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Experience in the Identification of Abuse Drugs in Urines Collected Under Treatment Alternatives to Street Crime

Treatment Alternatives to Street Crime (TASC) is a program through which the federal government has supplied grant funds to local governments to assist them in their efforts to control the criminal activity of drug-dependent individuals. The Special Action Office for Drug Abuse Prevention (SAODAP), the Law Enforcement Assistance Administration (LEAA), and the National Institute of Drug Abuse (NIDA) are presently sponsoring 24 of these programs throughout the country.

Philadelphia was one of the first to participate in this project. The city was given a grant totalling one million dollars in the summer of 1972, with the hopes of achieving the following overall goals:

1. Decrease the incidence of drug-related crime with the attendant cost to the community.
2. Interrupt the drug-driven cycle of street crime to jail to street crime, by providing treatment.
3. Rehabilitate drug-related arrestees to participate in productive activity.

By the late fall of 1972, a multimodality, multicity agency identification, diversion, and treatment system was functioning under the Philadelphia TASC program. The role played by the Philadelphia Police Laboratory in TASC was to identify by urinalysis those individuals within the criminal justice system who were involved with drugs. Urine specimens were collected on arrestees brought into the central detention unit of the Philadelphia Police Administration Building. Analyses were performed on all specimens to determine first if the major urinary heroin metabolite, morphine, was present. This was followed by a more comprehensive examination for the following other drugs of abuse: (1). amphetamine, (2) methamphetamine, (3) amobarbital, (4) butabarbital, (5) pentobarbital, (6) phenobarbital, (7) secobarbital, (8) cocaine, (9) codeine, and (10) methadone. The results of these findings would later be used as part of a statistical study that was being conducted within TASC to ascertain what, if any, relationship exists between drug usage and non-drug-related criminal offenses (for example, homicide, burglary, robbery, rape).

A staff of seven laboratory technicians and five laboratory helpers was employed on a round-the-clock basis to handle the anticipated volume of 100 urine specimens per day.

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Results of the "quick screen" for morphine had to be completed within two hours of collection time and the results made available to a court bail program interviewer, whose job it was to determine if the arrestees met the criteria for the TASC program. Findings of the more comprehensive drug analysis were to be reported to the statistical unit within TASC on a weekly basis. Existing space and facilities in the laboratory, cost per sample, availability of existing supervision, techniques and methods to be employed, and the reliability and speed of the analysis all had to be considered prior to embarking upon this mass drug-urine screening program.

In deciding which drug separation procedure would be instituted, many questions arose, such as the time required, cleanliness of the extract, cost per sample, efficiency of the extraction of the drugs, number of steps required, and degree of expertise needed on the part of the laboratory technicians. Isolation techniques such as unisolvent or polysolvent extractions [*1,2*], resin-impregnated paper [*3*], or resin-loaded columns [*4*] were evaluated based on the following features inherent in each:

(1) cost for equipment and reagents,
(2) operator's skill and time required,
(3) cleanliness of extract,
(4) percentage recovery of drugs from urine,
(5) health hazards associated with the reagents,
(6) reproducibility,
(7) effects on the integrity of the drugs, and
(8) compatibility with identification techniques to be used.

After much investigation, it was finally decided that an activated-charcoal adsorption technique [*5*] would be employed for the drug separations. This method was found to require very little expenditure in the way of equipment and reagents. Very little skill and time were demanded on the past of the analyst (12 min per sample). Reagents created no health or safety hazards, since the volume of solvent to be evaporated was only 2.5 ml. The extracts were clean and no apparent alterations of the drugs were observed. Although recoveries were low for some drugs (amphetamines, phenobarbital, and morphine) using the charcoal method [*6*], the purity of the extract made it far superior to other techniques which provided rather dirty extracts. Finally, the separation procedure lent itself well to the chromatographic and spectrofluorometric techniques that were subsequently employed.

Of the many available techniques evaluated—thin-layer chromatography (TLC) [*1*], instant thin-layer chromatography (ITLC®) [*7*], gas liquid chromatography (GLC) (manual and automated) [*7,8*], gas liquid chromatography/mass spectrometry (GLC/MS) [*9*], spectrofluorometry (SPF) (manual and automated) [*10-13*], radioimmunoassay (RIA) [*14*], free radical assay technique (FRAT®) [*15*], enzyme multiplied immunoassay technique (EMIT®) [*16*], and hemaaglutination inhibition (HI) [*17*]—it was decided upon to use a modified spectrofluorometric procedure based on one described by Mulé and Hushin [*11*] for the "quick screen" for morphine. Selection of this technique over the others was based upon the following findings.

1. The selectivity was equal to none except GLC/MS, which was more selective. However, relatively high costs for this type of equipment, much lower sensitivity, considerable analysis time required, and higher equipment downtime all resulted in eliminating GLC/MS as a candidate for this program.
2. The sensitivity (modified Mulé procedure) was equal to that of RIA (10 ng/ml of

urine), with the advantage of being more selective and costing less per sample to analyze (pennies per assay).

3. The speed was relatively slow when compared to EMIT® and FRAT® (2 min per sample versus 90 min per sample); however, sensitivity (500 ng/ml of urine for EMIT® and FRAT® versus 10 ng/ml of urine) and selectivity of SPF outweigh this time advantage. The 90-min analysis time was well within that required by the TASC program.

4. There was a minimum amount of data to be analyzed and interpreted, noting the presence or absence of an emission band. Very little time was required to learn to operate equipment (several hours).

5. The cost of the equipment was relatively cheap ($4-5000) with only 1% downtime.

Two dual-column, automated, solvent-free sample injection gas chromatographs interfaced with an automatic data reduction system [8] were used to screen and tentatively identify the other abuse drugs in the urine specimens. This equipment was selected over the others for several reasons. It was able to separate and identify all the required drugs with the necessary degree of sensitivity (1 μg/ml urine). It was capable of performing these identifications with a high degree of accuracy. The use of an automated, solvent-free injection onto two different columns considerably reduced the risk of obtaining false positives. The equipment was able to analyze the samples within the required period of time. A complete examination for all the drugs takes 21 min per sample (the time required for sample introduction, chromatographic analysis, and sample cycling), which may seem inordinately long for a mass screening project. However, it must be remembered that during this time many functions are being performed by the system. Two chromatographic analyses are being conducted simultaneously. Immediately following the analyses, a complete analytical report from each column is printed out. All GLC information is provided and the identified drugs are printed out by name, with concentration expressed in any desired unit. This entire process occurs without using any of the analyst's time. Date evaluation with this system was considerably reduced; generally the time required to assess and interpret chromatograms is quite lengthy and fatiguing when using conventional equipment, but this time was reduced as much as 50% using the automatic data reduction equipment. Finally, the system was capable of being operated with a minimum of skill and knowledge. Only a few days of instruction were necessary for the normal operation of the equipment. Troubleshooting the more common malfunctions required more time and was usually learned with experience. This system (with the two gas chromatographs) more than adequately handled the analyses of 100 samples per day.

The procedure was found inadequate for morphine determination due to its lack of sensitivity, necessitating that SPF screen for morphine be confirmed by EMIT®. Another problem associated with this system was the considerable amount of downtime experienced during most of the duration of the comprehensive drug analysis (20 to 25%). This electronic perplexity was manifested by a periodic program abort. Although its source could never really be traced, it was speculated that spurious electrical artifacts generated by the teletype were the causative agents. Even with this highly sophisticated system, it was still found necessary to confirm all positive results by TLC or GLC (derivatized and nonderivatized) or both.

Experimental

Apparatus

Fluorescence spectrophotometer, Perkin Elmer Model MPF2a, with recorder, Hitachi Model QPD-33 (input 10 mV)

Gas chromatographs (two), Perkin Elmer Model 900, each with dual FID and dual-channel amplification
Autosamplers (two), Perkin Elmer AS-41, with programmers and closing device
8K data processor, Perkin Elmer PEP-1
Dual-channel recorders (two), Perkin Elmer Model 56
Dual-column adapters (two)
Instrument interfaces (four—two for each instrument)
Formic acid column conditioners (two—one for each instrument)
Gas chromatograph, Perkin Elmer Model 990, with dual FID and single-channel amplification
Single-channel strip chart recorder, Leeds and Northrup Model Speedomax H®
Multi-Temp Blok® (60 samples), Lab-Line Instruments, Inc.
Vortexer, Scientific Products Deluxe Mixer
6-qt pressure cooker, Presto
Centrifuge (24 samples), Adams Dynac®
Repipets (three), Labindustries, 5-ml
Repipet, Labindustries, 10-ml
Repipet, Labindustries, 1-ml
MLA pipetter, Dow Chemical Co., 1000-μl with disposable tips
MLA pipetter, Dow Chemical Co., 20-μl with disposable tips
Syringe, Hamilton Model 701-N, 10-μl
Solid sampler, Hamilton Model 5560-N
Silica gel plates, Quantum Industries No. 5091, precoated 20 by 20-cm glass plates containing 250-μm layer of silica gel in combination with an ultraviolet-sensitive phosphor and a 3-cm preadsorbent spotting area, LQD-F

Glassware

Screw-cap culture tubes, Pyrex No. 9826, 16 by 100 mm with teflon caps
Culture tubes, Kimax No. 45048, 12 by 75 mm
Microcaps, Drummond, 10 lambda, disposable
Culture tube, Pyrex No. 9820, 6 by 50 mm

Reagents and Solutions

Decolorizing carbon, Fisher Scientific Norit A®
Trimethylanilinium hydroxide, Pierce Chemical Co. Meth Elute®, 0.2*M* in methanol

pH 11.0 Buffer

Dissolve 49.1 g of $Na_2CO_3H_2O$ and 8.4 g of $NaHCO_3$ in water and dilute to 1000 ml.

Solvent Mixture

Mix 500 ml of chloroform, 540 ml of ethyl ether, and 100 ml of 2-propanol.

Iodoplatinate Spraying Agent

Dissolve 0.4 g of chloroplatinic acid in 4 ml of water and mix with a solution of 4.0 g of potassium iodide in 80 ml of water. The resulting solution is diluted to 100 ml with water.

Mixed Internal Standard

The mixed internal standard is a methanol solution of barbital (1 mg/ml), scopolamine hydrobromide (1 mg/ml), and nalorphine (3 mg/ml).

Mixed Drug Standard

The mixed drug standard is a methanolic solution of amphetamine sulfate, methamphetamine hydrochloride, butabarbital sodium, amobarbital sodium, pentobarbital sodium, secobarbital sodium, glutethimide, phenobarbital, methadone hydrochloride, cocaine hydrochloride, and codeine phosphate (all at 1 mg/ml); morphine sulfate (2 mg/ml); and quinine hydrochloride (3 mg/ml).

Urine Standards

The urine standard for comprehensive screen is prepared by adding methanolic solutions of drugs to drug-free urine at the following concentrations: amphetamine sulfate, methamphetamine hydrochloride, morphine sulfate, and quinine hydrochloride—3 mg/ml urine, and butabarbital sodium, amobarbital sodium, pentobarbital sodium, phenobarbital, glutethimide, methadone hydrochloride, cocaine hydrochloride, and codeine phosphate—1 mg/ml urine. The urine standard for amphetamine confirmatory analyses is a solution containing 5 μg/ml of urine of amphetamine sulfate and methamphetamine hydrochloride. The urine standard for barbiturate confirmatory analyses is a solution containing 5 μg/ml of urine of the sodium salts of butabarbital, amobarbital, pentobarbital, secobarbital, and phenobarbital.

Procedure

Comprehensive Screen

Extraction—Activated charcoal (100 ± 10 mg) is measured into a 16 by 100-mm screw-cap culture tube. One millilitre of buffer is added and the mixture is agitated for several seconds to wet the charcoal completely. Ten millilitres of urine are transferred to the tube, which is capped, inverted several times, and vortexed for 30 s. The tube is centrifuged for two minutes and the liquid phase is removed by aspiration. One millilitre of distilled water is added and the tube is vortexed for a few seconds to suspend the charcoal. The mixture is again centrifuged and the liquid phase removed by aspiration. After addition of 2.5 ml of mixed solvent, the mixture is vortexed vigorously for 30 s and centrifuged for 2 min. The solvent is then carefully decanted into a 12 by 75-mm culture tube. One drop of a 5% methanolic solution of HCl is added. Half of the solution is transferred to a second culture tube and both samples are placed in the heating block and evaporated to dryness at 60°C under a stream of dry air.

Gas Chromatographic Analysis—Samples are prepared for gas chromatographic analysis by the following procedure. Each chromatograph is equipped with an AS-41 autosampler which accepts up to ten cartridges, each of which holds ten aluminum capsules. One of the previously dried urine extracts is taken up in 20 μl of methanol and transferred to one of the capsules along with 3 μl of the mixed internal standard solution. The capsule is then dried by gentle heating, hermetically sealed, and the cartridge is loaded into the magazine of the autosampler. Once the instruments are initialized (under the PEP-1 control) the system is totally automatic. A splitter (dual-column adapter) is located between the injector port and the two columns so that half of the sample is directed into one column and the other half into the other column. The two columns are interfaced with the PEP-1 processor, so that each sample generates both an analog and a digital chromatographic report for each column. One mixed drug standard (mechanolic) and one spiked extract of a urine standard are analyzed with each batch of samples. Figures 1 and 2 are typical analog and digital records of a mixed drug standard generated by the system.

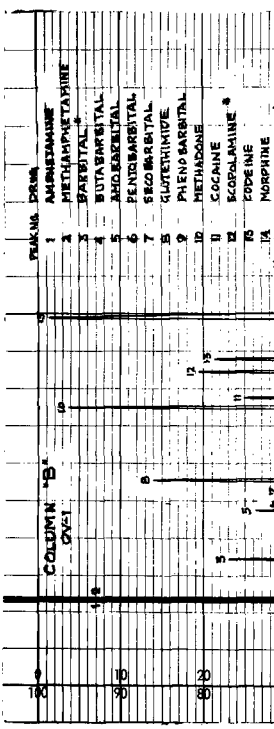

FIG. 1—*Analog results of a methanolic mixed drug standard chromatographed on the Perkin Elmer 900-PEP-1 system. Attenuation: Column A, 32 by 10, and Column B, 64 by 10.*

MIXED DRUG STANDARD

THRESHØLDS 200 16

RN 1 DRUGS ØV-17 B

ØST 4 , METHØD 47 , FILE 21 3:

TIME	AREA	RRT	RF	C	NAME
.66	13.0604	.257,	1.0000,	3.3690,	AMPHETAMINE:
.73	19.1968	.285,	1.0000,	4.9520,	METHAMPHETAMINE:
2.56	43.2179	1.000,	1.0000,	11.1480,	BARBITAL:
3.56	9.1116	1.390,	1.0000,	2.3504,	BUTABARBITAL:
3.77	12.4121	1.472,	1.0000,	3.2018,	AMØBARBITAL:
4.01	11.0912	1.567,	1.0000,	2.8610,	PENTØBARBITAL:
4.33	11.9596	1.7571,	1.0000,	3.0850,	SECØBARBITAL:
5.10	17.4259	2.212,	1.0000,	4.4952,	GLUTETHIMIDE:
6.12	10.4300	2.816,	1.0000,	2.6905,	PHENØBARBITAL:
6.43	21.7907	2.999,	1.0000,	5.6212,	METHADØNE:
7.29	11.1865	3.508,	1.0000,	2.8856,	CØCAINE QUALUDE:
8.12	49.5795	4.000,	1.0000,	12.7896,	SCØPØLAMINE:
8.59	15.2710	4.278,	1.0000,	3.9392,	CØDEINE:
9.32	16.7891	4.684,	1.0000,	4.3308,	MØRPHINE:
10.15	114.1196	5.000,	1.0000,	29.4384,	NALØRPHINE:
11.27	10.0259	5.425,	.0000,	.0000,	?
12.72	4.9152	5.976,	.0000,	.0000,	?
13.27	11.0067	6.185,	1.0000,	2.8392,	QUININE:

THRESHØLDS 200 16

RN 1 DRUGS ØV-1 B

ØST 3 , METHØD 31 , FILE 23 3:

TIME	AREA	RRT	RF	C	NAME
.64	6.5379	.688,	1.0000,	2.7678,	AMPHETAMINE:
.73	9.1171	.784,	1.0000,	3.8598,	METHAMPHETAMINE:
1.26	22.1824	2.000,	1.0000,	9.3912,	BARBITAL:
2.76	4.5166	2.967,	1.0000,	1.9121,	BUTABARBITAL:
3.10	5.5504	3.333,	1.0000,	2.3498,	AMØBARBITAL:
3.27	5.7500	3.516,	1.0000,	2.4342,	PENTØBARBITAL:
3.59	5.4617	3.860,	1.0000,	2.3122,	SECØBARBITAL:
3.90	9.2534	4.193,	1.0000,	3.9174,	GLUTETHIMIDE:
4.79	5.0123	5.150,	1.0000,	2.1220,	PHENØBARBITAL:
5.84	10.4828	6.138,	1.0000,	4.4380,	METHADØNE:
6.10	5.4553	6.373,	1.0000,	2.3096,	CØCAINE:
6.79	24.5580	7.000,	1.0000,	10.3968,	SCØPØLAMINE:
7.13	6.9232	7.308,	1.0000,	2.9310,	CØDEINE:
7.82	8.6889	7.750,	1.0000,	3.6784,	MØRPHINE:
8.27	83.2256	8.000,	1.0000,	35.2336,	NALØRPHINE:
9.18	4.7535	8.504,	1.0000,	2.0133,	?
9.63	3.0016	8.754,	1.0000,	1.2707,	?
9.77	12.3424	8.831,	1.0000,	5.2252,	QUININE:

FIG. 2—*Digital results of a methanolic mixed drug standard chromatographed on the Perkin Elmer 900-PEP-1 system.*

Gas Chromatographic Conditions—dual-column injection.
Columns: (A) 6 ft by 0.08-in. inside diameter by ¼-in. outside diameter, glass 3% OV-17 Gas-chrom, Q 100/120 mesh and (B) 6 ft by 0.08-in. inside diameter by ¼-in. outside diameter, glass 3% OV-1 Gas-chrom, Q 80/100 mesh
Carrier gas: Helium flow 60 ml/min, pressure 70 psi
Injection port temperature: 260°C
Manifold temperature: 300°C
Column temperature: Programmed, 180 to 280°C at 16°C/min and held at 280°C for 8 min
Attenuation: Column A (OV-17), 32 by 10, and Column B (OV-1), 64 by 10

Fluorometric Analysis—The second previously dried extract in the culture tube is treated with 100 μl of concentrated sulfuric acid, vortexed for 10 s, and allowed to remain in the heating block at 60°C for 2 min. One millilitre of distilled water and 1.25 ml of ammonium hydroxide are added successively, vortexing after each addition. The sample is then autoclaved for 15 min at 250°C, cooled to room temperature, placed in the spectrofluorometer, and the fluorescence spectrum is recorded. Urines containing 0.004 and 0.001 mg. of morphine per 100 ml of urine, respectively, are analyzed with each batch of samples.

Fluorometric Conditions

Excitation wavelength: 396 nm
Emission wavelength: 400 to 440 nm on emission drive
Slits: Excitation 8 nm and emission 6 nm
Scan speed: High
Chart speed: Medium

Confirmatory Analyses

Gas Liquid Chromatography—Gas liquid chromatography was used to confirm all the comprehensive screen positives for amphetamines and barbiturates.

Amphetamines—Two millilitres of urine are placed in a 16 by 100-mm screw-cap culture tube. One drop (approximately 0.03 ml) of 20% aqueous Na_2CO_3 and three drops (approximately 0.1 ml) of acetic anhydride are added and the tube is heated on a flame to just below boiling. After cooling under tap water, 400 μl of chloroform are added and the tube is capped and inverted gently 40 times. The mixture is centrifuged and the chloroform layer is transferred to a 6 by 50 mm test tube. The urine standard containing the amphetamine and methamphetamine is analyzed with each batch. Ten microlitres of the chloroform extract are withdrawn, using a 10-μl syringe, and placed on a solid sampler, which is then injected into a Perkin Elmer 990 gas chromatograph under the following conditions:
Column: 3 ft. by 1/8-in. outside diameter stainless steel OV-17 gas chromatograph, Q 100/120 mesh
Carrier gas: Helium flow 60 ml/min
Column temperature: 160°C
Injection port temperature: 290°C
Manifold temperature: 290°C
Chart speed: 1 in./min

Free drug barbiturates—Two millilitres of urine are placed in a 16 by 100-mm screw-cap culture tube. One drop (approximately 0.03 ml) of 10% HCl is added,

followed by 400 μl of chloroform. The tube is capped and the extraction is carried out exactly as with the amphetamines. A urine standard containing the mixed barbiturates is analyzed with each batch. Chromatographic conditions are the same as for the amphetamines except for the column temperature, which is 180°C for butabarbital, amobarbital, pentobarbital, and secobarbital and 210°C for phenobarbital.

Derivatized barbiturates—Any positive results obtained from the underivatized barbiturate analyses are confirmed by methylating the chloroform extract with trimethylanilinium hydroxide. Ten microlitres of the same extract are placed on the solid sampler, followed by 0.5 μl of trimethylanilinium hydroxide. The mixture is dried and injected into the gas chromatograph. Butabarbital, amobarbital, pentobarbital, and secobarbital are chromatographed at 160°C and phenobarbital at 180°C.

Thin-Layer Chromatography—All positive results for methadone, cocaine, and codeine were confirmed by thin-layer chromatography. The charcoal extraction technique was used to recover the drugs. In this case the sample was not split, but the entire extract was used.

To the dried extract in the 12 by 75-mm culture tube is added 40 μl of methanol. After gently warming the tube the entire extract is spotted on an LQD-F silica gel plate. The plate is developed until the solvent front reaches 10 cm in a mixture of dioxane and ammonium hydroxide (95:5). After drying in an oven for 10 minutes at 105°C, the plate is sprayed with iodoplatinate reagent. The drugs are identified by their R_f values and the colors produced with the iodoplatinate spray. Standards of the drugs in question are run on the same plate (10 μg of each drug are spotted).

Discussion

The adaption of charcoal extraction to a modified fluorometric determination of morphine has resulted in what appears to be one of the most sensitive techniques available for detecting that drug in urine. Heating the extracted sample with H_2SO_4 at 60° for 2 min enhanced the detection limit of morphine in urine by a factor of 20 over that reported by Mulé and Husin in their paper [*11*]. The sensitivity of this method is usually 0.010 μg/ml or even better, although occasionally this value is somewhat higher (approximately 0.040 μg/ml) when a high background interference is produced by some urines. This has been demonstrated by studying urine specimens of known non-drug-users, that is, our laboratory staff, to which morphine of varying concentration was added. These time-temperature studies carried out with the sulfuric acid treatment stage were explored over a wide range. Temperatures ranging between 25 and 120°C at intervals of 20°C and times between one minute and one hour at various intervals were studied. Allowing the sample to stand at 60°C for 2 min with H_2SO_4 produced a sensitivity that could not be improved upon. Sensitivity fell off at lower and higher temperatures. Figure 3 clearly demonstrates the effects of temperature on the production of the morphine fluorophore. Figure 4 shows that after 40 s the reaction rate has reached a maximum and is stable up to at least 1 h thereafter. For the sake of convenience, a time of 2 min was selected, since this was the time required to add the sulfuric acid to all the samples within a typical batch analysis.

Because of the great sensitivity of the method, the cleanliness of the glassware is a critical factor. To avoid any contamination problems that may arise, it is strongly suggested that disposable glassware be employed. If this is not possible, then extreme care must be exercised to ensure that the glassware used is totally devoid of any material either containing morphine or capable of producing morphine (that is, hydrolysis of

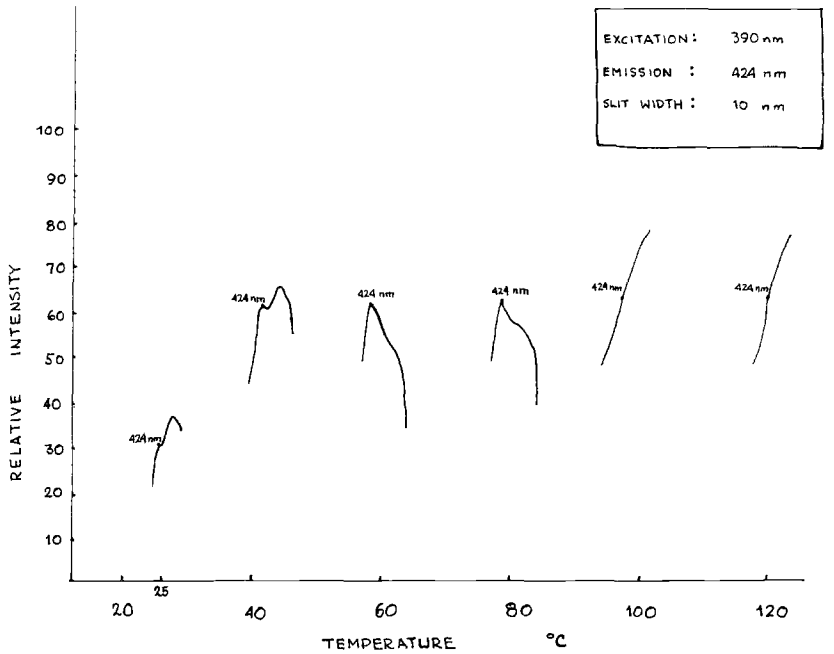

FIG. 3—*Results of the spectrofluorometric analysis of 0.01 mg of morphine per 100 ml of urine, varying the temperature of the sulfuric acid treatment state. Time of treatment was held constant at 2 min.*

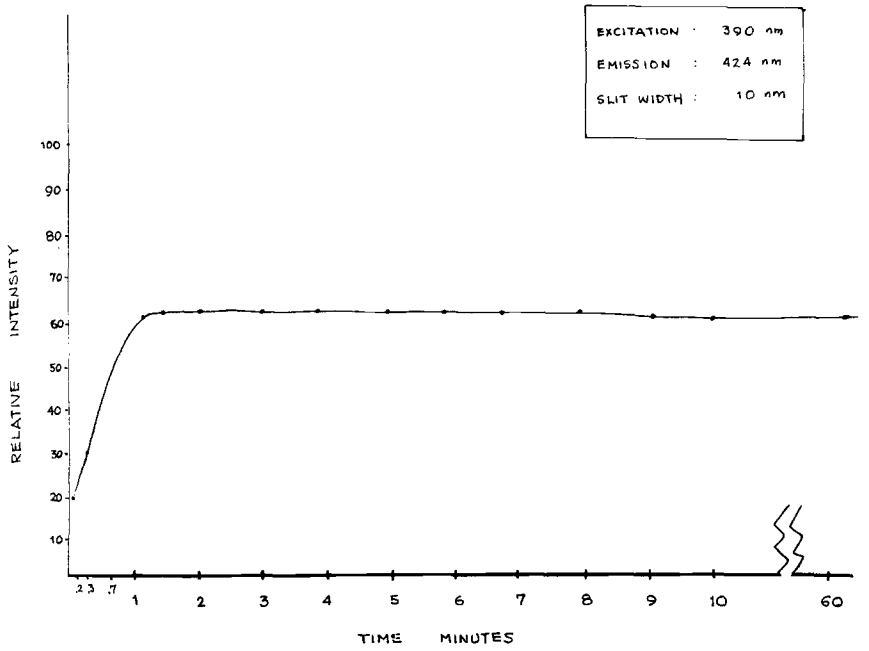

FIG. 4—*Results of the spectrofluorometric analysis of 0.01 mg of morphine per 100 ml of urine, varying the time of the sulfuric acid treatment stage. Temperature was held constant at 60° C.*

heroin or codeine). Laboratories also involved in analyzing street samples should be acutely aware of this potential hazard.

The charcoal technique was found to be the cleanest and fastest method available for the extraction of drugs from urine. It is also quite inexpensive and covers a wide variety of drugs in one extraction. An extract is produced with this method that is not only clean but that also contains most of the drugs at concentrations capable of being identified by TLC.

Some problems were encountered in the interpretation of the digital printouts from the gas chromatographic data reduction system. Secobarbital and phenobarbital posed some difficulties. A urine normal caused a high incidence of false positives for secobarbital. The phenobarbital peak tended to wander considerably, but this compound is notorious for its poor behavior on most chromatographic columns [*18-21*]. The retention times for the other compounds were more reproducible. Methadone proved to be easily and accurately determined by this system. Associated with every urine extract containing methadone were two major methadone metabolites. These metabolites were completely resolved on both columns and were eluted prior to methadone. Their presence served to confirm methadone. The morphine concentrations were generally so low in most of the urine specimens that this drug could not be reliably detected by gas chromatography. Methamphetamine and amphetamine were well separated and identified by this system. The only problem encountered was in the case in which both were present, one at a much higher level than the other. In this instance the processor would only identify the more concentrated one. As a result of these problems, it was necessary to perform confirmational analyses.

Overall, the AS-41 autosampler functioned very well. Its reproducibility makes it a valuable addition to a gas chromatograph, even without the computer. Under the conditions used, it handled about three samples per hour. Although this does not appear very fast, one must remember that the unit, once loaded, operated completely automatically and freed the analyst to do other work. The two units, processing six samples an hour, easily handled the 1500 to 2100 urines per month work load. The weakest link in the system was the teletype (ASR 33), which was not designed to handle the 24-hour-a-day output of the system. It required rather frequent servicing for adjustments and worn parts. The average life of the OV-17 and OV-1 columns was about two to three months (5000 samples) before they required changing.

Recently, our laboratory has acquired an EMIT® system, with sera to detect the following types of drugs: opiates, amphetamines, barbiturates, methadone, and cocaine (by its metabolite benzoylecgonine). Results from these determinations tend generally to be generic rather than specific and indicate a high probability of the presence of a class of compound, not individual drugs. For this reason, the value of the method lies in its ability to very quickly screen for drugs of abuse in urine. In conjuction with a reliable confirmatory technique, it could provide a very good system for drug analysis. Our laboratory is presently investigating the use of the gas chromatograph with a data reduction system, complemented by EMIT® for the identification of the above classes of drugs in urine. Tables 1 and 2 present the data accumulated during the course of the TASC project. It should be pointed out that the values are representative of approximately 60% of the total criminal population being processed in the central detention area of the city of Philadelphia. For various reasons, it was impossible to exceed this percentage.

Summary

This paper describes the criteria and analytical approach that were employed to cope

TABLE 1—*Results of TASC morphine screen from December 1972 to January 1974, inclusive.*

Month	Specimens Analyzed	Positive	Positive, %	Negative	Negative, %
Dec. 1972	605	155	25.6	450	74.4
Jan. 1973	968	181	18.7	787	81.3
Feb.	1 840	357	19.4	1 483	80.6
March	2 149	400	18.6	1 749	81.4
April	1 842	313	17.0	1 529	83.0
May	1 668	223	13.4	1 445	86.6
June	1 680	243	14.5	1 437	85.5
July	1 672	231	13.8	1 441	86.2
Aug.	1 738	254	14.6	1 484	85.4
Sept.	1 558	188	12.1	1 370	87.9
Oct.	1 552	207	13.3	1 345	86.7
Nov.	1 635	217	13.3	1 418	86.7
Dec.	1 484	155	10.4	1 329	89.6
Jan. 1974	1 635	194	11.9	1 441	88.1
Total	22 026	3 318	15.1	18 708	84.9

with a mass drug urine screening program. Motives and justifications for selecting one technique over another are covered, along with a detailed description of those methods selected. Advantages, disadvantages, and limitations of each procedure are discussed. Results are presented for over 11,500 samples of urine collected from the criminal segment of Philadelphia's population over a period of six months. These were examined for amphetamine, methamphetamine, amobarbital, butabarbital, pentobarbital, phenobarbital, secobarbital, cocaine, codeine, methadone, and morphine.

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TABLE 2—*Results of TASC comprehensive screen from 3-12-73 to 9-30-73. Total specimens analyzed: 11,506.*

Drug	Month							Total	Incidence, %
	March	April	May	June	July	Aug.	Sept.		
Morphine	273	313	223	243	231	254	188	1725	15.0
Methadone	38	53	47	47	50	48	30	313	2.72
Cocaine	...	...	1	2	...	...	2	5	0.043
Codeine	7	7	3	3	6	5	1	32	0.28
Amphetamine	6	6	8	5	2	5	14	46	0.40
Methamphetamine	15	18	4	3	11	7	3	61	0.53
Amphetamine and methamphetamine	31	82	68	53	72	109	82	497	4.32
Amobarbital	1	1	4	2	...	2	3	13	0.11
Butabarbital	...	3	...	...	2	2	...	7	0.06
Pentobarbital	...	3	1	3	2	...	5	14	0.12
Secobarbital	2	2	...	2	8	1	11	26	0.23
Phenobarbital	13	22	28	27	16	6	12	124	1.08
Amobarbital and secobarbital	...	4	...	3	5	7	5	24	0.21

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