WORKPLACE SUBSTANCE USE, THE RISK OF OCCUPATIONAL INJURY, AND TESTING

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Over the past 20 years, the ‘‘workplace substance abuse prevention industry’’ has grown enormously in size and become more sophisticated in its marketing approach. Drug testing alone has become a $6 billion industry. Employee assistance programs are now widely used by employers at significant cost. This thesis presents a brief review of drug use patterns as related to occupational injuries together with a history of workplace testing. Results from studies suggest that drug-free workplace programs are an important public health approach to improving workplace health and safety through early intervention and, quite possibly, substance abuse prevention.

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1. INTRODUCTION

Substance abuse remains one of the nation's most important public health problems, resulting in significant morbidity and mortality [1]. Drug use is especially prominent in the United States, which comprises only 6% of the world's population, but participates in 60% of the world's illicit drug use [2]. Drug use has plagued America for decades. "In 1962, four million Americans had tried an illegal drug. By 1999, that number had risen to 87.7 million, according to the National Household Survey on Drug Abuse." Drug use is in every aspect of society. The issue of drug use has now expanded to include the workplace [32], [33].

In the United States, national surveys can be used to track patterns of self-reported drug use. The National Household Survey on Drug Abuse began in the period 1971-1972 and has continued ever since. The national surveys show that marijuana use increased over the decade of the 1970s, reached a plateau in the 1980s and began to drop in the late 1980s and early 1990s. Cocaine use grew through the 1970s and early 1980s but then reached a plateau and also began to decrease. Among Americans over the age of 12, the number currently using illicit drugs (i.e. having used them in the past month) dropped from 23 million in 1985 to 13 million in 1991, or by more than 40% [3]. During the same period, current cocaine use dropped by about two thirds [5].

In 1991, among full-time employees, 6% were current users of illicit drugs. Drug use varied significantly from industry to industry. Among full-time employees aged 18-34, current drug use ranged from 15.4% among construction workers down to 6.5% among professionals. In most industries, the %age of current drug users in this age group has been decreasing since 1988 [3]. The annual Monitoring the Future Survey conducted by the Institute for Social Research at the

University of Michigan showed a similar pattern of drug use among secondary school pupils aged 17-18 in the period 1975-1990 [4]. The number of such pupils who had used marijuana in the last year increased from 40% in 1975 to 51% in 1980, but subsequently dropped to 27% in 1990. Similarly, cocaine use increased from 6% in 1975 to 12% in 1981 but dropped to 5% in 1990 [5].

Current national data reported by the 2000 National Household Survey on Drug Abuse (NHSDA) indicate that 15.4% of persons aged 18 years and older used illicit drugs during the past year, while 8.8% were current (past month) users [6]. Heavy drinking (drinking five or more drinks on the same occasion on each of five or more days in the past 30 days) was reported by 7.3% of the population. Persons aged 18 to 25 had the highest reported rates of current illicit drug use and heavy drinking, 15.9% and 12.8%, respectively.

Epidemiological data suggest that the substance use patterns of employed individuals resemble those for society in general (7). Although some research suggests that unemployed persons have the highest rates of substance use (8), virtually all experts agree that the majority of alcohol and drug users - and quite possibly a majority of those experiencing substance-related problems - are in the workforce [9], [10], [11], [12], [13].

Alcohol and other drugs have had an extended and varied association with the workplace. At one time, for example, the British navy paid one third of each sailor's salary in rum. The first federal law on alcohol in the United States of America was passed when the nation was barely a year old; a 1790 statute authorized that every soldier be given a daily ration of a quarter pint of rum, whiskey or brandy ([14], p. 129).

Despite this legacy, the ill effects of alcohol and other drugs have periodically alarmed many who are interested in the smooth and efficient functioning of enterprises. In the early

1800s, farmers in the United States and small business owners were distressed by the manner in which employees' excessive drinking affected their work performance. Such concerns were among the driving forces behind the emergence of the temperance movement [15]. In the late nineteenth century, industrialists in the United States who were worried about their employees' health and such "undesirable" activities as heavy drinking, which endangered the operations of their factories, hired welfare secretaries to shape a "new, improved and contented" workforce that would not disrupt factory life.* A major automobile manufacturing company hired investigators to probe employees' drinking habits during their off-work hours. Persons who would not, or could not, abide by corporate expectations often were summarily dismissed [16], [17], [18], [19], [20]. In the 1940s, management and workers' groups developed occupational alcoholism programs (the forerunners of modern employee assistance programs) to identify alcohol-related problems among workers and to persuade alcohol-impaired employees to seek assistance [13]. *See. Blair [22] for an early report on drug abuse in the workplace

Recent responses to alcohol and other drug use by employees represent a continuation of earlier cycles of concern. A major difference in the current flurry of activity, however, is a growing sensitivity regarding the adverse consequences associated with illicit drug use by members of the workforce. In the 1960s, heroin addiction was deemed a threat to worker health and safety [21]. In the 1970s and 1980s, attention shifted to other illicit drugs, most notably marijuana and cocaine. Regardless of the specific drug, the focus switched away from alcohol use (which continues to be the drug most widely used and abused by employees) to illicit drug use. Illegal drug use by employees was defined as a "serious" problem. The problem's severity was uncertain; ways to resolve it were unclear [13].

With the shift in attention to illegal drugs, enterprises were confronted with a new set of issues. In addition to the impact of drug use on work performance, productivity and business costs, new questions arose about such matters as workplace security, public confidence and unlawful activities by organization members. Traditional methods for dealing with substance use in the workplace were challenged; new, more comprehensive strategies were developed. In some countries (most notably the United States) the workplace was designated as a crucial battlefield in a "war on drugs" [13].

Much of the early experience in drug screening large numbers of people came from the United States military. The military had initially introduced urine drug screening to identify heroin users returning from military duty in Viet Nam in the late 1960s and early 1970s. That program was extended to screening soldiers reporting for active duty in the early 1970s. In 1980, the United States Department of Defense published a survey of substance abuse among active duty military personnel [23]. Overall drug use in the military services was reported at 26%. Among young enlisted men aged 18-25, usage was as high as 47 % in the United States Navy and Marine Corps. In May of 1981, a Marine Corps aircraft crashed aboard the aircraft carrier Nimitz. Of the 14 people who died, 9 revealed evidence of cannabinoids in the autopsy. In addition, the pilot was taking a prescribed antihistamine without the knowledge of his commanding officer or flight surgeon. The publicity surrounding the crash accelerated the decision by the Navy to implement across-the-board drug screening [5].

In 1986, the United States Government began full-scale efforts to advocate urine drug testing in the workplace. In the spring of 1986, the President's Commission on Organized Crime released its report on habits of Americans: drug abuse, drug trafficking and organized crime. After outlining the relation between organized crime and illegal drug use, the Commission turned

towards solutions. Since attempts to limit the supply of drugs had failed, the Commission advocated a series of measures to decrease demand. In particular, it called upon the Government to "provide an example of the unacceptability of drug use. The President should direct heads of all federal agencies to formulate immediately clear policy statements with implementing guidelines, including suitable drug testing, expressing the utter unacceptability of drug use by federal employees" [24]. On 15 September 1986, President Ronald Reagan issued Executive Order 12564 on the Drug Free Federal Workplace. President Reagan stated that drugs were causing billions of dollars of lost productivity each year. In particular, he stated that federal employees using illegal drugs were less productive, less reliable, and prone to absenteeism. He asserted: "the profits from illegal drugs provide the single greatest source of income for organized crime, fuels for violent street crime, and otherwise contribute to the breakdown of our society". He then called on all federal employees to refrain from using illegal drugs and mandated each executive agency to establish a program to "test for the use of illegal drugs by employees in sensitive positions" [25]. Federal agencies moved quickly to set up drug-screening programs [5].

This federal initiative defined a model drug-free workplace (DFW) program that included the following components [26]:

> (1) a written policy describing the employer’s expectations about drug use and consequences of policy violations;
>
> (2) an employee assistance program (EAP) to provide confidential problem assessment, counseling, referral to treatment, and follow-up support after treatment;

(3) supervisor training to orient supervisors to the employer's drug abuse policy, to define the supervisor's responsibility to refer employees when job performance deficits are noted, and to recognize and respond to employees with problems;

(4) employee education to describe the signs and symptoms of drug abuse and its effects on performance and to explain the program; and

(5) drug testing on a controlled and carefully monitored basis.

Following the federal initiative, private employers and public sector agencies adopted DFW programs. Reliable data on the use of DFW programs are unavailable, but surveys suggest that workplace substance abuse prevention activities, especially drug testing, are now used by more than one-half to two-thirds of major U.S. businesses [26]. Despite the importance attached to substance abuse prevention, little formal evaluation of DFW programs has been conducted [27].

In January 1987, a passenger train crashed at Chase, Maryland, killing 16 passengers, injuring 174 and causing millions of dollars in property damage. The urine specimens from both the engine-driver and brakeman of the train were positive for marijuana. On 21 January 1987, the United States Department of Transportation proposed rigorous drug- testing programs, requiring pre-employment, post-accident and random testing of airline pilots, railroad workers, air traffic controllers and other employees in safety-related positions [5], [28].

In addition to the military and transportation markets mentioned above, drug testing has now been extended to other areas including pre-employment screening for private industry (workplace market), testing of inmates and parolees (criminal justice market), toxicology screening in the emergency room (clinical market), monitoring of rehabilitating addicts (rehabilitation market), and testing of students participating in athletic activities (education and

sports market). In the U.S., the workplace niche is the largest market segment. Most workplace drug testing programs follow the guidelines established by the U.S. Department of Health and Human Services' Substance Abuse and Mental Health Services Administration (SAMHSA), while the U.S. Department of Transportation (DOT) establishes separate guidelines for programs under its jurisdiction [29], [30], [31].

The current trend in the workplace is an increase of drug testing conducted by employers. "Since 1987, the number of U.S. corporations that use drug testing has risen 277%. Ninety per cent of Fortune 500 companies use drug tests to screen potential employees, including on-the-job screening [33], [34].

At present approximately 35 million drug tests are performed each year at a direct cost exceeding one billion dollars [35]. This money is distributed among numerous parties within an enormous drug testing industry, and recipients include laboratories, third party administrators (TPAs), medical review officers (MROs), substance abuse professionals (SAPs), specimen collectors, and others. Indirect costs of this effort are rarely contemplated and involve decreased productivity as a result of time lost for testing. Tests are typically performed before employment, after accidents, for suspicious behaviors, in a random fashion, or for follow-up of individuals with a history of drug use. It is estimated that companies with drug-testing requirements employ half of the American workforce. The vast majority of employees believe that these tests deter drug use. Most also believe that drug tests reduce accidents and product defects [36], [37].

2. SUBSTANCE RELATED PROBLEMS IN THE WORKPLACE

Anecdotal and inferential evidence suggests that illicit drug use and alcohol abuse produce numerous problems in the workplace, including threats to work-site safety and security, higher

accident rates, lower productivity, legal liabilities, and dangers for the public [38], [39]. Business leaders, workers and others view substance use and abuse as critical issues confronting business and industry [40], [41], [42]. Consequently, efforts to establish drug -free work environments are supported widely by most citizens [43], [44], [45], [46], [47], [48], [49], [50]. It seems clear that drugs and alcohol can impair individual performance (e.g. perceptual ability, visual-motor coordination, interpersonal behavior) [51], [52], [53].

An early study by Observer and Maxwell [54] discovered that alcohol abusers had twice as many accidents on the job as a comparison group of workers of the same age, sex, ethnicity, job tenure and job class. Two more recent studies showed that alcohol was the most common drug involved in occupational fatalities, being present in 10.7% and 13.3% of the cases [55], [56]. Other evidence tentatively 'suggests that alcoholics/problem drinkers are approximately 2 to 3 times more likely to be in industrial accidents than non-problem drinkers' [57], [58].

A study of job applicants for the United States postal service at Boston, Massachusetts, found that newly hired employees who tested positive for marijuana or cocaine had higher rates of job turnover, industrial accidents, absences, occupational injuries and disciplinary episodes during their first year of employment [59]. In a two-year follow-up study, it was discovered that the work-related difficulties experienced by persons testing positive for cocaine remained relatively unchanged during their second year of employment; however, the risk of work-related problems appeared to decline slightly for employees who had tested positive for marijuana use [60].

Another blind, multi-site study of the United States postal service, covering the first year of employment, found that newly hired employees with drug-positive urine had higher absenteeism rates than other newly hired employees (6.6% versus 4.2%) [13].

A study by a major motor vehicle manufacturer based in the United States found that drug-dependent employees who utilized employee assistance programs experienced twice as many occupational injuries as non-drug dependent workers [61]. A case-control study involving hourly workers of a large manufacturing plant found that, over a five- year period, substance-abusing employees averaged significantly more absences than non-substance-abusing workers. They also were more likely to experience accidents and injuries [62]. Several studies of United States military personnel have concluded that illicit drug users are more likely than others to encounter work-related problems and to be discharged for unsuitability or performance problems [63], [64], [65].

In Harris County, Texas, Lewis and Cooper reported on 196 fatal work-related injuries occurring between 1984-85. Of this group alcohol was detected in 13.3% of cases examined, and drugs capable of altering physiologic function in 7% of cases examined [66]. In 1989 Taggart described a dramatic decline in “personal injuries” associated with fewer positive tests in a railroad industry following the institution of drug and alcohol testing in 1984 [67].

A study of 459 workplace deaths conducted in Alberta, Canada revealed 10 workers who tested positive for cannabis, and 40 who tested positive for alcohol. Fifty tested positive for either prescription or non-prescription drugs [68].

A retrospective review of deaths in New Mexico noted that information about the presence of alcohol or drug use was available in 530 of 613 occupational deaths. The presence of alcohol was detected in 13.6% of deaths, and 6.4% of these were legally intoxicated. Drugs of abuse were present in 4.5% of the deceased, but 1.3% of these were also positive for alcohol [69].

Another Canadian study of 470 occupational fatalities that occurred between 1986 and 1989 in Ontario noted the presence of alcohol in 2% of those tested, and the presence of cannabis in 17% of those tested, but no other drugs of abuse were identified [70].

Investigators reviewed claims of work-related accidents and injuries from 1984 until 1988 at a company with 48 facilities in Wisconsin. Twelve utilized drug testing and 36 did not. Accident rates were identical, but post-accident testing in 3 facilities was associated with a decrease in claims when compared to the pre-testing period, or with facilities only using pre-employment testing [71].

A study of the construction industry used questionnaires from 69 companies who responded of 405 companies (17%) selected. The workers' compensation experience rating modification factors (MODs) were noted to be lower in companies utilizing drug tests. Additionally the average injury claim rate declined after institution of drug testing [72].

Dawson studied the association between the frequency of heavy drinking and occupational injury, and noted an increased risk for light, moderate, or heavy daily drinking [73].

Lipscomb *et al* reviewed 3955 deaths that occurred between 1988 and 1994 among construction workers in North Carolina. There were significant differences between work-related and non-work related fatalities. Fifty-seven % of the non-work-related victims were impaired by alcohol, compared with 5 % of the victims with work-related injuries [74].

The Washington Drug-Free Workplace Program (WDFW) was associated with a selective, industry-specific preventive effect. For three industries, construction, manufacturing, and services, the net reduction in (all) injury rates was both meaningful and statistically significant. In terms of more serious injuries involving lost work time, a significant preventive effect was documented for two industry groups: construction and service. Due largely to this

selective effect, the annual risk of any injury was reduced by about three cases per 100 person-years, while the risk of more serious (time loss) injuries was reduced by about one injury per 100 person-years [27].

For construction, manufacturing, and service industries the average (medical and disability) cost per injury was $4,851, $2,228, and $3,222, respectively (1996 dollars). Given these costs, the injury risk reduction associated with the drug-free workplace program for a company with 50 employees would generate an estimated annual savings of approximately $11,600 for construction companies, $3,800 for manufacturing companies, and $11,450 for service companies. These figures, however, do not represent net savings because they do not account for the costs of drug testing or EAP services that the employer would pay. Depending upon the frequency of testing and the cost of EAP services, these gross cost savings figures could be reduced by $1,500 to $2,000 assuming a per drug-test cost of $50 and an annual EAP cost of $20 per employee [27].

The WA State study by Wickizer, et al, focused on assessing the outcomes of the intervention in terms of injury rates. They were unable to examine the effects of individual program components, for example, drug testing, use of EAPs, or supervisor training. But, a limited process evaluation that included both a survey (mailed questionnaire) of WDFW participant employers and site visits to selected participant companies was conducted. The survey revealed that the great majority of employers fully implemented the program and complied with its requirements with respect to performing drug testing, developing a formal workplace policy, and offering training, education, and treatment. Qualitative information gathered through the site visits suggested the program may have helped to change the work culture in ways that promoted safety. Before the program, employers and employees, especially

in the construction trades, often accepted the inevitability of workplace injuries. For companies experiencing high injury rates and substance abuse problems, the program appeared to help promote a work culture that emphasized safety and the importance of reducing injury risk through substance abuse prevention and treatment activities [27].

The strongest evidence of an intervention effect may come from the construction industry. Injury rates in the pre-intervention period for the intervention and comparison cohorts were similar, but the rate for the intervention cohort declined markedly shortly after the start of the drug-free workplace program.

This study has several important strengths that also bear mention. First, the study spans a substantial period of observation, seven years that includes a two and a half-year baseline (pre-intervention) period as well as a three-year intervention period. Second, the injury rates analyzed by the study are based on workers' compensation insurance claims information rather than worker self-report. Third, the intervention and comparison cohorts are based upon a large number of companies representing a large workforce in different industries. Fourth, they were able to test the robustness of a confidence interval analysis by applying more sophisticated statistical analyses (ARIMA models) to control for possible time series effects [27]. This study represents the most detailed analysis of a drug-free workplace program conducted to date. Data for the study were based on the experience of 261 companies that enrolled in the drug-free workplace program representing a population of approximately 14,500 workers. Injury rates among this population of workers were compared to the injury rates of 20,000 comparison companies representing a workforce of approximately 650,000 workers. The drug-free workplace program studied had a selective, preventive effect on occupational injuries. What effect it may have had on other workplace outcomes, such as absenteeism or turnover, is unknown [27].

3. TESTING METHODS

Methods for drug and alcohol detection have existed for centuries. Urine testing, through visual inspection, dates from the time of Hippocrates [76]. The origin of workplace drug testing has been established with the rise of the American occupational medicine movement in 1916 [77}. Several tests for detecting alcohol use were developed in the early twentieth century; they were based on physical assessment, crude biochemical measures and behavioral observation

[78]. By the 1920s, glass capillary kits were used by some police departments to spot drunken drivers. In the 1930s, when more portable devices were developed, breath testing replaced blood testing, and chemical testing for alcohol use became more widely accepted [78], [79].

Observational and clinical tests for narcotic use were employed by hospitals, drug treatment programs and the criminal justice system before 1950. By the latter half of the 1950s the nalorphine pupil test emerged as the standard means to uncover narcotics use by parolees [78]. The technology that enabled relatively accurate mass urine screening in the workplace was not developed and refined until the early 1960s, however [80], [81], [82]. For the most part, these initial mass screening methods were moderately specific (i.e. they correctly identified drugs) but relatively insensitive (i.e. they did not detect low concentrations of drugs) [83].

Drug (and to a lesser extent alcohol) testing emerged as major work- place issues in the 1980s. Several forces seemed to converge and become catalysts for the renewed interest in drug testing - especially mass, compulsory testing of current employees and job applicants:

(1) Technology developed to the point where inexpensive and reliable means were available for spotting and identifying drugs and their metabolites;

(2) Concern about the adverse consequences of drugs in the workplace reached a critical point [84], [85]

(3) Rising-health care costs and liability insurance became critical factors in some countries (e.g. the United States) [85]

(4) In the United States, governmental policy and regulations, such as the Drug-Free Workplace Act of 1988 and Defense and Transportation Department mandates, encouraged drug testing as a means to reduce and prevent drug-related harm in the workplace. Employers who thought they were accountable under the

Drug-Free Workplace Act were much more likely than other employers either to have, or to be planning to develop, a testing program (81 % of those who believed they were accountable compared with 56 %, of all respondents) [86], [13].

As interest increases in employment-related drug testing, the technologies and the interpretive skills of analysts continue to evolve. Although recent literature indicates that significant refinements and modifications have been made in drug-testing technology, the complexity of drug effects is so great that many problems exist in the interpretation of test results. The most frequent problems that confront the toxicology laboratory are associated with developing technology that can determine how much and when a drug was taken, how long after use the tests are capable of showing positive results, the causes and rates of false positives and false negatives, and how tests can be "beaten" by employees [87].

Detection of a drug depends largely on its absorption, distribution and elimination properties. There are various routes of drug administration; oral drinking, e.g. alcohol), intravenous (injecting into a vein, e.g. heroin) and inhalation (smoking, e.g. marijuana; snorting, e.g. cocaine; and sniffing, e.g. glue). Drugs taken orally are usually the slowest to be absorbed (i.e. by the brain and other body organs), whereas the intravenous and inhalation routes result in the fastest absorption. Once the drug enters the bloodstream it is rapidly distributed to the various tissues in the body. The amount of drug stored depends on the nature of the drug, the quantity, the duration of ingestion, the tissue holding the drug and the frequency of use [87].

A false -positive finding can have a serious impact on the livelihood of the person being tested. Therefore, special attention needs to be paid to the testing methods used. Ideally, the analytical method should be specific for the drug being tested (i.e. no false positive) and should be easy and inexpensive to use. Confirmation methods should also be readily available. The availability of technical and scientific expertise to perform the tests is also essential [87].

The interpretation of the analytical results needs to be carefully considered as even a normal diet can sometimes result in positive drug identification. Poppy seed ingestion [88] can result in a true-positive analytical report but it is a false positive for drug use. Some ethnic diets may also lead to such confounding problems [87].

Ideally, the parent drug, rather than its metabolite should be looked for in the analysis, although this may not always be possible as some drugs are rapidly metabolized (e.g. heroin metabolism to morphine). The sensitivity of the analytical procedure should be dictated by the psychoactive pharmacological properties of the drugs. If the drug is shown to be devoid of abuse potential, then its detection beyond the time of pharmacological activity, although important in the clinical management of the patient, does not necessarily serve a useful purpose in a workplace drug-screening program [87].

The guidelines developed by the National Institute on Drug Abuse (NIDA) [89] in April 1988 deal with five "illegal" drugs (marijuana, phencyclidine (PCP), amphetamine, cocaine and heroin). Rapid screening methods that allowed for 'mass screening' were available at that time, as were the confirmation methods for those five drugs [87].

The workplace market segment consists of several components including employer, employee, collection site, express delivery service, the testing laboratory, medical review office (MRO), and third-party administrator (TPA) [31].

When an employer requests a drug test from an employee, the employee is instructed to go to a collection site. There, the employee's urine is collected in a specially designed secure cup and sealed with a tamper- resistant tape. The cup is then sent by express delivery service to a testing laboratory where it will be tested for several drugs [31].

The first step at the testing site is to split the urine into two aliquots. One aliquot is first screened for drugs using an analyzer that performs immunoassay as the initial screen. If the urine screens positive then another aliquot of the sample is used to confirm the findings by gas chromatography – mass spectroscopy (GC-MS) methodology. All test results are relayed to an MRO where a medical physician reviews the results. If the result of the screen is negative, the MRO informs the employer that the employee is negative and has no detectable drug in the urine. However, if the test result of the immunoassay and GC-MS are positive, the MRO contacts the employee and tries to determine if there is any legitimate reason for the employee to have a positive result such as a medical treatment or prescription. If it is determined that the positive result is truly due to drug use, the MRO then informs the employer of the positive result. Statistics show that about 5% of the urine samples tested in the U.S. turn out positive for drugs [93]. The employer may contract the service of the various components by itself, or in most cases, it would retain the service of a TPA to oversee the entire process [31].

With the improvement in the accuracy of on-site test devices (notably the lateral flow test devices), an increasing number of collection sites are running the tests themselves instead of sending the samples to the laboratory for analysis. In this new scenario, the employee goes to the collection site where the urine is collected and tested by the collection site staff using an on-site test device. The results are known within minutes. If the results are negative, the employee is notified that he/she is cleared and can go to work. Since about 95% of employees test negative,

most employees can be cleared quickly. The positive samples are sent to the laboratory by express delivery service for confirmatory testing. The result of that testing goes through the MRO route before the employer is informed [31].

There are several significant implications of this new trend. This trend comes about only because on-site devices have become more reliable, enabling them to be widely accepted by both the scientific and regulatory communities. This new scenario simplifies the testing process and saves time. In the older process, turn-around time was at least 24 hours whereas the current turn-around time is down to about a half an hour. Economically, the employer realizes substantial savings by eliminating the costs associated with express delivery, laboratory testing, and MRO service for 95% of the testing [31]

Hair analysis is a newly developed technique that has been labeled less invasive than urinalysis. The technique, developed by Dr. Warner and Annette Baumgartner is a radioimmunoassay (RIAH) test that takes hair specimens from close to the scalp [91]. Drugs are deposited in the hair as it grows. The amount of the drug in the hair correlates with the amount ingested by the individual [91]. Hair grows at an approximate rate of 1/2 inch per month [91]. This means that analysis during a particular week or month will show drug use during that period. Therefore, hair analysis can distinguish between frequent, heavy, and occasional users of a drug [91]. Some advantages cited concerning hair analysis include the inability to manipulate samples with dye or bleach, its less invasive nature, and the fact that ceasing drugs prior to testing on a temporary basis does not work [91]. Most drugs take several days to be deposited in the hair [91]. As a result, hair analysis shows long-term drug use or patterns of drug use over time. It cannot detect recent drug use or impairment that is immediate [91]. In addition, there is the question of the effect of natural environment exposure to hair [91]. The Naval Research

Laboratory conducted a study to address this issue. It found that non-drug using persons may come in contact with sufficient quantities of drugs that contaminate sweat, which will in turn be absorbed by the hair. This does not wash out quickly, and can thereby provide incorrect results of a drug test [92]. Perhaps the biggest drawback of hair analysis is its expensive nature. The cost for hair analysis is almost twice as much as urinalysis [91]. Hair analysis involves “laborious and tedious [procedures], rendering the method unwieldy for use by most laboratories other than research laboratories” [33], [91].

3.1. DRUGS TESTED

Most of the testing follows the Substance Abuse and Mental Health Services Administration (SAMHSA) guidelines, which mandates testing for five drugs including marijuana (THC), cocaine (COC), morphine (MOR), amphetamine (AMP), and phencyclidine (PCP). Additional drugs commonly tested include methamphetamine (MET), methadone (MTD), barbiturates (BAR), benzodiazepines (BZO), tricyclic antidepressants (TCA), and methylenedioxymethamphetamine (MDMAor ecstasy). Most of the testing utilizes urine as the sample matrix. However, for certain drugs the parent drugs may not exist or only exist in minute amounts in the urine. Therefore, drug testing for THC and cocaine actually detects their respective metabolites named THCc a r- boxylic acid (THC-COOH) and benzyecognonine (BE), respectively. Moreover, some of the cutoff concentrations for the confirmatory GC-MS processes are lower than the cutoff concentrations of the screening immunoassays. This is because GC-MS detects the actual drug or drug metabolite whereas immunoassays also detect

cross - reactivity due to structurally closed metabolites. *Table 2* shows the cutoff concentrations of the 11 most common drugs [31].

3.2. DRUG SCREEN TECHNOLOGIES

In the 1960s and 1970s, the screening method of choice was thin-layer chromatography (TLC), which is inexpensive, quick, and permits the simultaneous detection of many substances. However, TLC is not specific and not adaptable to mass screening. In the radioimmunoassay (RIA) and enzyme multiplied immunoassay technique (EMIT)began to appear, leading to automation and lower costs. EMIT and other nonradioactive immunoassays soon were adapted to large analyzers capable of running thousands of samples per day [31].

Currently, simple on-site tests are beginning to replace large automated machines. The most common form of on-site test uses the lateral flow immunoassay format in which an immobilized drug competes with the drugs in the samples for limited antibody binding sites. Lateral flow immunoassay technology has allowed the simultaneous testing of multiple drugs on a single test device. This new approach has simplified testing and decreased the cost of running a drug test, thus contributing to the increasing popularity of such devices. Because of its simplicity, speed, and accuracy, lateral flow immunoassay has been gaining popularity and SAMHSA is allowing on-site drug screening [31]

3.3. ISSUE OF ADULTERANTS

One of the inherent concerns of employers who use drug testing is the validity of the urine sample. Drug users have attempted to defeat drug tests by adding adulterants to the urine to invalidate the test results. Such adulterants act either by interfering with the immunoassay procedures or by converting the target drugs to other compounds. It is estimated that approx. one million adulterant products were purchased in 2001. Currently, most laboratories performing drug screens test for adulterants routinely. On-site adulterant test strips using urinalysis technology have been developed. To determine contamination, samples are evaluated against several parameters. These parameters include testing for creatinine and specific gravity conditions; testing for nitrite and glutaraldehyde; checking pH for the addition of basic or acidic adulterants; and testing for oxidizing substances such as bleach and pyridinium chlorochroate [93]. Adulteration testing is gaining importance because some of the new generations of adulterants are quite effective. Recent data show that a few of these adulterants are not detectable after 5–6 hours [94]. In this instance, rapid testing to check for adulterants could effectively be done by the use of an on-site adulterant dipstick device [31].

Substituting "clean" or drug-negative urine for drug-positive urine is the most common way to fool the drug-screening system. A number of entrepreneurs have attempted to bypass urine sample inspection in this manner. A company in Florida sells lyophilized (freeze-dried) "clean" urine samples through newspaper and magazine advertisements. Hiding condoms containing "clean" urine on the body or inside the vagina is another common trick. Recently, a patient at an addiction research clinic was, caught substituting "clean" urine when a glass bottle that had fallen into the toilet bowl was discovered by the supervising nurse. It was later discovered that the bottle had been sealed with a thin aluminium wrap and had been inserted into the patient's vagina [87].

Others have attempted to substitute apple juice or tea for urine samples. Persons have been known to add to urine samples various household products, ranging from bleach to liquid soap to eye-drops, hoping that their drug use would be masked. Others have hidden a masking substance under their fingernails and released it into the urine specimen. Another method is to poke a small hole into the urine sample container with a pin so that the sample leaks out by the time it reaches the laboratory [87], [90].

Since adding table salt (NaCl) or bleach to urine samples is a common practice, many laboratories routinely test for sodium and chlorine in urine samples. Liquid soap and crystalline drain cleaners, strong alkaline products containing sodium hydroxide (NaOH), are also used to adulterate urine samples. These contaminators can be detected by checking for high pH levels in urine samples. *In vivo* alkalizing or acidifying the urine pH can also change the excretion pattern of some drugs, including amphetamines, barbiturates and PCP [87].

Water-loading poses a challenge to testing laboratories. Specific gravity has been used to detect dilution; however, the measurement range is limited. Creatinine levels in random urine samples have also been studied as a possible water-loading detection method, but without much success [87].

In order to reduce the opportunities for specimen contamination, some workplaces require that employees provide urine samples under direct supervision. Another way to detect any sample adulteration is to take the temperature of the sample. When the temperature of samples are taken within one minute of voiding, the temperature range falls to between 36.5 deg. and 34deg. C, reflecting the body core temperature. It is difficult to achieve this narrow temperature range by hiding a condom filled with urine in the armpit or adding water from a tap or toilet bowl to the urine sample. The temperature of the sample must be measured immediately after it is taken, since the temperature drops rapidly [87].

3.4. FUTURE TREND

It appears that saliva-based testing is gaining importance due to the challenges of adulteration and monitoring murine-based testing. However, because of the low concentrations of drugs present in oral fluids and the complexity of the matrix, development of oral fluid drug testing has been slow. The first generation of oral fluid testing has an analytical sensitivity down to 5–50 ng/mL; the next generation of screen with sensitivity down to less than one ng/mL will enable such tests to be used in situations comparable to urine and expand the usefulness of the technology to other markets [31].

4. DISCUSSION

Occupational injuries are a major public health problem resulting in substantial disability. In the construction industry alone, there were 194,000 reported occupational injuries in 2000 involving at least one day of lost work time (Bureau of Labor Statistics 2002). It is unclear how many of these injuries could potentially have been avoided by preventive actions organized through drug-free workplace programs. The results suggest that such programs do offer a potential to reduce the occurrence of occupational injuries but on a selective basis. Two key factors influence the potential of drug-free workplace programs to reduce injury risk: the background level of injury risk and the prevalence of substance abuse in the workforce. If the prevalence of substance abuse among employees is low, a company is unlikely to benefit from a DFW program [27].

Programs for alcohol and drug testing in the workplace can be understood as a continuation of a long line of efforts by Governments, employers' organizations, workers' organizations and enterprises to prevent and reduce alcohol and drug related problems in the workplace.

All workplace initiatives that respond to alcohol and drug related problems are based on at least four interrelated assumptions:

(1) Substance use poses serious difficulties in the workplace;

(2) The particular response that is implemented will resolve those difficulties;

(3) The benefits gained by implementing an initiative outweigh the costs of the initiative;

(4) The response is consistent with ethical and legal standards [19].

5. CONCLUSION

Over the past 20 years, the ‘‘workplace substance abuse prevention industry’’ has grown enormously in size and become more sophisticated in its marketing approach. Drug testing alone has become a $6 billion industry [75]. Employee assistance programs are now widely used by employers at significant cost. Results suggest that drug-free workplace programs are an important public health approach to improving workplace health and safety through early intervention and, quite possibly, substance abuse prevention [27].

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