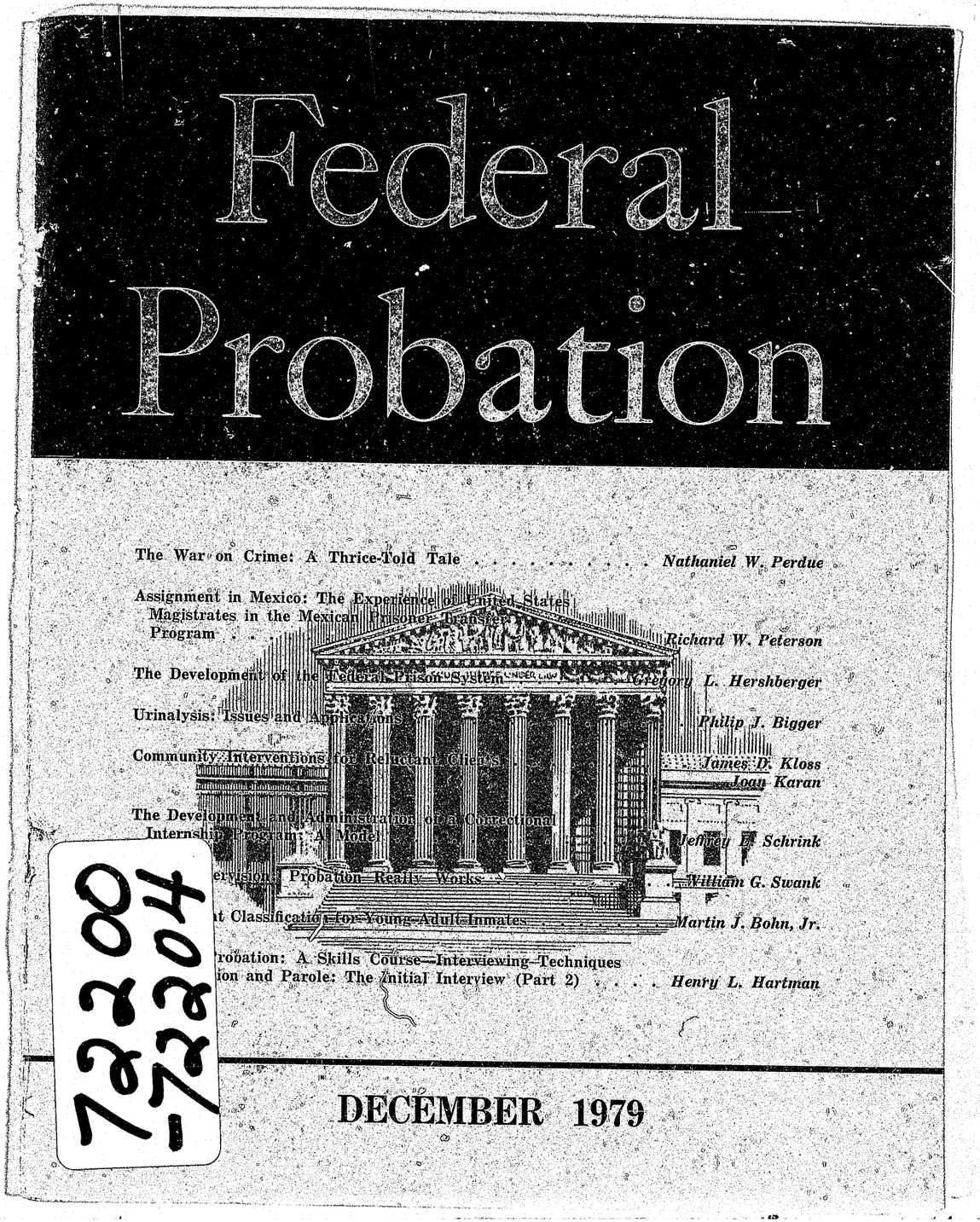

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All phases of preventive and correctional activities in delinquency and crime come within the fields of interest of FEDERAL PROBATION. The Quarterly wishes to share with its readers all constructively worthwhile points of view and welcomes the contributions of those engaged in the study of juvenile and adult offenders. Federal, state, and local organizations, institutions, and agencies—both public and private—are invited to submit any significant experience and findings related to the prevention and control of delinquency and crime.

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This Issue in Brief

The War on Crime: A Thrice-Told Tale.—Parole as part of public policy is currently receiving mixed reviews—some bad and some terrible, asserts Nathaniel W. Perdue, vice chairman of the Virginia Parole Board. It has reached the slightly enviable position of being denounced by both liberals and conservatives; prosecutors and defenders; police officers and prisoners; professionals, nonprofessionals, and unprofessionals, he adds. Why all the fuss? This fable suggests the state of things past, things to come, and things to come again—as we continue our war on crime.

Assignment in Mexico: The Experience of United States Magistrates in the Mexican Prisoner Transfer Program.—In December 1977 a number of United States magistrates were named verifying officials to conduct hearings in Mexico at which qualified Americans serving Mexican jail sentences had the opportunity to consent to return to the United States to complete those sentences. This article by Richard W. Peterson, describes the treaty between the United States and Mexico by which this prisoner transfer was authorized and the implementation of the treaty. The roles of the Department of Justice attorneys, Federal Public Defenders, personnel from the Bureau of Prisons and Probation Division to the transfer program are explained. The article concludes with the history making elements of the prisoner transfer program and its importance as a precedent for future treaties with other nations.

The Development of the Federal Prison System.—This article by Gregory L. Hershberger presents a historical overview of the Federal Government response to those incarcerated for violating Federal law. Events discussed include the establishment of the first Federal prison facilities in the late 19th century; the formation in 1930 of the Bureau of Prisons within the Department of Justice; the early attempts at programming and the subsequent development of those efforts; and facility acquisitions, institution closings, and mission changes of various institutions up to the present day.

Urinalysis: Issues and Applications.—Despite the wealth of material written about the various aspects of urinalysis, U.S. Probation Officer Philip

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J. Bigger asserts that there is a need to compile the pertinent highlights of that material into one general essay in order to provide the layman with a working knowledge of the subject. Hence, the purposes of urinalysis and the background issues are discussed, followed by a descriptive review of the types of analysis applied by toxicologists to specimens. Finally, the author provides a guide to the interpretation of test results for use in the field.

Community Interventions for Reluctant Clients.—The people with the greatest need for services are often reluctant to participate in community programs, write James D. Kloss and Joan Karan. Within corrections, a number of intensive probation programs have been developed to meet this need, but these have not demonstrated their effectiveness. The Complex Offender Project developed procedures to obtain and maintain the participation of persons with long histories of legal and psychological difficulty. The combined use of outreach, rapport building techniques, negotiated treatment contracts, and financial incentives proved effective in maintaining the involvement of this very difficult client group, and these procedures may be useful in other community programs working with reluctant clients.

The Development and Administration of a Correctional Internship Program: A Model.—Over the last decade and a half there has been a dramatic increase in the number of colleges and universities offering corrections-related programs, according to Dr. Jeffrey L. Schrink. Such curricula have focused student attention of corrections at an unprecedented level and consequently large numbers of students are now interested in serving internships in some type of correctional setting. Unfortunately, there is a dearth of publications in the professional literature aimed at providing detailed guidelines or blueprints to assist the correctional administrator in the establishment and administration of a correctional internship program. This article attempts to fill this void by proposing a model internship program which can be modified to reflect the unique circumstances of most correctional settings.

Home Supervision: Probation Really Works.—San Diego County has the most acutely overcrowded Juvenile Hall in California, reports County Supervising Probation Officer William G. Swank. In 1977 a new concept of Home Supervision became law and San Diego discovered that minors can successfully be detained under "house arrest" without committing further crimes. The key is intensive surveillance. Minors are personally seen 7 days a week: mornings, afternoons, nights (unannounced). If they are not where they are suppose to be, they are arrested. The County probation officers are also involved in crisis counseling and the program has proven to be highly therapeutic, rehabilitative—and it has reduced overcrowding.

Management Classification for Young Adult Inmates.—Since May 1977, the Federal Correctional Institution at Tallahassee, Florida, has used a system which assigns young adult males to one of three general categories of potential violence and is based primarily on the Minnesota Multiphasic Personality Inventory (MMPI). Results comparing periods before and after introduction of the system showed a decrease in serious incidents and assaults, reports Dr. Martin J. Bohn, Jr., chief of the Psychology Department. This management classification system has the advantages of being economical of staff personnel and time, and it has categories related to extensive psychological research. The results from the Tallahassee study suggest that the system has contributed to making the institution safer and has facilitated management decisions.

Interviewing Techniques in Probation and Parole: The Initial Interview (Part 2).—In the final article of this reprinted series on interviewing techniques, Dr. Henry L. Hartman continues a discussion of the initial interview. Methods of converting a directive to a nondirective technique are discussed. In a recapitulation of the entire series of four articles, Dr. Hartman reviews those techniques which are of particular use to the probation and parole officer in his counseling relationships with the probationer and the parolee. He updates the article at the end with current comments.

Urinalysis: Issues and Applications

By Philip J. Bigger
U.S. Probation Officer, Eastern District of New York, Brooklyn

Much has been written about urinalysis for the detection of drugs of abuse. There is no pretext here to suggest that what follows offers new insights or original information. This article's value, however, is seen in its attempt to bring together in one work the information developed by others on the various aspects of the topic. The data is presented wherever possible in non-scientific terms for, indeed, the author himself is a layman in the methods of toxicology. But a layman who, like others in the criminal justice field, must have a solid, working knowledge of urinalysis in their work. In short, as probation officers we must be knowledgeable in areas of expertise. The purpose of this article is to help in one of them.

I. Purposes and Issues

Definition and Purposes of Urinalysis

Urinalysis is the analysis by accepted toxicological methods of a urine specimen submitted by an individual for the purpose of determining the presence or absence of illicit or unauthorized drugs. There are several purposes for such testing. One is to provide an objective means to determine and measure the nature and extent of drug use; a second is to assist in the day to day management of clients in treatment; a third, to aid in early detection and intervention; and a fourth, to provide a chronological record of drug abstinence or use and permit a probationer or parolee to prove abstinence.

Several helpful corollaries of urinalysis can be mentioned here. It has been found that the very knowledge that tests are being conducted has reduced drug taking to a significant extent in several programs (Carroll and DiMino, 1975). It has also supported program credibility by revealing a more accurate picture of drug use or abstinence in such facilities as correctional institutions (Smith, 1979). Similarly, urinalysis results have been used to gauge the effectiveness of certain treatment methods within rehabilitation programs (Babst, 1979).

Of course, urinalysis cannot be considered as

the sole determinant indicator of drug use or abstinence. There are other means which should also be included in developing a full picture of the addict or user, such as historical data, medical reports, criminal record, family data, physical examinations, nalline tests, nasal swabbing as well as the client's own revelations. Indeed, even the urinalysis tests themselves are not absolute indications of drug use, as we shall see later, subject as they are to a number of factors beyond the control of the explicit tests. Yet, despite its limitations and qualifications, urinalysis is one of the most important factors in the identification and treatment of substance abuse.

Emotional and Legal Factors in Urinalysis

There have been strong feelings raised against the employment of urinalysis which include the opinion that it is dehumanizing, that it is an infringement upon constitutional rights, and that it works at cross-purposes with treatment by creating an atmosphere of doubt and suspicion.

The Human Issue

As to whether or not the submission of a urine sample is dehumanizing, we point to the lack of such feeling in medical officers when testing is done to assist in the diagnosis of an illness. In these instances, the trusting atmosphere is established because the patient is seeking help for a problem on a wholly voluntary basis. He or she knows that the outcome of a urinalysis test will determine the treatment regimen. It will not result in a jail sentence. Further, the patient usually wants to rid himself of the ailment. There is no intrinsic pleasure or comfort derived from it. Finally, usually no one watches the patient voiding into a container. And it is perhaps this last factor, the forced disclosure of a very personal act to others, that raises the issue of dehumanization. And it is at this point that the therapist must bring his professionalism to the forefront. In those instances where the client is reluctant or inhibited, the matter must be discussed fully and candidly in the treatment session with the reasons described in depth. Certainly, the therapist himself may even feel embarrassed in his first days in this type of work. Needless to say, the time for the actual voiding is not one for personal quips or sarcasm. The atmosphere created will determine whether or not the submission of a sample is dehumanizing or degrading.

The Legal Issue

That urine sampling is not an infringement upon constitutional liberties has been clearly established in the courts. In fact, the extrusion of evidence from a person's body has been generally accepted by judges as long as the method was not so objectionable as to "shock the conscience of the Court" as found in *Rochin* v. *California,* 342 US 165, 1952, in which case a stomach pump was employed to produce drugs which a suspect swallowed to avoid discovery.

One of the first urinalysis cases was *Rigdell* v. *United States,* D.C. Mun. App., 54 A. 2d 679, 1947, where police arrrested an individual for negligent homicide and, after giving him a warning that the test results could be used against him, obtained a urine for analysis to prove the influence of alcohol. The defense later unsuccessfully objected that this test was a violation of the privilege against self-incrimination as provided in the fifth amendment. In another case in 1954 a Federal District Court, in denying a suppression motion of the defense found that police acted properly when they instructed a man arrested for vehicular manslaughter to submit a urine sample without any warnings to determine if he had been drinking *(United States* v. *Nesmith,* 121F. Supp. 758). This motion, as in the 1947 case, was made on the basis that the act was self-incriminating. In reaching its decision, the District Court cited an earlier Supreme Court ruling *(Holt* v. *United States,* 218 U.S. 245) which stated in part, "But the prohibition of compelling a man in a criminal court to be a witness against himself is a prohibition of the use of physical or moral compulsion to extort communications from him, not an exclusion of his body as evidence when it may be material." This latter case involved a defendant who was required to put on a blouse to determine ownership. In *Nesmith,* the District Court also cited a case directly related to urinalysis *(Bratcher* v. *United States,* 149 F. 2d 742) in which a defendant took benzedrine before an army induction to develop signs of high blood pressure. Urinalysis disclosed the drug. Objections to the test on both fourth and fifth amendment grounds were held untenable. The conclusion of the Court in the *Nesmith* case has been generally accepted as governing in urinalysis cases.

> The law is clear, therefore, that the privilege against self-incrimination is limited to the giving of oral testimony. It does not extend to the use of the defendant's body as physical or real evidence. The conclusion is inevitable that it does not bar the use of secretions of the defendant's body and the introduction of their chemical analysis in evidence.

There have been cases after the 1954 *Nesmith* decision but all of those located, save one, continued to uphold urine sampling against attacks on fourth and fifth amendment grounds. (See, for example, *People* v. *Fidler,* Colorado, 1971, 485 P. 2d 725; *Campbell* v. *Superior Court in and for Maricopa County,* Arizona, 1971, 479 P. 2d 685, 106 Ariz. 542; *Ewing* v. *State,* Indiana, 1974, Ind. App. 1974, 310 N.E. 2d 571; *Russell* v. *State,* Alabama, 1974, 54 Ala. Cr. App. 452; *Wiseman* v. *Sullivan,* Nebraska, 1973, 211 N.W. 2d 906; *State* v. *Williams,* Nebraska, 1972, 201 N.W. 2d 241; *Committee For G.I. Rights* v. *Callaway,* 518 F.2d 466 (1974). The one notable exception referred to above concerned a soldier who refused to furnish a urine specimen on the grounds that the evidence that could be obtained from a urinalysis could be used to incriminate him. A Military Court found that the soldier could not be punished for this refusal for the reason that the soldier gave, but noted that rights of servicemen against self-incrimination in USMJ Article 31 (a) were broader than those provided in the fifth amendment *(United States* v. *Ruiz,* 23 USCMA 181, 48 CMR 797, 1974).

We have attempted to provide those cases which are directly related to urinalysis. However, it should be mentioned that one of the leading cases on the permissibility of testing biological fluids is *Schmerber* v. *California,* 384 U.S. 757, 1966 which dealt with the withdrawal of blood samples. Another case which is important in the drug treatment field is *United States ex rel Ramos* v. *Pinto,* 425 F.2d 1344, 1970 which found that the inspection of arms for needle marks was not an infringement upon constitutional rights.

The Therapeutic Issue

There have been a number of serious studies which have questioned the therapeutic value of urinalysis (see, for example, Kahn and Schramm, 1978; Goldberg, 1975). It seems, however, that the questions raised were concerned with the criminal consequences of illicit drug use as discovered by urinalysis as well as the testings' value in light of its costs and possible infringement on personal rights. A more interesting study (Sessler and Goldberg, 1975) examined the use of urinalysis in a number of methadone programs with questions such as "Generally does urinalysis have a positive therapeutic benefit to the client in treatment?" put directly to the agencies' counselors. The results of this initial study suggests that urine testing is of positive value in that it provides information, assists in the relationships with the client, shows concern that the counselor is watching, and helps make discussions more candid.

If we ask if it is possible that urine testing could be counter-therapeutic the reply must be affirmative. Not because of the urinalysis, however, but because of the therapist's use of the results. If the treatment specialist is reproachful instead of concerned; if the therapist discharges a client for a positive urine instead of taking the test result as a clue to intercede, then certainly the *use* of urinalysis is countertherapeutic. However, the problem seems to lie more in the behavior of the therapist than in the tool of urinalysis.

Should we rely on the relationship established between a therapist and a client rather than a scientific test to discover drug use? We believe not for several reasons. First, the reliability of addicts' responses varies, and for numerous reasons users do not always tell the truth (Ball, 1967; Cox and Longwell, 1974. Stephens, 1972; Page et al., 1977. Pernanen, K., 1974; Whitehead and Smart, 1972; Smart, 1975; Amsel et al., 1976). In the criminal justice setting, a user may feel that he may lose his freedom if he admits an involvement with drugs; or he may admit to only the use of some drugs or to a frequency less than correct. For immediate intervention, prompt knowledge is necessary which fact appears to be self-evident. However, in long-term treatment corroborative data is also appropriate. In the latter case, a user may feel that a relapse to drug use has in some way disappointed the therapist. He may feel that he has had a chance already in treatment and if he reverts—however briefly, to using again—in his mind he may believe that he will go to jail. The reasons are many which a user may give. Not accepting what a person says at face value does not imply that they are thought of less. It is simply a necessary responsibility that urines be taken throughout the treatment process.

There are several other reasons for not relying on a personal relationship for determining drug use. Just as often as a therapist may subjectively and intuitively conclude that a client is not abusing drugs when in fact he is, so also may the therapist conclude that a client is taking drugs when he is not. Urinalysis will free the client from un-

warranted accusations and suspicions. Further, as noted in a recent laboratory bulletin:

> Street drugs are often not what they are claimed to be. The record of analysis of seizures and of street drugs submitted to laboratories for testing have amply confirmed that drug sellers do not maintain any high ethical standards of merchandising. They will sell anything and everything that a buyer will ask for if they think the buyer will not recognize that he is being taken. A "heroin buy" may contain only milk sugar. If no heroin is present, it cannot show up in the urine. The same applies to any other drug. (The Laboratory For Chromatography, 1976).

To which we would add that a user may purchase one drug while thinking he is purchasing another. Finally, we believe that a record of negative urinalysis results serves a healthy purpose in treatment. The client who begins to do well will not only feel better but will also be able to point to a documented record. He is otherwise forced to rely on the personal opinion of a therapist who may change his position or leave an agency during the course of a client's treatment. And in a sense the client will have to "prove" again his drug-free state.

We have tried to review briefly the reasons behind urinalysis as well as some of the objections to it. For further information and discussion, the reader is referred to the bibliography which we have attempted to make as thorough as possible. Let us move ahead now to examine the process of urinalysis and tests employed by laboratories.

II. The Urinalysis Process

Drugs in the Body

Before we begin to examine the process of analyzing specimens and interpreting the results, we ought to discuss briefly the biological route that drugs take through the system and in what form they are ultimately excreted.

Users can take drugs orally, such as in pill and liquid form or through smoking; intravenously (I.V.) by injection directly into a vein; intramuscularly (I.M.) by injection into a muscle; subcutaneously by injection into a layer of skin; and finally, nasally, by breathing in a gas or powder. Once inside an individual's system the body begins to act on the substance taken by first metabolizing it, i.e., changing its chemical form, and then by excreting it. Thus, in the first stage, heroin is changed to morphine and morphine glucuronide. Rarely, if ever, is heroin excreted from the body as heroin. About 20 percent of the drug is converted to morphine and about 80 percent to morphine glucuronide, a fact which becomes important in the analyst's attempt to detect the drug, depending upon the procedures he uses as we shall see later. Cocaine breaks down into benzoylecgonine with very little of the original cocaine remaining. Amphetamines and barbiturates are excreted both in the forms taken as well as in their metabolic state (Catlin, 1973).

A word about excretion. Whatever the quantity be of a drug that is taken, all of it will be excreted. The only variant is the relative *rate* of excretion. And it is this factor which the user who wishes to conceal his use attempts to manipulate. For example, drinking large quantities of acidic substances such as vinegar does not "mask" or hide the results of a test from the toxicologist as addicts suggest. Rather, it speeds up somewhat the rate of excretion of some drugs, slows down the rate in others and has no effect on still others. Given a good-sized sample and the sensitivity of modern test equipment, however, variations in the excretion rate will not prevent discovery of the drug.

It should be noted, too, that the rate of excretion of drugs also varies due to a number of other factors which are not associated with the conscious manipulation to deceive. These will be discussed at greater length a little later. But despite the number of factors which affect the amount of a drug to be analyzed at any one time, all of the drug that a person takes will be excreted and routine screening on a regular basis will usually detect it.

Chain of Custody

Great care must be taken in securing biological fluids for analysis to insure that the result ultimately obtained corresponds exactly with the individual from whom the sample was taken. This is evident not only for treatment purposes but also for judicial reasons. There may come a time when the client denies in a judicial or administrative process that the result of a urinalysis was correct, claiming that the specimen must have been mixed up with another. To refute this claim, the therapist must be able to testify with certainty as to the steps that were taken. Clearly the first step in the chain of custody is the knowledge that the urine in the container when obtained belongs to the client. Only direct observation of the act of voiding can assure this (and even then as we shall see, there are several means of providing a false urine). Even before the client voids, however, his or her name should be on the container when handed over to give the specimen. Thereafter, the name and/or identifying number of the client should be recorded in the manner prescribed by the laboratory on its form. The name and number on the form should be identical to the name and number on the container. The specimen is then stored in a safe location until its delivery to the laboratory. When the laboratory receives the specimen they usually assign their own identifying number (accession number). Upon receipt of the result, the name and number of the client must again be compared for accuracy. These are only general guidelines. Describing a specific recording procedure has been avoided since each agency may have its own style. What is important, however, is that client and result are matched exactly.

Laboratory Procedures

Definitions (following De Angelis, 1973; Catlin, 1973).—Several terms are frequently used in urinalysis which should be defined.

Concentration.—This term refers to the amount of a drug or its metabolite in a given volume. The amount is nearly always expressed in micrograms ug; or one-millionth of a gram) and the volume in milliliters (ml). When describing the sensitivity (defined below) of their tests for certain drugs, laboratories will refer to their capability to detect a minimal concentration of the substance in micrograms per milliliter (ug/ml). Concentration of a drug in a person's urine varies as was noted earlier by the conscious manipulation of users to dilute their urine as well as by a number of other independent factors.

Sensitivity.—This is the minimal concentration of a drug or its metabolite that can be detected and is expressed in micrograms per milliliter (ug/ml). Because laboratory tests have been constantly improving, the minimum concentration of a drug to be detected is very low; so low, in fact, that the smallest possible concentration is not sought since this would devalue the use of normal urine screening. For example, let us suppose that Laboratory X sets its sensitivity level for barbiturates at 1.0 ug/ml, the usually accepted level. At this setting, short-acting barbiturates can be detected for about 36 hours after ingestion; long-acting barbiturates can be found from 3 to 5 days. Now, if the laboratory sets its sensitivity level at 0.1 ug/ml it would report positive results for much more than a week. For the treatment clinic that requires the client to report once or twice a week and produce a urine, the results obtained from the lower sensitivity level would appear to indicate continued barbiturate use when in fact the use may have been on only one occasion. To prevent this misinterpretation, laboratories have set common sensitivity levels.

Specificity.—This refers to the degree to which a test can discriminate between different drugs, especially those that are chemically related such as methadone and propoxyphene. Not being able to make such a distinction would limit the usefulness of a test. Occasionally, a certain procedure such as immunoassay can take advantage of not making a distinction between substances such as morphine and morphine glucuronide since both are derived from heroin. However, there may be difficulty in the same procedure in making a distinction between codine and morphine. Similarly, in the thin layer chromatographic process propoxyphene, novacaine, methadone and phencyclidine may have similar appearances and a gas chromatograph is employed to separate them.

Urinalysis Tests

We will attempt to describe here the various tests which are employed by laboratories in the analysis of urine, fully conscious that others have already done so and in greater depth (Catlin, 1973; De Angelis, 1973; Sohn, et al., 1972). We are not advocating one process over another but will point out the advantages and disadvantages of each as we have learned or experienced them.

Thin Layer Chromatography

Perhaps the oldest, accepted chemical test is thin-layer chromatography (TLC). In this process, the first step after receiving the specimen is to isolate and concentrate the drugs, if any, in the urine. There are several methods that can be used in this stage, termed "extraction," all of which are acceptable. One concentrates the drugs in an organic solvent; others bind them to ion-exchange paper, resin, cellulose or other materials. The organic solvents may be further concentrated by evaporation. In some cases, it may also be necessary to heat the specimen at this stage to arrive at the concentration. Another important step, but not done by all laboratories, is called hydrolysis. One of its purposes is to convert morphine glucuronide into morphine. When an addict takes heroin, the body will metabolize it, as we have

seen, into these two elements: morphine and morphine glucuronide. The former may represent only 10 percent of the total morphine present while the latter can make up as much as 90 percent. Most methods of extraction for TLC do not remove morphine glucuronide, hence the necessity for hydrolysis. If this is not done, many returns will be marked negative when they should have been noted as positive (an error known as a "false negative"). The next step is separation of the drugs. In this, a small amount of the concentrate is placed in one position on the edge of a glass plate coated with a thin layer of absorbent powder, either a silica gel or aluminum oxide. There is room on this plate to place concentrates from about 16 specimens without any danger of cross-contamination. The concentrate then travels up the plate by capillary action, carrying with it the unknown compounds. Since different drugs travel at different rates it is possible to see them as separate on the plate when it is sprayed with a "visualizing reagent." The plates are sprayed sequentially which provide different visible colorations to the unknown substances. These positions and colorations are then compared to known standards. If no drugs are present, there will be no spotting coloration on the plates. The advantages of TLC are in its specificity, sensitivity and low cost. It takes approximately one and a half hours for 16 tests and requires the presence of a skilled interpreter of the plate markings.

We must add at this time that any test which is employed and results in a positive finding should be confirmed through the use of a test procedure different from the first. A procedure that can confirm TLC results, as well as being a valid procedure in its own right is Gas-Liquid Chromatography.

Gas-Liquid Chromatography (GLC)

In gas-liquid chromatography, the preparatory steps of extraction and hydrolysis are essentially the same as in TLC. However, the concentrate, in the next step, is injected into a gas chromatograph and converted (volatilized) into a gas. The compounds are then forced through a column and separated. Each compound reaches the end of the column at a different time and is referred to as the "retention time." A detector notes the retention time and a visual record is made on a graph. Each drug has a different peak which must be interpreted by a skilled technician. Again, as in TLC, the system requires a well trained operator. The analysis of one sample requires 15 to 30 minutes. Sensitivity and specificity are very good.

Spectrophotofluorometry (SPF)

This procedure relies on the fact that, under certain conditions some chemicals, in this case the derivatives of drugs, will fluoresce. The drug must first be extracted as in TLC and GC. Then, by chemical reaction, the drug is converted to a fluorophore (a chemical which fluoresces) and subjected to a monochromatic light in the ultraviolet range. The wavelength (excitation) which is directed at the sample causes the fluorophore to emit light at another wavelength (emission) which is detected by a photocell and is visually seen on a recorder. The advantage of the system is its ability to analyze up to 500 samples in 8 hours. However, this type of analysis is limited to detecting only mophine related drugs, quinine and LSD as described by Mule and Hushin (1971) and Gillis and Kubic (1974).

Immunoassays

The use of immunochemicals in the detection of drugs of abuse began in 1970. The procedures to be followed are relatively simple and rapid. The theoretical chemical framework which obtains, however, does not lend itself easily to lay interpretation and the reader is referred to a number or thorough reference works in this area (for example, Catlin, 1973; DeAngelis, 1979; Brattin and Sunshine, 1973; Cleeland, *et al.*, 1976). Very generally, in immunoassay a drug of interest, e.g., morphine, is chemically bound to a protein forming a protein-drug complex. The complex is then injected into a laboratory animal which will produce antibodies in response to the drug portion of the injected complex. When the antibodies are withdrawn from the animal they are known to have a high affinity to the drug for which they were created, in this case morphine. Another substance now is added to the antibody mixture which closely resembles the drug to be detected and is sometimes referred to as "tagged" or "labeled" morphine (or cocaine, amphetamine, etc.). Because the prepared antibodies are attracted to the morphine like substance, they join with it. Later, when this mixture is added to a urine containing true morphine, the true morphine will compete against the "tagged" morphine in binding to the antibodies and ultimately displace all the "tagged" morphine which is released and measured. The amount of the "tagged" morphine is equivalent to the amount of true morphine present in the urine. Consequently, a valuable byproduct of the immunoassay technique is the capacity to determine quantity of drugs present in the urine as opposed to detecting just their presence in "yes" or "no" form. In actual practice, the antibody-"tagged" morphine is supplied to the user of the assay equipment. The latter then simply mixes the urine specimen with the supplied preparation, processes it through a machine and reads the result on the printout.

The advantages of an immunoassay system are several, such as simplicity of design and operation. It has drawbacks such as "cross reactivity" so that it is not as specific as non-immunoassay techniques and might possibly report a drug not actually present (a "false positive") because a drug, such as codeine, might act like morphine causing displacement of the "tagged" morphine thus resulting in an incorrect result. These procedures are for screening purposes, however. A certain number of false positives are introduced and confirmation is required. Immunoassays can only be performed on one drug at a time as compared, for example, with TLC which by its nature can screen for a number of drugs at once. The use of any procedure, however, will be determined by the purpose for which it is needed. If, for example, an agency desired to test all samples for one particular drug, such as the Army did in Europe to detect methaqualone abuse in 1973-74, the immunoassay might be an appropriate procedure (Rock and Moore, 1976).* Of course, all positive results on immunoassay should be confirmed by a non-immnuoassay technique.

There are four immunoassay techniques which exist: the Free Radical Assay Technique (FRAT), the Enzyme Multiplied Immunoassay Technique (EMIT), Radioimmunoassay (RIA) and Hemagglutination Inhibition (HI).

In the FRAT system, the "tagged" drug is labelled with a stable nitroxide radical. When mixed with a urine containing the true drug, the "tagged" drug becomes detached from the antibody and is detected by electron spin resonance spectroscopy. The signal intensity will then reflect the concentration of the drug in the urine sample. This system is no longer offered commercially.

With the EMIT process, a drug is attached to an enzyme to form the "tagged" drug. When added to urine with the corresponding true drug, the enzyme will be activated and will react with bacteria which is also contained in the test solution. The reaction causes a clearing of the originally cloudy test solution, which clearing is measured by a spectrophotometer.

The RIA procedure involves the binding of a radiolabeled ("tagged") drug to an antibody. It is combined with a urine containing the true drug, precipitated and centrifuged, and placed in a test tube for counting in a scintillation counter. The presence and amount of true drug present is measured by the radioactivity of the "tagged" drug.

Hemagglutination Inhibition is the only test of the immunoassays in which the chemical reactions are seen by the analyst and judgments made by those observations. The "tagged" drug in this procedure is in the form of red blood cells to which the drug has been attached. When a urine is added to the solution in a small conical well, the analyst will see the red blood cells stick together (agglutinate) in a diffuse pattern in the well if the true drug is not present in the urine. If the true drug is present, the reaction between the antibody and the "tagged" drug is prevented or inhibited and the red cells will settle as a pellet in the tip of the conical well. This test is one not widely used.

One last test should be mentioned. It is not one of the immunoassays but one which provides the only unequivocal identification of drugs.

Mass Spectrometry

Mass spectrometry has been described as the most sensitive and specific technique available. Sample molecules are volatilized and ionized. An analysis is then made of their mass-to-charge ratios. What is produced is a record of the summed atomic weights of the atoms present in each ion which absolutely identifies a drug. The mass spectrometer, however, is most expensive and analyzes only about 35 samples per day.

III The Interpretation of Urinalysis Results

Having looked at why we take urines for analysis and at some of the issues in this area, as well as having had a glimpse of the analytical procedures used in the detection of drugs, we finally arrive at what we have been waiting for:

* The immunoassays as a group are used to detect several drugs, viz, morphine, barbiturates, amphetamines, methadone and benzoylecgonine, although all assays will not test for all these drugs.

the urine result provided by the laboratory. We will take that result and do something with it: either compliment a client for remaining drug-free or intercede with a client for continuing use or something similar. Before we act, however, we must have a good understanding of what the result means. We have to ask whether or not a negative result actually means that the client is not using drugs, or was the drug not detected. We must ask if a positive result was confirmed, and if so, does it reflect new usage by the client or a detection of a lingering drug in the system which was detected on the last sampling? Catlin (1973) presented a truth table which outlines all the possible results of a urine test very simply:

Test Results	Drug Use: Yes	Drug Use: No
Positive	True Positive	False Positive
Negative	False Negative	True Negative

True Positive means that a drug is in the urine and is detected as such; a True Negative means that no drug was in the urine and none was detected; False Positive means that a drug was not in the urine but reported as if it was; and False Negative means that a drug was in the urine but was not reported. We must make one qualification about tests at the outset. In considering whether or not a test result is truly negative or positive, attention has to be paid to the time when the person last used a drug. If, for example, an individual used cocaine 7 days prior to the test and the test came back negative, can we consider the result as a true negative? We believe that we must. We cannot impart the responsibility to an analytical procedure of being able to pick up any drug at any time after usage. To do so would be to fail to consider, for example, the role of metabolism and excretion by the body in ridding itself of the drug. Similarly, if the client took heroin 6 hours before one test which was found positive and was retested 12 hours later, we understand that the second test might also be positive but must realize too, that it was so soon after the first that we do not know whether the result represents a new use of heroin or a redetection of the earlier use. To help in resolving this question, we list now the *average* time that drugs remain in the system. We stress "average" because many factors will influence this time. Some drugs have been known to remain in the system for several weeks. However, we must assume that the procedure used to detect the drugs at such low levels were highly sensitive, calibrated to a sensitivity far beyond what is standard.

Drug	*Maximum Length of Time in System*
Alcohol	+ 12 hours
Amphetamines	24-48 hours
Barbiturates	
Long-Acting (Barbital, Phenobarbital)	4-5 days
Short-Acting (Pentobarbital, Amobarbital, Secobarbital)	+ 36 hours
Cocaine	24-48 hours
Heroin	24-96 hours
Methadone (40-50 mg.)	24-96 hours
Phencyclidine	24-48 hours
Quinine	3-10 days
Benzodiazepine	+ 7 days

In arriving at the times above, the factors which we cite now may contribute to the amount of drug present in the urine at the time the sample was taken (from Biomedical Laboratories, 1977):

A. Drug and Chemical Factors
   - Dosage Form
   - Use and dose
   - Route of administration
   - Concentration of toxicant
   - Duration of exposure

B. Human Factors
   - Age
   - Weight
   - Time of sampling
   - Method of analysis and presence of metabolites
   - Treatment given, if any
   - Time interval between sampling and analysis
   - Storage of specimen

C. Pathological Factors
   - Disease state (esp. renal and hepatic)
   - Body water (normal or dehydration)
   - Menstruation
   - Anatomical abnormalities (congenital or surgically and/or traumatically caused)
   - Genetic disorders (pharmacogenetics)

D. Pharmacological/Biochemical Factors
   - Gastrointestional absorption
   - Tissue binding at active and inactive sites
   - Rate of elimination (excretion)
   - Storage (bone, hair, nails, fat)
   - Induction or inhibition of microsomal enzymes
   - Synergistic or antagonistic action of other drugs
   - Tolerance (from prolonged use or use of drugs with cross tolerance)
   - Rate of detoxication (metabolism or biotransformation)
   - Additive drug effects

Given the background knowledge of the length of time drugs usually remain in the system and the factors which affect drug concentration in any one sample, we can proceed to examine the Catlin diagram with more assurance.

True negative results and true positive results, ideal as they are, are generally possible and can be expected more often than not. Let us look at the more dangerous situations of false negative and false positive results individually. A false negative result occurs because of errors in collection such as mislabeling and client subterfuges; errors in testing such as improper reading of results in the laboratory or in transmitting incorrect results to the treatment agency or finally in incomplete procedures such as the lack of hydrolyzing specimens. Both the treatment agency and the laboratory, by using common sense care, can avoid most false negatives. False positive results are potentially more dangerous since the subject whose urine was tested may be discharged from treatment, denied treatment or incarcerated. These results can be caused by the misreading of a chemical substance which is not a drug; by the action of a drug not being sought but which produces similar activity; as well as by the switching of a urine by an addict who believes that he has substituted a "clean" urine for his own "dirty" one when, in fact, the substitute also contained drugs. Laboratories are aware of many more of the potential dangers of false negative and false positive results and have developed quality control practices to deal with them (e.g. Sohm *et al.*, 1972).

Quinine

In discussing the interpretations of urinalysis results, some attention must be given to the value of detecting and reporting the quinine found in biological specimens. Quinine is a substance which is present in medications, beverages and in pure form. It is also used in the preparation of illicit drugs such as heroin or cocaine as "cutting" or diluting agent. The question arises, "Because the existence of quinine is present in so many forms, many of them non-prescriptive and legitimate, should treatment agencies bother to have a laboratory check for it? If the specimen is found positive for quinine, is it any help in treatment?" We believe that knowing of the presence of quinine is useful and for several reasons. First, let us consider the sources of quinine. In 1971 a reference laboratory surveyed numerous medications and found that 245 contained quinine. However, many of the medications had such small quantities of the substance and/or were in such application form (as topical) that laboratories would not detect the quinine through urinalysis. In other cases, the medication had to be prescribed which is verifiable by the treatment agency. This leaves very few legitimate, over-the-counter medications containing detectable quinine. Instructing the client in a drug abuse program from using certain over-the-counter preparations is not unreasonable as substitutes can be found. It is our experience, too, that even where quinine is part of a prescribed medication, a simple conversation with the doctor will generally result in a substitute prescription. It is the rare situation, indeed, where quinine cannot be exchanged for another substance.

There are other sources of quinine that were not included in the 245 medications surveyed. These are the nonalcoholic beverages such as tonic water and bitter lemon and some imported wines. The author participated in a short study of tonic water with another officer and found that after drinking six ounces of tonic water, the urines were found to be positive from 3 to 5 days. In a second study, six ounces each of two wines believed to contain quinine were consumed. No quinine in either was detected. Correspondence with the Bureau of Alcohol, Tobacco and Firearms of the Department of the Treasury determined (1974) that quinine as a hydrochloride salt or as a product of cinchona bark was only permitted in some natural domestic and foreign wines in amounts not to exceed 58 parts and 83 parts per million, respectively. These scant amounts virtually defy detection at standard sensitivity. Our solution, therefore, has been to prohibit the use of any medication, beverage or preparation which contains quinine, without express permission, throughout the treatment period. We might add that in our five and a half year experience with urinalysis, quinine results were nearly always a clear clue to illicit drug use.

In the very rare situations where quinine results persist and client either denies the use of any drug or preparation which might contain quinine, or insists on his right to legitimate beverages, and no needle tracks or evidence of skin popping is observed, but drug use is suspected, we have found the nasal swab to be extremely helpful. This is particularly the case where snorting of heroin is suspected. The nasal swab, of course, is not a urine test but can be employed as a complement to it. In these cases, two cotton-tipped applicators are wetted with ordinary tap water and each is used to swab one nasal cavity each. The applicators are then placed in a urine bottle and sent to the laboratory for analysis. If the analysis is positive for quinine it means that quinine in its pure form, unmetabolized by the body, was found in the nose. If the user had been claiming the use of tonic water, the only way that the quinine could be found in the nasal passage would be, then, if he improbably insisted that this was the route by which he normally drank soda.

Client Subterfuges

Drug abusing clients may sometimes try to avoid disclosure of their drug use by denying it, failing to come in for treatment, drinking large quantities of liquids to reduce the concentration of drugs in their system, switching "clean" urines for their own, adding compounds and water, and by ostensibly being unable to produce a specimen at the time requested. Concealment of drug use by denial and by failing to report can be resolved, albeit not necessarily with ease, through the case work process and home visits. These procedures are common to all helping agencies and will not be discussed here. But let us look in more detail at the other attempts at concealment.

Flushing

The practice of drug users of drinking large quantities of fluids or of taking emetic preparations to rapidly remove fluid from the body is known as flushing. As more fluid is discharged with a drug, concentration of that drug is reduced. If 0.6 ug/ml of morphine was present in the urine, a detectable amount, flushing might reduce it to 0.3 ug/ml, a concentration below the standard level of sensitivity. Flushing is often done by drinking large quantities of beer, water or soda. It can also be accomplished by the use of an emetic. In this regard, the *New York Times* reported in 1974 (August 7) that some California toxicologists reported difficulty in detecting heroin when the client was drinking an herb known as goldenseal in tea form. It was believed that the herb when excreted interfered with, and consequently prevented, the discovery of heroin in chemical tests. This has proved to be untrue. However, goldenseal does act as an emetic, causing additional excretion of bodily fluid, and thus reducing the concentration of the drug in the urine. It is good practice not only to instruct a client to avoid excessive consumption of liquids before a test but also to request the testing laboratory to inform of dilute-appearing, pale-colored urines. In addition to visual observation, laboratories can also perform specific gravity tests. The closer a specimen approaches a specific gravity of 1.0000 (water) the greater the likelihood of dilution.

Switching and Substituting

There must be, indeed, a street-folklore about successful and unsuccessful attempts to conceal a "dirty" urine with one that is clean. In our experience, the practice is not frequent, but consistent. Schemes to switch a negative urine for the user's own is limited only by the addict's imagination. The more common attempts can readily be prevented by the direct observation of the client voiding. These machinations include (but are not limited to): the carrying of a container with clean urine with the hope for an opportunity to pour it into the container given by the therapist; dropping a specimen container into the commode "by accident" and bringing it up with water in it; and attaching a plastic bag to the body with a tube running down to and along the penis to give the appearance of actual voiding. More sophisticated, and consequently more rare attempts, include false penises and urine contained in thin-skinned sacks inserted in the vaginal cavity and ruptured easily by a fingernail.

Additions

Clients do not often add anything to a urine provided in order to hide the drugs which may be present. It is true that some have managed to get plaster and charcoal into the container but such substances are readily observed by the therapist. In any event, no liquid or solid added to the urine can block the tests from finding abused drugs.

Stalls

A stall has been described as the failure of a client to produce a urine sample for testing. This can result from intentional withholding of a specimen or of a quantity of specimen sufficient for testing, or from an inability to produce a specimen. If a client produces an unobserved specimen or does not appear for collection these too are considered stalls. It is important to look into the reasons for stalls, some of which may not be for the conscious purpose of hiding drug use. If a client withholds a specimen or provides only a fractional amount or fails to appear as scheduled, to hide his drug use, then the stall is simply another manipulation, such as flushing and switching. If, however, a stall is viewed as acting out behavior (Kram, 1975), the stall begins to take on a new dimension. First, let us quickly mention some physiological contributors to stalling which are beyond the client's control. Among these are kidney failure and urologic diseases. It is also known that some medications inhibit the ability to void. Methadone is one of these inhibitors. If a client is reporting daily for his maintenance dose, he will normally submit a urine. This may involve some difficulty. If, later in the day, the client must submit another urine to a representative of another agency, the difficulty in voiding is *compounded.*

Considering the stall as acting out behavior implies an unconscious motive of the client. The therapist should be aware of this. Situations have been reported (Kram, 1975) where stalls have occurred because of (1) reactions to staff, as in the case of a conflicted homosexual who believed others were making sexual advances toward him; (2) hostility, occasioned, perhaps by a change in counselors; and (3) a desire for punishment. As Kram points out, "Acting out attempts to affect the behavior of others. Consequently, it is essential that the staff recognizes its role in the acting out." Viewed as non-verbal communication, the stall must be examined by the therapist for its hidden meanings as well as the more obvious ones.

IV. Proficiency Testing and Quality Control

With the passage of the Clinical Laboratories Improvement Act of 1967, the efforts begun 3 years earlier by the Center for Disease Control to improve laboratory performance were enhanced. Now, any toxicology laboratory doing business across state lines or receiving Federal funds from methadone programs must submit to proficiency testing through the CDC. This testing consists of the sending of urine samples with drug contents known to the CDC to participating laboratories who, in turn, must correctly identify and report the contents back to the CDC. The passing grade is 80 percent. For a full discussion of the background of the CDC program, the reader is referred to Guerrant and Hall (1977).

In addition to the Federal CDC proficiency testing program, many states maintain their own proficiency standards. In New York State, for example, all laboratories must be licensed by the state in order to do business within the state. Proficiency testing includes not only the mailing of samples of known content to be analyzed but also on-site, surprise visitations by state officials, carrying samples which they observe being analyzed. In this way, not only are results graded, but procedures are evaluated, too. Any laboratory which is selected for urinalysis should be a CDC participant as well as state licensee.

Quality Control refers to the internal checks on quality and performance which both a laboratory and treatment agency can engage in. Laboratories should have high standards for maintaining sound procedures that cover numbering specimens, avoiding contaminated glassware, confirmation of tests and the like. Treatment agencies can routinely check their laboratory by sending one specimen, divided in half, to the laboratory, using a fictitious name on the second half of the specimen. It is also possible to obtain specimens from some state licensing agencies, disguise them to appear as normal agency specimens and send them to their own laboratory. The results can then be compared to what the state agency knows to be the true contents. Treatment agencies must also take care to maintain high internal standards of quality, as mentioned for laboratories, by using proper labeling, recording, storage and delivery procedures.

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The bibliography is divided into two parts. The first is composed of works which are generally informative to those working in fields requiring urinalysis. The second is composed of the toxicological aspects of urinalysis which may be of interest to some. This latter group is only a selection of articles. For further information the reader is referred to the scientific periodicals and indices.

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