Random Student Drug Tests
Are They Effective for Identifying Occasional Drug Users?

Robert L. DuPont, M.D.

Despite lingering controversies, the two recent U.S. Supreme Court decisions affirming the Constitutionality of random drug tests of student athletes and of students participating in extracurricular activities in public schools have given student drug testing (SDT) a firm legal foundation[1, 2]. There is no similar legal controversy over the drug testing in private schools where schools are free to set their own policies on student drug testing.

The support of SDT by the White House Office of National Drug Control Policy (ONDCP) and the U.S. Department of Education (ED) have given a programmatic stamp of approval to SDT[3]. A 2002 ED study of 9 pioneering public and private schools that were conducting SDT showed that these programs shared many core elements including that all of the schools incorporated SDT into comprehensive approaches to drug prevention. All 9 SDT programs were confidential and non-punitive. All of these programs included the involvement of the school, parents, and, where-needed, treatment to help the youth who tested positive to quit drug use[4]. Since this time, there has been a growing interest in using random student drug testing as a uniquely valuable component of school-based drug prevention, as demonstrated by the 14% of school districts nationwide that conducted random drug testing of students in the 2004-2005 academic school year[5].

One of the common misconceptions about random drug tests is that they principally identify the experimenter or the occasional user of illegal drugs. Such infrequent users are the most common group of drug users among teenagers but these infrequent users are seldom identified in random drug testing because it is extremely unlikely that the time for a random test will coincide with a time that these individuals have very recently used an illegal drug. To make this point, several years ago a study looked into the probabilities of identifying drug use by random urine drug tests at varying testing frequencies[6, 7].

In order to clarify the relationship between random drug test results and the pattern of illegal drug use which leads to a positive test result, general characteristics of drug use were linked to assumptions made by an expert panel using probability theory. This method allowed an estimation of the expected drug test results given the characteristics of illegal drug use.

A survey was conducted of 15 professionals with extensive experience in drug abuse treatment to define typical patterns of illegal drug use in contemporary America. These experts, who had an average of 16 years of experience in drug testing and/or addiction treatment and who had published a total of over 1,000 professional articles, were asked to estimate the drug use patterns of typical Americans who had used illegal drugs at least once in the prior year. The drug users were divided into annual, monthly, and daily users. The three groups correspond to the groupings used by the U.S. Department of Health and Human Services in its national surveys of illicit drug use[8].

In this annual national survey drug users were divided into four categories: "lifetime" users who had used a drug once or more in their lives, "annual" users who had

used a drug once or more in the past year, "monthly" users who used a drug once or more in the prior 30 days, and "daily" users who had used a drug every day or almost every day in the past 30 days.

The experts were asked to estimate the number of days in the prior year that the average member of each of the last three of these groups had used one or more illegal drugs, then to estimate the percentage of days the individual in each group had used an illegal drug so that a urine drug test would be (1) positive for only one day (lighter use); and (2) positive for three days (heavier use) [8].

Finally, the experts were asked to estimate the average percent of drug use that occurred on each of the seven days of the week for the three groups, assuming a standard Monday through Friday testing week. The answers to these questions were averaged to get a composite view of these variables. The experts estimated that 55% of the individuals who had used an illegal drug within the prior year were annual users, 37% were monthly users, and 8% were daily users. The annual users used an illegal drug an average of 7 days a year, monthly users an average of 43 days a year, and daily users an average of 228 days a year. These data are presented in Table 2.

ILLEGAL DRUG USE AND RANDOM DRUG TEST RESULTS

Using the mean responses from the survey data, a "profile" of illegal drug use for each typical user type was constructed to estimate a variety of probabilities. First the experts calculated the likelihood that a given type of user would use drugs on a given day. Mathematically, the probability that a given user type will use at a certain level (high/low dose) on a given day (assuming the likelihood of using at a "high" or "low" dosage is independent of the day of use) is

$$P(\text{use at given level on given day}) = P(\text{use})\, P(\text{at given level/use})\, P(\text{level of use/use})$$

TABLE 1. Expert estimates of general drug use patterns.

	Type of User		
	Daily	Monthly	Annual
	(1)	(2)	(3)
Percent of Users	8.0%	36.9%	54.5%
Number of Days Used/Year	228	43	7
Percent High-Dose Use	70.2%	39.9%	23.1%

Because of Rounding, percents may not sum to 100.0

To illustrate this computation, consider a "daily" user as an example. A daily user will have an average of 228 use-days per year, of which 70% are "high" dose episodes (see Table 1). This leads to a total of 160 "high" use-days and 68 "low" use-days during the year for a typical daily user. The survey responses related to use distribution by day of the week (Table 2) were then employed to estimate the expected number of "high" and

"low" use-days for each day of the week. Thus if 15% of the "high" use-days for a daily user are expected to occur on a Sunday, this results in approximately 24 of the 160 "high" use-days occurring on Sundays. Similarly, 12% of the "low" use-days for a daily user occur on a Sunday, leading to 8 (rounding) of the 68 "low" use-days occurring on Sundays. Therefore, on any given Sunday, there is approximately a 62% chance of illegal drug use by a daily user (i.e., 32 Sunday use-days over 52 possible Sundays) consisting of a 24/52 chance of illegal "high" drug use, an 8/52 chance of illegal "low" drug use and a 20/52 chance of *no* drug use on a particular Sunday.

Having developed estimates for each day of the week for each of the three user types, the experts then calculated the probability of detection (positive test result) of each user type if tested on a particular weekday. The probability of detection for a given day is the sum of the likelihoods of three mutually exclusive events:

1. the probability of *any* use ("high" or "low") on the day prior to the test;

plus

2. the probability of *no* use on the prior day, but a "high" use episode two days before;

plus

3. the probability of *no* use during the prior two days, but a "high" use episode three days prior.

The three mutually exclusive events represent the three use events which would lead to a positive urine test result.

Using their opinions and the probabilities of usage, the experts calculated the likelihood that a user who was tested would test positive for each of the five days of the traditional testing week for each user type. The results are presented in Table 4. From Monday to Friday, the projected percent of tests of daily users that would be positive ranged from a low of 69% (on Thursday) to a high of 90% (on Monday). The likelihood that monthly users would test positive ranged from 7.8% (Thursday) to 27% (Monday).

TABLE 2. Percentage of usage on each day of the week.

A. <u>"HIGH" DOSE EPISODES</u>

	Day of the Week						
Type of User	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Daily	15	10	9	10	12	21	24
Monthly	15	5	4	7	7	28	34
Annual	12	4	3	3	3	31	44

B. "LOW" DOSE EPISODES

Type of User	Day of the Week: Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Daily	12	11	11	10	13	18	18
Monthly	14	7	6	6	10	28	30
Annual	16	3	3	3	6	29	41

C. WEIGHTED AVERAGE

Type of User	Day of the Week: Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Daily	14	11	10	10	12	20	23
Monthly	14	6	5	6	9	28	31
Annual	15	3	3	3	5	30	41

Because of Rounding, percents may not sum to 100.0

Annual users who would be likely to test positive ranged from less than one percent (Wednesday through Friday) to 4% (Monday). Since disproportionately more illegal drug use takes place on weekends, testing on Mondays yields the highest likelihood of detecting a drug user. However, because the concentration of weekend drug use is more pronounced for annual users, the percentage of positive tests contributed by annual users is the highest for Monday testing.

The same data were used to calculate the probability of identifying an illegal drug user in each of the three user groups at various frequencies of testing from 10% to 300% per year.

Testing frequencies are the percent of the tested population who are tested each year. For example, a school with 1,000 students which conducted 500 random drug tests in one year would be testing at a frequency of 50%. These data are displayed in Table 4. At a 20% per year testing schedule, 16% of the daily users would be identified in one year of testing, while only 3% of the monthly and less than one-half of one percent of the annual users would be identified. For comparison, note that a 100% testing rate would identify 79% of the daily users, 15% of the monthly users, and less than 2% of the annual users.

TABLE 3. Probability a user will test positive if tested on a given day of week.

	Day Tested					
Type of User	Monday	Tuesday	Wednesday	Thursday	Friday	Random Weekday
	(1)	(2)	(3)	(4)	(5)	(6)
Daily	90.5	85.6	74.7	69.2	74.9	79.0
Monthly	27.4	18.8	10.2	7.8	10.4	14.9
Annual	4.4	2.2	0.9	0.7	0.9	1.8

TABLE 4. Probability of detection by user type and testing rate.

	Type of User		
Testing Rate	Daily	Monthly	Annual
	(1)	(2)	(3)
300 Percent	99.0%	44.8%	5.4%
200 Percent	99.0	29.9	3.6
100 Percent	79.0	14.9	1.8
50 Percent	39.5	7.5	0.9
20 Percent	15.8	3.0	0.4
10 Percent	7.9	1.5	0.2

Assuming that individuals were tested randomly at a 20% per year frequency, it would take more than three years to identify one-half of the daily users and almost 17 years to identify one-half of the monthly users. Testing would have to be conducted for 125 years to identify one-half of the annual users. Raising the rate of random testing from 20% per year to 100% per year raises the probability of detecting a daily user in one year of testing from 16% to 79%, while it raises the probability of detecting an annual user from 0.4% to 1.8%. Raising the rate of random testing to 300% offers relatively little improvement for detection of daily users (from 79% to 99%) while it offers substantial improvement for detection of monthly users (from 15% to 45%). In contrast, even 300% testing has relatively little effect on the likelihood of detecting an annual user, raising the likelihood of detection from 2% to 5%. Random testing would have to be conducted on all students at an average of 28 times a year (a 2800% testing frequency) to detect 50% of the annual users in one year of random drug testing.

If the population being tested consists of a given percent of drug users, the above results can be used to calculate the percent of positives expected from random testing throughout the week. Thus, if 7% of the tested population used illegal drugs at least once in the prior year, it is possible to estimate the probability of a random urine drug test being positive on each day of the week. Table 5 shows that, at a 7% rate of drug use, 1.4% of the tests will be positive on Monday, the day of the week with the highest probability of finding a positive test, and 0.6% on Thursday, the day of the week least likely to find a positive. The differences between the highest and the lowest percentages

by day of the week are relatively small because most of the positive tests on each day of the week are relatively small. This is true because most of the positive tests on each day are from daily users, and their use is relatively even throughout the week.

Table 6 shows the relationship between the rate of positive test results in the tested population and the expected extent of drug use during the prior year. The estimated rate of drug use among tested individuals is approximately eight times the average random testing positive rate. Assuming a 1.5% positive rate on random testing, the experts estimated that 12% of the tested population used an illegal drug at least once in the prior year.

The original calculations for this study were based on estimates in the workplace, not in schools. The National Household Survey contains data by age group. When people aged 12-17 are compared to people 21 and older the population falling into each of these categories is similar for each frequency-of-use category suggesting that the estimates based on the workplace estimates are reasonable approximations for schools as well. However the estimator used in this study does not take cheating into consideration. High rates of cheating change the rate of positive drug test results to the total level of drug use in the tested population.

TABLE 5. Expected percent of positive drug tests by day of the testing week assuming 7 percent of tested populations are illegal drug users.

Monday	Tuesday	Wednesday	Thursday	Friday	Random Day
1.4	1.1	0.7	0.6	0.7	0.9

TABLE 6. The relationship between drug use and the expected rate of positive random drug tests.

Assumed Percent of Annual Drug Users	Rate of Positive on Random Drug Tests
2%	0.3%
4	0.5
6	0.8
8	1.0
10	1.3
12	1.5
14	1.8
16	2.1
18	2.3
20	2.6
30	3.9
40	5.2
50	6.4

Given a positive drug test result, what is the likelihood that the person is a daily versus a monthly versus an annual user? In other words, what is the mix of user types

among the positive random urine drug tests? To answer this question, the experts relied on Bayes Theorem:

P(user type/positive) =
[P(user type) P(positive/user type)]/
P(positive among the user population)

The overall probability of detection given that a user is tested, is the sum of the detection probabilities for a given day, weighted by the corresponding share of the user population that a given user type represents on that day. The results of this analysis are presented in Table 8.

TABLE 8. Percent of identified drug users by user type, given a positive test result.

	Day Tested					
Type of User	Monday	Tuesday	Wednesday	Thursday	Friday	Random Weekday
	(1)	(2)	(3)	(4)	(5)	(6)
Daily	36.7	45.7	58.5	63.1	58.0	52.4
Monthly	51.2	46.3	36.8	32.8	37.2	40.9
Annual	12.2	7.9	4.8	4.1	4.7	6.7

The overall findings indicate that, among the identified drug users who test positive, 52% will be daily users (although they represent only 8% of all illegal drug users in this model) and 41% will be monthly users (who were estimated by the experts to comprise 37% of the illegal drug users). Most importantly, only 7% of the drug test positives will be from the annual users group, even though these infrequent illegal drug users represent 55% of the illegal drug user population.

DISCUSSION

This study shows that random urine drug tests are most effective in identifying more-or-less daily users of illegal drugs. They are much less effective in identifying occasional users of illegal drugs. Although random urine testing is likely to detect a small percentage of infrequent users, many people who use illegal drugs infrequently may be persuaded that even a relatively small chance of being detected is sufficient reason no to use illegal drugs at all. Daily, and to a lesser extent, monthly users of illegal drugs would be more influenced by the preventive goals of random testing. The most frequent drug users are likely to be detected by drug testing, even when random testing is not intensive.

Even a relatively low rate of positive results indicates the presence of a significant number of illegal drug users in the tested population. The estimated rate of illegal drug use within the population tested on an annual basis is estimated to be approximately eight times the random testing positive rate. Schools that find a 3% positive rate on random testing during a year can assume that approximately 24% of their student body used an illegal drug at least once during the year of testing. Random drug testing is not only fair

in that all students are equally at risk to be tested, but it is remarkably effective in targeting the heavy, frequent user of illegal drugs rather than the occasional user of illegal drugs.

The purposes of random drug testing are to intervene with heavy users of illegal drugs and to discourage casual drug use. Based on the nature of illegal drug use and the characteristics of random urine drug test results, this study suggests that random drug testing can accomplish both goals reasonably well.

This study was focused on urine testing. It did not consider the impact of cheating on drug detection. The emergence of widespread cheating on unobserved urine testing shifts to higher levels the calculation of total drug users in the tested population based on the rate of positive tests in a school population. Commercial urine laboratories find twice as many or more adulterated samples as they do positive samples. This finding suggests that the ratio of annual drug use to percent positive on random urine test findings in the tested population may not be 8 to 1 but perhaps as high as 16 to 1.

Saliva testing, as opposed to urine testing, has the advantage compared to urine testing, of being resistant to cheating. Saliva testing has the additional advantage of being easily collected without the privacy problems associated with the use of a lavatory. Saliva testing has the disadvantage that it is less sensitive to marijuana use then is urine testing.

Hair testing shares with saliva testing resistance to cheating. It has a surveillance window of not 1-3 days as both urine and saliva do, but of 90 days. Hair testing also has the advantage that in the case of disputed results it is easy to collect a new sample for re-testing. However hair testing is unlikely to be positive for marijuana until the tested student has used marijuana at a rate of about twice a week in the prior 90 days. Of course, urine and saliva testing are also relatively ineffective in identifying infrequent drug users—the major part of this paper.

Thus although hair testing has a far longer surveillance window than urine or saliva there is a threshold of drug use frequency for marijuana (but not other drugs) that makes detecting occasional or infrequent marijuana use by hair testing unlikely. When urine, hair and saliva tests are done side by side on the same people at the same time, hair testing usually identifies the most illegal drug users and saliva identifies the fewest drug users. More general information on drug tests is discussed in other recent publications[9, 10].

REFERENCES

[1] *Veronia School District 47J v. Acton et ux.*, (9th U.S. Cir. 1995).
[2] *Board of Education of Independent School District No. 92 of Pottawatomie County et al. v. Earls et al.*, (10th U.S. Cir. 2002).
[3] Office of National Drug Control Policy. (2002). *What you need to know about drug testing in schools* (NCJ Publication No. 195522). Washington, D.C.: Office of National Drug Control Policy.
[4] DuPont, R.L., Campbell, T.G., & Mazza, J.J. (2002). *Report of a preliminary study—Elements of a successful school-based student drug testing program.* Washington, D.C.: United States Department of Education.
[5] Ringwalt, C., et al. (2008). Random drug testing in US public school districts, *American Journal of Public Health, 98*(5), 826-828.

[6] DuPont, R.L., Griffin, D.W., Siskin, B.R., Shiraki, S., Katze, E. *Random drug tests at work: The probability of Identifying Frequent and Infrequent Users of Illicit Drugs.* Journal of Addictive Diseases 14:1-17, 1995.
[7] DuPont, R.L. *Do Random workplace drug tests primarily identify casual or regular drug users?* MRO Update, 5-7, July-August, 1996.
[8] U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration. National Household Survey on Drug Abuse: Main Findings 1991. DHHS Publication No. (SMA) 93-1980, Rockville, Maryland: Substance Abuse and Mental Health Services Administration, 1993.
[8] Hawks RL, Chiang CN. Urine Testing for Drug Abuse. DHHS Publication No. (ADM) 87-1481, Rockville, Maryland: U.S. Department of Health and Human Services, National Institute on Drug Abuse, Research Monograph #73, 1986.
[9] DuPont, R.L., Selavka, C. *Laboratory and Psychological Diagnostic Testing.* Textbook of Substance Abuse Treatment. October 2002, 521-527.
[10] DuPont, R.L. A Commentary on "Urine testing in methadone maintenance treatment—Applications and limitations" Thinking outside the urine cup. *Journal of Substance Abuse Treatment*. April 10, 2003, 1-2.