Public Health Briefs

The Estimated Predictive Value of Screening for Illicit Drugs in the Workplace

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Abstract: This paper estimates the predictive values of screening tests for six illicit drugs of common concern in the workplace (amphetamines, barbiturates, cocaine, hallucinogens, marijuana, and opiates) using published information on test sensitivity and specificity and survey data on prevalence. Estimated predictive values (negative) were generally high, whereas the estimated predictive value of a positive test ranged from 1 per cent for amphetamines to 100 per cent for hallucinogens and was only 38 per cent for marijuana, the most prevalent drug. (*Am J Public Health* 1988; 78:817–819.)

Introduction

Workplace drug screening programs contribute to worker safety and health only if the basic principles of medical screening are applied. These principles have been enunciated for individuals in the community[1] and revised for screening in the workplace.[2] While the legal and ethical aspects of urinary drug screening have been widely discussed,[3–6] relatively little attention has been given to epidemiologic considerations.

The purpose of this paper is to demonstrate the range of predictive values for screening six classes of illicit drugs of common concern in the workplace: amphetamines, barbiturates, cocaine, hallucinogens, marijuana, and opiates. Screening usually proceeds in two stages. The initial drug screening tests are either radioimmunoassay or enzyme immunoassays. Optimally, positive results are then retested by thin layer chromatography, gas chromatography, or a combination of gas chromatography and mass spectrometry (GC/MS). The latter is considered the best confirmatory test.

An important measure of the efficacy of screening tests is the concept of predictive value. Predictive value (positive) is the percentage of screenees with positive tests who in reality have the condition being screened (true positives). Predictive value (negative) is the percentage of individuals who test negative who do not have the drug being screened (true negatives). In practice, predictive value (positive) is influenced more by specificity and prevalence than by sensitivity.[7] For example, if sensitivity is held constant at 95 per cent with prevalence 10 per cent, decreasing the specificity from 100 per cent to 50 per cent will decrease predictive value (positive) from 100 per cent to 16 per cent. By contrast, with 10 per cent prevalence and 95 per cent specificity, a drop in sensitivity from 100 per cent to 50 per cent only reduces predictive value (positive) from 67 per cent to 50 per cent.

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Methods

The sensitivity and specificity of each test and the prevalence of drug use were determined prior to calculating the predictive values. Sensitivity and specificity were obtained from: manufacturers' reports of the accuracy of their own assays[8–16]; additional unblinded evaluations of urinary drug screening tests[17–25]; and blinded proficiency testing conducted by the Centers for Disease Control (CDC)[18,20] and others.[17,26] In some studies, confirmatory tests were performed prior to the release of results. Unfortunately, the method of confirmation was rarely described.

Estimates of the prevalence of illicit drug use among the working population in 1982 were obtained from a household survey, the National Survey on Drug Abuse (NSDA) conducted by the National Institute on Drug Abuse, which is described in detail elsewhere.[27] Using one-month prevalences (because these most closely reflect current usage) for persons aged <25 and those >25, and the 1984 census data on the age distribution of US workers,[28] we computed the age-adjusted prevalence of use of each of these illicit drugs in the US workforce.

We computed the ranges of predictive values for each drug and also estimated the probable predictive values (positive) based on the midpoints of the ranges of sensitivity and specificity. We graphed the predictive values (positive) for one drug (cocaine), assuming a range of prevalence, sensitivity, and specificity.

Results

Table 1 lists the estimated prevalence among the workforce, the range of sensitivity and specificity, and the calculated predictive values for all six categories of illicit drugs. The probable predictive values (positive) are low. Even for marijuana which has the highest prevalence only 38 per cent of positive tests reflect true positives.

Figure 1 illustrates how predictive value decreases as prevalence, specificity, or sensitivity decreases. The slope is particularly steep for prevalence below 10 per cent which is the range of most illicit drug use in the workforce.

Discussion

Predictive value is an important concept because it affects both the meaningfulness of a screening test and the cost of implementing the screening program. The predictive values for urinary screening tests for six classes of drugs vary according to the individual drug being screened, the test used, the proficiency of the laboratory performing the tests, and the prevalence of use of the illicit drug in the population being screened. It is essential to consider predictive value when considering the likelihood that a screening program will be effective. Available data suggest that predictive value will be low in unselected populations given the current variability

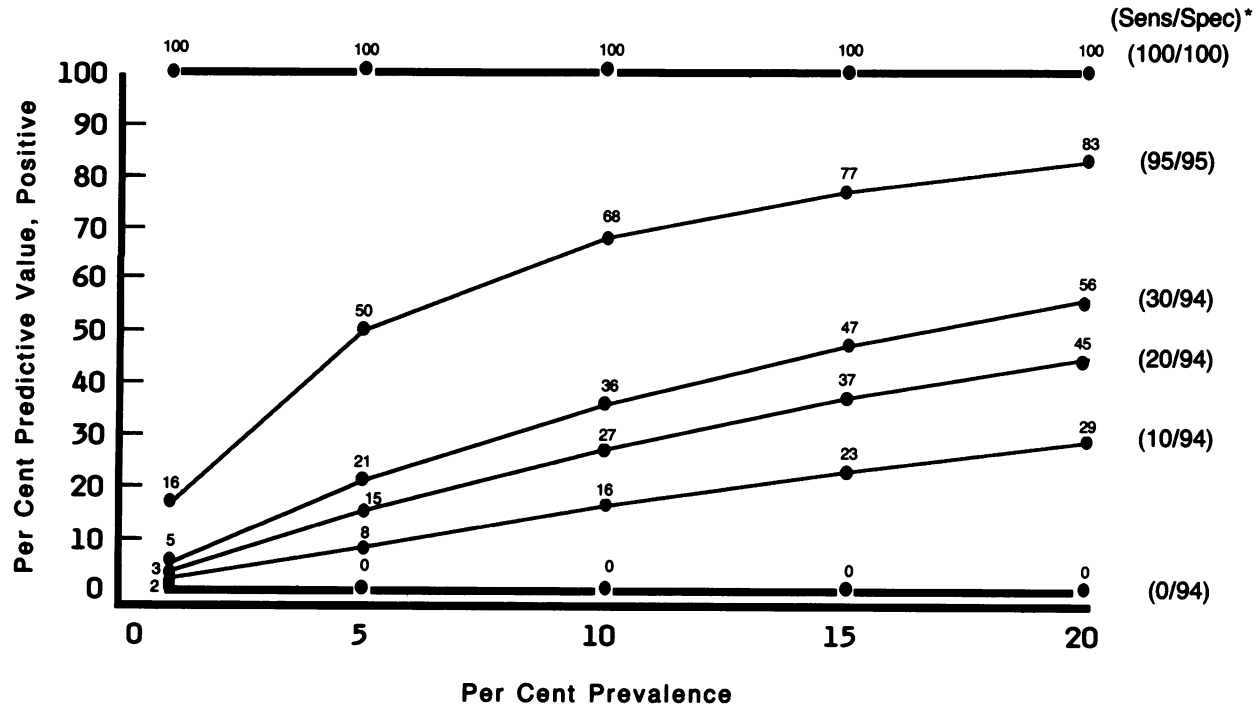
TABLE 1—Estimated Prevalence among the Workforce, Range of Sensitivity and Specificity, and Calculated Predictive Values for Six Categories of Illicit Drugs

Drug	Past Month Prevalence*	Sensitivity* Range (Midpoint)	Specificity* Range (Midpoint)	Predictive Value Positive* Range (Probable)	Predictive Value Negative* Range (Probable)
Amphetamines[a]	1	0–100[17,18] (50)	0–100[9,10,17,18] (50)	0–100 (1)	0–100 (99)
Barbiturates[a]	1	6–100[17,18] (53)	89–100[11,22,26] (95)	1–100 (8)	98–100 (99)
Cocaine	3	0–100[18] (50)	94–100[12,18,26] (97)	0–100 (35)	97–100 (98)
Hallucinogens	0.5	95–100[8,13,14] (98)	100[13,14]	100–100 (100)	100–100 (100)
Marijuana	11	38–100[8,21,23] (69)	72–100[8,15,18,23,25,27] (86)	14–100 (38)	90–100 (96)
Opiates	0.5	0–100[18,19] (50)	90–100[16,18] (95)	0–100 (5)	99–100 (99)

*All Values in per cents.
[a]Nonmedical Use.

of laboratories. Improvements in predictive value can come from the use of more accurate confirmatory tests, ensuring the proficiency of laboratories, and restricting mass screening to populations of high prevalence. The wide range of estimated predictive values for each class of illicit drug is based on the wide range of reported sensitivity and specificity of the tests used. The upper limits come from the manufacturers' reports. There are several limitations of these data:

- First, these results were usually not derived blindly and may not reflect usual laboratory performance. The CDC demonstrated that laboratories performed better when participating in known proficiency testing than when samples were submitted blindly. When samples were sent to the same laboratories at a given time, the lower limit of sensitivity dropped from 68 per cent to 0 per cent when the samples were not identified as being part of a proficiency test; the lower limit of specificity dropped from 92 per cent to 68 per cent.[18]
- Second, the capabilities of the screening tests as determined in the controlled environment of a manufacturer's laboratory may be different when conducted in a commercial laboratory.
- Third, the presence of cross-reactive drugs may be minimal in samples collected for trials by the companies manufacturing the test materials but may pose a substantial problem in the industrial setting. Only a few (at most 90) of the 60,000 industrial chemicals have been tested for cross-reactivity.



*Sensitivity and Specificity, in percents, in parentheses

FIGURE 1—How Predictive Value, Positive Varies with Varying Sensitivity/Specificity/Prevalence (Cocaine)
***Sensitivity = 100%–0%**
Specificity = 100%–94%
Prevalence = 1%–20%

The estimated predictive values of positive urine tests were surprisingly low. The predictive values (positive) may be higher when GC/MS is used appropriately to confirm positive screening tests. Also, organizations may select laboratories with superior performance, for example, by conducting blind proficiency tests. Unfortunately, we have no data regarding the extent to which individual organizations perform such studies, nor which laboratories are performing the majority of tests. Thus the predictive values calculated from the sample of laboratories in this study may not reflect the overall performance of all laboratories conducting testing.

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