of the drug from the body and the lengthy detection time in urine (Hawkes and Chiang, 1986).

Another factor that influences the distribution of the drug is binding to plasma (blood) proteins. Drug molecules may become bound in plasma, which renders the drug inactive until it is released. The amount of drug free to exert the intended pharmacological effect consists of drug molecules not bound to plasma protein. Extensive plasma protein binding will prolong the drug effect and slow drug elimination.

Table 3. The main routes of drug administration

	Route of Administration	Site of Absorption	Drug Examples
Common for drugs of abuse	Intravenous injection	Blood	Heroin, diazepam, cocaine
	Inhalation	Lungs	Anaesthetics, Marijuana, cocaine
	Intranasal	Mucous membrane	Cocaine
	Sublingual	Mouth	Nitroglycerine, LSD
	Subcutaneous injection	Skin	Steroid hormones
	Oral	Intestine	Amphetamine, Valium, codeine
Not common for drugs of abuse	Intramuscular injection	Muscle	Insulin
	Spinal injection	Cerebrospinal fluid	Opiate analgesics
	Eye drops	Cell layer (epithelial tissue)	Physostigmine
	Transdermal	Skin	Nicotine, Nitroglycerine patches

Metabolism

The primary function of metabolism is to terminate the pharmacological activity of a drug, in other words, deactivate the drug and produce metabolites that will be more easily excreted in urine. Metabolism refers to enzymatic degradation of drug molecules, which occurs mainly in the liver. While other areas in the body, such as the kidney, lung, and intestine, also have metabolic abilities, the metabolism that occurs in these areas is minimal.

Biochemical degradation of molecules usually occurs in two phases, known as Phase I and Phase II. Both stages normally decrease the lipid solubility of the substance, thereby increasing the rate of urinary clearance. The metabolism occurring as a result of

Phase II enzymes is primarily involved in the deactivation of the drugs and metabolites, facilitating their excretion in urine.

However, other effects of metabolism can occur. Phase I metabolism can produce reactive intermediate compounds. In some cases, these metabolites have different pharmacological activity than the drug that was taken, which can cause adverse side effects. In the extreme, metabolites can produce toxic effects. An example of a toxic metabolite is cocaethylene, which is created in the liver as a result of taking alcohol and cocaine simultaneously (Horowitz and Torres, 1999).

Metabolites can also have biological activity similar to the parent compound, which prolongs the pharmacological effect long after the parent drug has been eliminated. Many benzodiazepine metabolites have this characteristic. In fact, while oxazepam (Serax) is sold as a prescription drug, it is also a common benzodiazepine metabolite. Some drugs only become pharmacologically active after they have been metabolized. This is the case with codeine, which is inactive until it is metabolized to morphine. In cases such as this, the drug administered is termed a pro-drug.

Repeated exposure to some drugs can cause an increase in their own metabolism, as well as that of other drugs metabolised by the same system, known as enzyme induction. This is one mechanism that accounts for the development of tolerance to a particular drug or class of drugs. If metabolism is increased, the drug will be eliminated more quickly, and therefore the pharmacological effect of the same dose of a drug will be less than it was in the naive system.

A particular characteristic of some drugs taken orally is that they can be susceptible to an effect known as first-pass metabolism. This means they are metabolised in the liver before being distributed in the bloodstream. Some drugs can also be metabolised in the wall of the intestine. This greatly reduces the effectiveness of a drug, and a much higher dose is needed to give the desired pharmacological effect. Increasing the dose of a drug administered orally to overcome first-pass metabolism is not the most effective method. Certain drugs such as the benzodiazepine midazolam is not administered orally since a large proportion is no longer active after first pass metabolism. As was discussed, drug metabolites can have serious, sometimes toxic adverse consequences. If the extent of first-pass metabolism is great for a given drug, alternate methods of drug delivery that bypass this effect are employed.

Excretion

The major route of elimination of most drugs is from the kidney, where drugs and metabolites are excreted in urine. Some elimination can also occur in sweat glands, saliva, feces, and in expired air from the lungs. Drugs and metabolites are distributed to the kidney through the systemic circulation. Once there, molecules can either be filtered into the kidney, or transported across membrane barriers by an active carrier mechanism. In the kidney, drugs that are highly lipid soluble will be reabsorbed into the blood by passive diffusion. The result of reabsorption is the redistribution of drugs and metabolites via the bloodstream, which prolongs their activity and slows excretion, increasing the length of time they are detectable in urine. Drugs and metabolites that are not reabsorbed remain in the filtrate and leave the kidney to the bladder as urine.

Urinary pH also influences how quickly drugs are eliminated. The "ion-trapping" effect states that a basic drug will be eliminated more rapidly in acid urine, because the low pH within the tubule of the kidney will favour ionization and thus inhibit reabsorption. The opposite is true for an acidic drug, whose excretion would be most rapid if the urine is alkaline. Excretion of amphetamines and methamphetamine is influenced by urinary pH. For example, in 24 hours, 79% of a dose of amphetamine will be excreted in acidic urine, whereas only 45% will be excreted if the urine is more basic (Hawkes and Chiang, 1986).

Table 4 outlines some of the common drugs of abuse and clearance rates in urine. The length of time different drugs can be detected in urine varies considerably, and is highly dependent on pharmacological and chemical properties of the drug, and physiological characteristics of the user. In addition to the processes described above, there are individual variations in the ability to metabolise certain drugs (Hedenmalm et al., 1997)

Table 4. Clearance rates of some common drugs of abuse

Drug	Clearance rate
Alcohol	2 - 10 hours (at a constant rate of 18-20 mg/dL/h)
Opiates	1 - 2 days
Amphetamine	1 - 2 days
Cocaine	1 - 3 days
Ritalin	1 - 2 days
Prozac	2 - 4 days
Benzodiazepines	1 - 6 weeks
PCP	1 day - 5 weeks
THC	1-4 days single use; 14-21 days chronic use

APPENDIX B

CSC COLLECTION AND LAB PROCESSING

Notification to Provide

Under random urinalysis guidelines (Commissioner's Directive 566-10, 2003), each inmate is given written notification to provide a urine sample stating the reason for testing, which they are required to sign. From that time they have 2 hours to provide a urine sample. During this time they must be kept separate from any other person and supervised, preferably in a separate room. They are also allowed water during the 2 hour period. CSC guidelines further specify that the time and date of collection should be irregular, and offenders should not be informed in advance of the date and time they will be required to provide a sample.

Chain of Custody

A strict chain of custody is established from the time the sample is requested to the point where results are communicated back to the offender. This is done to protect the rights of the offender, as well as the integrity of the results. A Chain of Custody form must be completed by the collector, signed by the offender, and accompany each urine sample. The document includes data identifying the offender with the accompanying sample, and specifies the collection steps required and if they were completed by the collector.

Collection

The collector must escort the offender to the collection area, and may conduct a routine non-invasive or routine frisk search. The offender is required to remove any bulky clothing, and wash his/her hands. The specimen must be provided under direct observation by the collector, and once completed the offender must place the lid on the container before giving it to the collector. In the case of alcohol testing, the container is given over to the collector open, upon which the collector will extract a certain amount of the sample and place it in a separate vial specified for alcohol testing. The collector then closes both containers in the presence of the offender. A temperature reading must be

taken within 4 minutes of collection and recorded on the chain of custody form. In the presence of the offender, the collector places tamper-resistant tapes on each of the containers, and both the offender and collector initial the tape. The specimen is then sealed in a waterproof bag with chain of custody documentation. The samples are then shipped by purolator courier overnight to the CSC contract laboratory, MAXXAM Analytics Inc. Once the sample is received, the laboratory matches chain of custody paperwork and specimen bottles, and begins its own internal chain of custody documentation.

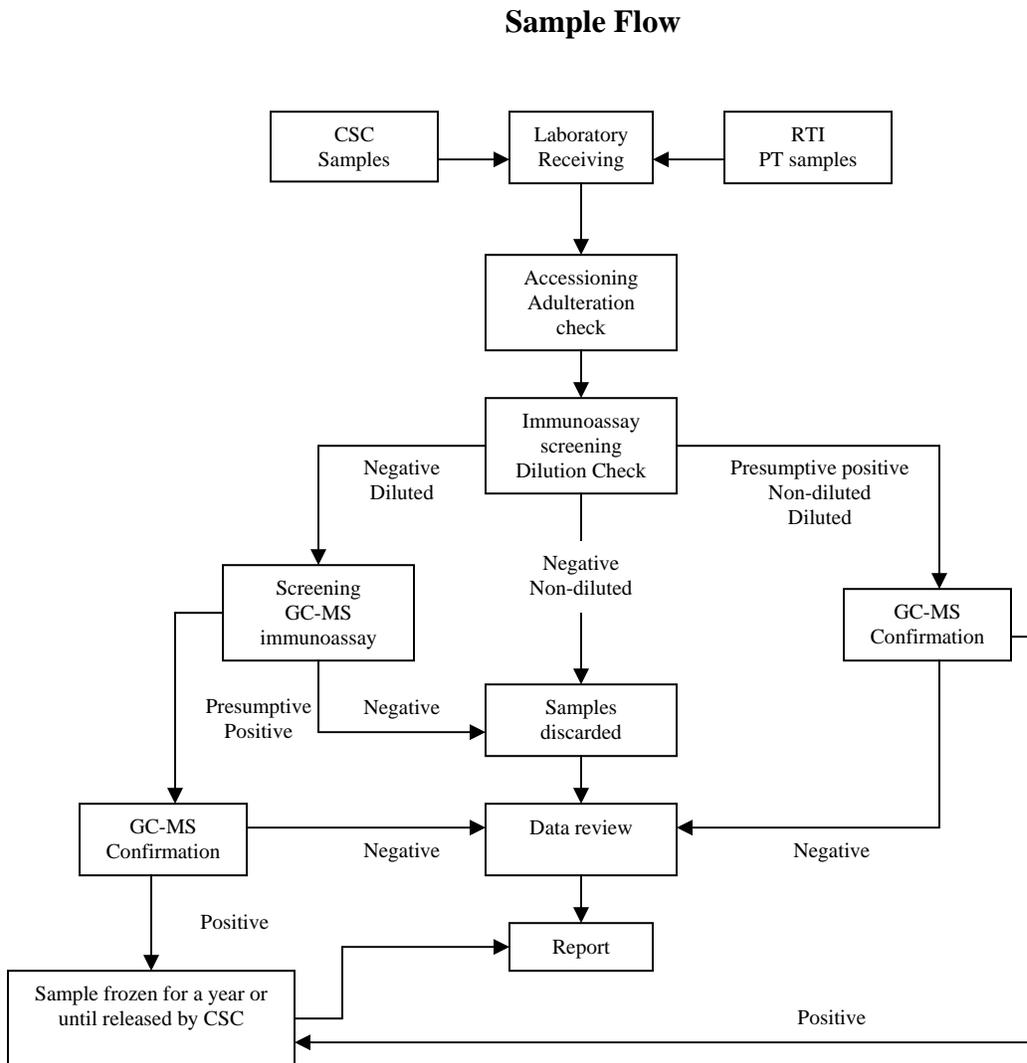
Collection Facilities

Urine collection requires that the inmate be under direct observation by the collector at all times during the collection process. For this reason collection facilities must be designed to be at least large enough for two people, yet allow sufficient space such that there is not a threat to the security of the collector, or that there is not unreasonable infringement on the privacy of the offender. Collection facilities should also be equipped with a small fridge to keep the urine samples, and a sink to be used by both the offender and the collector.

LABORATORY ANALYSIS

Purolator Courier transfers samples overnight to the CSC contract laboratory, MAXXAM Analytics Inc., in Mississauga, Ontario. Once at the laboratory, staff checks the packaging and verifies that the samples match with offender identification information. Receiving staff also checks specimens for any obvious signs of adulteration. The lab then starts internal chain of custody documentation (for a depiction of the lab process, see figure 1.)

Figure 1. Procedure for processing samples at Maxxam Laboratories. (reprinted with permission from *Overview of Urine Drug Testing 2003*, Security Division, CSC).



Once the lab has received the sample, a process begins whereby it is screened using immunoassay techniques as described previously. Non-diluted, negative samples are discarded, non-diluted positive samples are sent for confirmation testing, and diluted samples are screened again according to the dilution protocol and revised cut off levels. Presumptive positive samples that are confirmed to be positive using GC/MS are then stored for a year according to CSC policy. Diluted samples that screen positive are sent for confirmation testing, and if they are confirmed positive they also are stored for a year. Diluted samples that screen negative are discarded.

Drugs and Cut Off Levels

Table 5 outlines the drugs tested for in the CSC urine testing program and the cut-off levels associated with non-diluted samples.

Table 5. Screening and Confirmation Cut-Off Levels for CSC Urine Testing		
Drug	Screening Cut-Off Level (ng/mL)	Confirmation Cut-Off Level (ng/mL)
Stimulants		
Cocaine	150 (benzoylecgonine)	150 (benzoylecgonine)
Amphetamines MDMA	1000 (d-methamphetamine)	500 (amphetamine and/or methamphetamine + 200 amphetamine)
Opiates and Morphine Derivatives		
Opiates A (Morphine, Codeine, 6-monacetyl morphine)	300 (morphine equivalent)	300 (morphine and/or codeine)
Opiates B (Hydrocodone, Hydromophone, Oxycodone)	300 (morphine equivalent)	None (If the confirmation for subgroup a) of Opiates is negative, the laboratory will proceed to confirm subgroup b) by using the limit of quantitation for each drug as the cut-off.)

Table 5. Screening and Confirmation Cut-Off Levels for CSC Urine Testing

Drug	Screening Cut-Off Level (ng/mL)	Confirmation Cut-Off Level (ng/mL)
Hallucinogens		
Phencyclidine (PCP)	25	25
THC (cannabinoid)	50 (THC-COOH equivalent)	15 (THC-COOH)
Depressants		
Benzodiazepines	200	100
a) Oxazepam, Nordiazepam, Temazepam	(as oxazepam equivalents)	(If the confirmation for subgroup a) of Benzodiazepines is negative, the laboratory will sequentially proceed to confirm subgroup b) and then subgroup c) using the limit of quantitation for each drug.)
b) Alprazolam, Lorazepam, Triazolam		
c) Halazepam, Clonazepam		
Samples Tested on Demand Only (Special Request Tests)		
Alcohol	20	20
LSD	0.1	0.5
Volatile Substances (mg/dl)	LLOQ	LLOQ

Dilution

Dilute specimens are analysed under a specific dilution protocol (Figure 1.). If a specimen is considered dilute (creatinine < 20mg/dL) but tests positive in initial screening immunoassays, it is sent for GC/MS confirmation using the regular cut-off values for a positive test. If the drug or metabolite concentration is below the regular cut-off value for the confirmation test, the lowest limit of quantitation (LLOQ) cut-off for the drug is used instead. If the initial screening process fails to find any drug in a dilute sample (negative result), the immunoassay and confirmation cut-off levels will be lowered and drugs screened. If a sample then tests positive, it is sent for GC/MS

confirmation testing using the LLOQ for that drug class. Table 6 outlines the screening and confirmation cut-offs based on the diluted sample protocol.

Table 6. Screening and Confirmation Cut Off Levels for Dilution Protocol in CSC Urine Testing

Drug	Screening Cut-Off Level (ng/mL)	Confirmation Cut-Off Level (ng/mL)
Cannabinoids	20	6
Amphetamines	100	100
Cocaine Metabolite	15	15
Opiates (C + M)	120	120
PCP	5	5
Benzodiazepines	100	50