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# Drug Use by Tractor-Trailer Drivers

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**ABSTRACT:** Blood or urine samples or both were obtained from 317 of 359 randomly selected tractor-trailer drivers asked to participate in a driver health survey conducted at a truck weighing station on Interstate 40 in Tennessee. Altogether, 29% of the drivers had evidence of alcohol, marijuana, cocaine, prescription or nonprescription stimulants, or some combination of these, in either blood or urine. Cannabinoids were found in 15% of the drivers' blood or urine; nonprescription stimulants such as phenylpropanolamine were found in 12%; prescription stimulants such as amphetamine were found in 5%; cocaine metabolites were found in 2%; and alcohol was found in less than 1%. These results provide the first objective information about the use of potentially abusive drugs by tractor-trailer drivers. The extent of driver impairment attributable to the observed drugs is uncertain because of the complex relationship between performance and drug concentrations.

**KEYWORDS:** toxicology, driving (motor vehicle operation), marijuana, alcohol, cocaine, truck drivers, drugs, stimulants

In 1985, about 4500 people died in crashes involving tractor-trailer trucks. Only 17% of these deaths were sustained by the truck drivers; the remainder were sustained by other road users, and about 70% were occupants of passenger vehicles in collisions with trucks [*1*].

Truck drivers often spend long hours on the road and have to deal with fatigue, loneliness, boredom, and uncomfortable driving conditions. There is considerable informal information that many truck drivers use drugs as a means of coping with their difficult working conditions. Alcohol, marijuana, cocaine, and amphetamines generally are mentioned as drugs used. In a 1977 mail survey [*2*], stimulants such as "bennies, goofballs, and copilots" were the most common drugs reported by men truck drivers, with 14% saying they used such drugs occasionally or regularly to stay awake while driving. The percentage reporting the use of marijuana or narcotics while driving was much smaller, although self-reported marijuana use was higher among younger drivers (about 14% of drivers under 25 years of age said they used marijuana occasionally or regularly just before or while driving). Use of alcohol while driving was not queried specifically, but 6% of drivers reported that they felt they could drive without problems within two or three hours of drinking.

Other than anecdotes and these self-reports, however, there is little scientific evidence about drug use by truck drivers. Even in the case of alcohol, reliable information is limited to

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postmortem analyses of fatally injured drivers. Data from 23 states that test 80% or more of fatally injured drivers for alcohol indicate that about one in eight tractor-trailer drivers killed in single-vehicle crashes has blood alcohol concentrations (BACs) at or above 0.10 g/dL. About 15% have positive BACs [*1*]. In the much more common multiple-vehicle fatal crashes involving large trucks, the truck driver is rarely killed, and there is no systematic alcohol testing of such drivers.

The extent to which truck drivers are operating their rigs under the influence of drugs such as alcohol, marijuana, or cocaine that may affect their performance is an important question. It is also important to know if stimulants such as amphetamines or their less potent "look alikes" (for example, phenylpropanolamine or ephedrine) are being used by drivers to stay on the road for excessive hours. The present study was designed to gather information on the incidence of drug use by drivers of tractor-trailer trucks based on blood and urine samples. The study also gathered information on the general health status of truck drivers, but the current report is limited to analyses and findings regarding drug use.

## Methods

### *Sample Selection*

During the week of 15 Dec. 1986, 359 tractor-trailer truck drivers who stopped at the westbound side of the Brownsville, Tennessee, truck weighing station on Interstate 40 were asked to participate in the study. All trucks weighing more than 10 000 lbs (4 500 kg) are required to pull into the station and come to a complete stop at the scales. The present study was coordinated with a series of random log-book inspections scheduled by the Tennessee Public Service Commission (PSC) for the Brownsville Station. The log-book check typically requires only a few minutes and consists of checking required documentation. At the start of each sampling period, the first truck to be given a log-book inspection was selected randomly. Subsequently, each truck selected for inspection was the next truck across the scales following completion of the previous inspection. Because the completion of an inspection is unrelated to the characteristics of the next truck at the scale, the selection procedure provides a random sample of truck drivers. A selected truck was sometimes overweight or had a visible safety defect or both. These trucks were processed appropriately, then given the log-book check.

At the conclusion of the inspection, the driver was invited to participate in an anonymous and voluntary health survey. The driver was told that the survey was conducted by a nonprofit research organization, it was not connected with the state of Tennessee, and he could earn up to $30. Drivers of single-unit trucks were not included because these trucks were less likely to be involved in interstate transportation. Tandem or "double-bottom" rigs were excluded because their size would have been unmanageable within the existing parking facilities, given the volume of trucks that were being processed. Women drivers were excluded as were co-drivers not operating the tractor at the time it entered the station. Thus, the invited drivers were men operating randomly selected tractors pulling either no trailer or a single trailer.

Sampling was conducted during one 6-h sampling period and four 12-h periods. The 6-h period ran from noon to 6 p.m. on Monday, 15 Dec. 1986. The four 12-h periods began at 6 a.m. on Tuesday, 2 p.m. on Wednesday, 6 p.m. on Thursday, and 6 p.m. on Friday. Sampling was completed at 6 a.m. on Saturday, 20 Dec. 1986.

Of the 359 drivers asked to participate in the study, 38 declined. The most frequently cited reason for declining was that they were late or in a hurry (18 drivers). In addition to the 38 refusals, 4 drivers accepted the invitation but either could not or would not provide either blood or urine, for a total of 42 nonparticipating drivers (12%). The average age of the 317 drivers providing blood or urine was 37 years with an average of 12.7 years of driving experi-

ence. Data about the drivers who refused participation were limited. However, their average age (39 years) and the condition of their trucks as rated subjectively by the PSC officers were similar to those of the participants.

### *Driver Interviews and Testing*

The survey team operated in three motor homes parked in the corner of the weigh station lot as far from the enforcement officers as possible. Two of the motor homes were used for interviewing and testing, and the third was used for processing specimens.

Drivers were initially directed by the officers to one of the two motor homes used for interviews. Each was staffed with a male interviewer and a female registered nurse. The interviewer greeted the driver at the door, asked the driver not to reveal his name or the name of his company, described the study, explained that all information was to be strictly anonymous and requested that the nurse be allowed to take his blood pressure. The blood pressure test was followed by a driver interview. The first half of the driver interview consisted of questions concerning trucks and driving.[3] The second half, administered by the nurse, consisted of health related questions.

Following the interview, the nurse requested that drivers provide a urine sample. Urine was provided unobserved in the bathroom of the motor home. The nurse then requested a blood sample from the driver. Blood was drawn into one 7-mL tube plus two 13.5-mL tubes. The urine samples and the 7-mL tube of blood (containing appropriate preservative and anti-coagulant) were immediately refrigerated. The two other tubes of blood were allowed to coagulate, placed in a centrifuge, and the resulting serum was refrigerated. All specimens were assigned case numbers and shipped, on the same day as obtained, by air from Memphis, Tennessee, to SmithKline BioScience Laboratories in Waltham, Massachusetts.

Drivers were paid $30 for participating in the study and agreeing to provide urine and blood. Drivers were also offered a coded envelope, which their doctor could use to request the results of their tests.

### *Drug Testing Procedures*

SmithKline screened the urine, blood or serum samples, or some combination of these for the substances shown in Table 1. The screen was performed using SmithKline's standard procedures for drug analyses with two exceptions. First, SmithKline's standard procedure at the time was to test and confirm the presence of cannabinoids in urine by two independent enzyme multiplied immunoassay tests (EMIT®). For this study, positive findings in urine were additionally confirmed by gas chromatography-mass spectroscopy (GC-MS) or high-performance thin layer chromatography (HPTLC) where there was sufficient urine. The second exception was an additional test of the urine samples using a new TDx fluorescence polarization immunoassay for amphetamine and methamphetamine.

When a substance was detected in either urine or blood, the finding was checked and confirmed, usually by an alternative, chemically independent test procedure; only confirmed findings are presented in the results with one exception. Nine cases where cannabinoids were found in urine had too little urine for alternative tests. However, four of the nine cases were found to have cannabinoids in the corresponding blood samples, and the other five were positive on two independent EMIT tests. Although these last five are unconfirmed by alternative tests, it is unlikely that they represent false positives, and they are included in the test results.

When drugs were detected, their concentrations were quantitated in blood (or serum) wherever possible (for example, alcohol). For several drugs of interest (marijuana, cocaine,

[3]The driver interview form is available from the authors on request.

TABLE 1—*Drugs tested by SmithKline's comprehensive drug analysis.*

| | | |
|---|---|---|
| Acetaldehyde | Diphenhydramine | Norpropoxyphene |
| Acetaminophen | Disopyramide | Nortriptyline[a] |
| Acetone | Doxepin | Oxycodone[a] |
| Amitriptyline | Doxylamine[a] | Pentazocine[a] |
| Amobarbital | Ephedrine[a] | Perphenazine |
| Amoxapine[a] | Ethanol | Pentobarbital |
| Amphetamines[a] | Flurazepam | Phenacetin[a] |
| Barbital | Glutethimide | Phencyclidine[a] |
| Benzoylecgonine[a] | Hydrocodone[a] | Phenmetrazine[a] |
| Brompheniramine | Hydromorphone[a] | Phenobarbital |
| Butabarbital | Ibuprofen | Phensuximide |
| Butalbital | Imipramine | Phenylpropanolamine[a] |
| Cannabinoids[a] | Isopropanol | Phenytoin |
| Carbamazepine | Lidocaine | Primidone |
| Carisoprodol | Loxapine | Procainamide |
| Chlordiazepoxide | Meperidine | Prochlorperazine[a] |
| Chlorpheniramine[a] | Mephenytoin | Promazine[a] |
| Chlorpromazine | Meprobamate | Promethazine[a] |
| Chlorpropamide | Mephobarbital | Propoxyphene |
| Clorazepate | Morphine[a] | Pyrilamine[a] |
| (as Nordiazepam) | Methadone | Quinidine |
| Cocaine[a] | Methadone Metabolite | Quinine[a] |
| Codeine[a] | Methamphetamine[a] | Salicylates |
| Demoxepam | Methanol | Secobarbital |
| Desipramine | Methaqualone | Thioridazine |
| Desmethyldoxepin | Methsuximide | Trifluoperazine |
| Dextromethorphan[a] | Methyprylon | Tripelennamine[a] |
| Diazepam | Nordiazepam | |

[a]Tested in urine only; not quantitated.

and the sympathomimetic amine class of stimulants such as amphetamine or phenylpropanolamine). SmithKline provided only qualitative tests in urine. When these drugs were detected and confirmed in urine, the corresponding blood or serum samples were provided to Chemical Toxicology Institute (CTI) in Foster City, California, for further testing and quantitation.[4] In addition, blood or serum samples from the 18 drivers who had provided no urine were analyzed by CTI for evidence of marijuana, cocaine, and sympathomimetic amines, since the comprehensive drug analysis provided no test for them in the absence of urine.

As a cross-check on laboratory test procedures, CTI reanalyzed all blood samples for alcohol, and a random sample of 25 urine specimens were retested for the drug classes described in Table 2. CTI's results were essentially the same as SmithKline except for minor differences in the alcohol findings (see Results) and, in one case, phenylpropanolamine was detected and confirmed by SmithKline but not by CTI.

## Results

A total of 317 drivers provided sufficient quantities of either urine or blood for analysis. Urine samples, in sufficient quantity for most of the analyses, were provided by 299 drivers; blood samples were provided by 307 drivers; and 289 provided both substances.

[4]Blood samples from all drivers whose urine tested positive for amphetamine or methamphetamine by the TDx assay were analyzed by CTI for sympathomimetic amines whether or not the urine test was confirmed.

TABLE 2—*Drugs tested by CTI in 25 randomly selected urine samples.*

| | |
|---|---|
| Amphetamines | Flurazepam |
| amphetamine | Marijuana |
| ephedrine | delta-9-tetrahydrocannabinol (THC) |
| methamphetamine | carboxy-THC (metabolite) |
| phenylephrine | Opiates |
| phenylpropanolamine | codeine |
| pseudoephedrine | heroin |
| Antidepressants | hydrocodone |
| amitriptyline | hydromorphone |
| amoxapine | morphine |
| desipramine | oxycodone |
| doxepin | Opioids |
| imipramine | meperidine |
| loxapine | methadone |
| maprotiline | pentazocine |
| nortriptyline | propoxyphene |
| trazodone | Phencyclidine |
| Antihistamines | phencyclidine (PCP) |
| Barbiturates | PHP |
| amobarbital | TCP |
| butalbital | Phenothiazines |
| butabarbital | |
| pentobarbital | |
| phenobarbital | |
| secobarbital | |
| Cocaine | |
| cocaine | |
| benzoylecgonine (metabolite) | |

*Alcohol*

All urine and blood samples were analyzed for the presence of alcohol, using gas chromatography with a nominal detection threshold of 0.01 g/dL in blood or urine. Alcohol was detected in the blood of three drivers and in the urine of a fourth. The alcohol concentrations in the three positive blood samples were 0.01, 0.02, and 0.03 g/dL. The driver with the positive urine sample had no detectable alcohol in blood, and the driver with blood alcohol concentration of 0.01 g/dL had no detectable alcohol in urine. CTI's reanalyses of the blood samples (detection threshold of 0.002 g/dL) found slightly lower concentrations of alcohol in two cases and no alcohol in the third case (BAC = 0.01 g/dL for SmithKline) or any of the other 304 blood samples. The slightly lower concentrations found by CTI (0.004 and 0.020 g/dL) probably reflect some evaporation of alcohol during the repeated sampling from the blood specimens. Only two cases of detected alcohol are considered confirmed (less than 1% of the drivers).

*Marijuana and Cocaine*

Fifty drivers (16% of all 317 participating drivers) had evidence of marijuana (15%) or cocaine (2%) use or both in their urine or blood; four drivers (1%) had metabolites of both substances in urine or blood (Table 3). Among the 47 drivers with evidence of marijuana use in either urine or blood, followup analyses found delta-9-tetrahydrocannibinol (THC)—the primary psychoactive constituent of marijuana—in the blood samples of 11 drivers, or 3% of the total sample (five drivers who had cannabinoids in their urine did not provide sufficient blood for analysis). At the thresholds used in this study, measurable quantities of THC indi-

TABLE 3—*Tractor-trailer drivers with evidence of marijuana or cocaine use.*

| Drug | Urine Analysis[a] | | Urine and Blood Analyses[b] | |
|---|---|---|---|---|
| | No. | Percent | No. | Percent |
| Marijuana | 43 | 14 | 47 | 15 |
| (THC)[c] | not tested | | (11) | (3) |
| Cocaine | 6 | 2 | 7 | 2 |
| Marijuana or cocaine | 46 | 15 | 50 | 16 |
| Total specimens | 299 | ... | 317 | ... |

[a]Urine samples for 299 drivers were tested for the presence of cannabinoid metabolites by EMIT with a nominal detection threshold of 50 ng/mL. All positives were reaffirmed by a second independent EMIT. In all cases where there was sufficient urine for additional testing, the presence of cannabinoids was confirmed by chemically independent, alternative tests as well as the second EMIT. In 32 cases, alternative confirmation was obtained by GC-MS; 2 cases with less fluid were alternatively confirmed in urine by high-performance thin-layer chromatography. Nine cases had insufficient urine for alternative testing, but marijuana was found in blood or serum of four of these cases by GC-MS.

The presence of cocaine or its metabolites in urine was determined by thin-layer chromatography with a detection threshold of 1 μg/mL and confirmed by EMIT.

[b]Cannabinoids and cocaine metabolites were tested for and quantitated by GC-MS in the blood samples of 38 drivers who were positive in the urine screens (5 drivers with positive urine results did not provide sufficient blood for analysis); nominal detection thresholds were 2.5 ng/mL for cannabinoids and 50 ng/mL for cocaine and its major metabolite, benzoylecgonine. Blood samples for an additional 18 drivers who provided insufficient urine were screened for the presence of marijuana or cocaine by radioimmunoassay (RIA, detection threshold of 10 ng/mL for cannabinoid metabolites and 50 ng/mL for cocaine and its metabolites) and positive results were confirmed and quantitated by GC-MS.

[c]THC was tested for in the blood samples of 38 drivers whose urine tested positive for cannabinoids (excluding 5 drivers with no blood for analysis) and 4 drivers who provided no urine but whose blood samples tested positive for cannabinoids.

cate either recent or relatively frequent use of marijuana [*3–5*]. Thus, at least 3% of the drivers appear either to be frequent users or to have used marijuana recently. Among the other drivers with evidence of marijuana use, little can be determined about the recency of use because marijuana metabolites can be detected even in blood for up to two weeks after intake by frequent users [*6*]. Individual results for all marijuana tests, including blood concentrations, are in Table 4.

Table 5 shows the results of followup analyses of the blood samples (when available) from drivers whose urine tested positive for marijuana and cocaine. Marijuana metabolites were detected in 30 of the 38 blood samples analyzed. Eight of the drivers whose urine samples had been confirmed for cannabinoids had no detectable concentrations of THC or other cannabinoids (for example, carboxy THC) in their blood. This finding is not unusual, because marijuana metabolites are detectable in urine for a much longer period (even weeks for frequent users) than in blood. These drivers, although they had cannabinoids in their urine, probably had not used marijuana in several days.

Among five drivers whose urine showed evidence of cocaine use and who had provided blood samples, three were positive for cocaine or its metabolites in blood by radioimmunoassay. However, none had measurable quantities of unmetabolized cocaine in blood as measured by GC-MS; one had benzoylecgonine (less than 50 ng/mL), a major metabolite of cocaine. One additional driver with no urine was positive for cocaine metabolites in blood; he had no detectable cocaine, and the concentration of benzoylecgonine was less than 50 ng/mL. These results probably reflect the rapid metabolism of cocaine. Typically, its use is detectable in urine for only two or three days and for even shorter periods of time in blood.

TABLE 4—*Test results for marijuana.*

| Specimen No. | Urine Results/ Confirming Test[a] | Blood/Serum Results[b] | | | |
|---|---|---|---|---|---|
| | | Substance | RIA | THC | Carboxy-THC |
| 524 | +/GC-MS | blood | + | – | 20 |
| 526 | +/GC-MS | blood | + | 3.0 | 54 |
| 527 | +/GC-MS | blood | – | | |
| 532 | +/GC-MS | no blood or serum | | | |
| 533 | +/GC-MS | blood | + | 2.8 | 66 |
| 535 | +/EMIT | blood | – | | |
| 536 | +/EMIT | blood | – | | |
| 543 | +/EMIT | blood | + | – | 52 |
| 544 | +/EMIT | blood | – | | |
| 548 | +/EMIT | blood | – | | |
| 550 | +/EMIT | blood | + | 12 | 45 |
| 553 | +/HPTLC | blood | – | | |
| 565 | +/EMIT | serum | + | – | 15 |
| 569 | +/GC-MS | serum | + | – | 6.8 |
| 571 | +/GC-MS | serum | + | – | 17 |
| 574 | +/GC-MS | no blood or serum | | | |
| 584 | +/GC-MS | serum | + | – | 40 |
| 586 | no urine | blood | + | <2.5 | 18 |
| 595 | +/GC-MS | serum | + | – | 16 |
| 596 | +/GC-MS | serum | + | – | 20 |
| 599 | no urine | blood | + | – | 3 |
| 610 | +/GC-MS | serum | + | – | 7.5 |
| 611 | +/EMIT | no blood or serum | | | |
| 629 | +/GC-MS | serum | + | – | 34 |
| 640 | +/GC-MS | serum | + | – | 62 |
| 677 | +/GC-MS | serum | + | – | 87 |
| 696 | +/GC-MS | serum | + | – | 3.9 |
| 698 | +/GC-MS | serum | + | 3.3 | 63 |
| 771 | +/GC-MS | serum | + | – | 5.6 |
| 773 | no urine | blood | + | <2.5 | 9 |
| 775 | +/GC-MS | serum | + | – | 22 |
| 780 | +/GC-MS | serum | + | – | 31 |
| 795 | +/GC-MS | no blood or serum | | | |
| 797 | +/HPTLC | blood | – | | |
| 808 | +/GC-MS | blood | + | – | 3.7 |
| 828 | +/GC-MS | serum | + | 5.5 | 67 |
| 839 | +/GC-MS | blood | + | – | 15 |
| 841 | +/GC-MS | no blood or serum | | | |
| 876 | +/GC-MS | serum | + | 11 | 148 |
| 881 | +/EMIT | blood | + | – | 8.1 |
| 889 | +/GC-MS | serum | + | – | 18 |
| 890 | +/GC-MS | serum | + | – | 55 |
| 894 | +/GC-MS | serum | + | 7.0 | 148 |
| 897 | +/GC-MS | serum | – | | |
| 899 | +/GC-MS | serum | + | – | 66 |
| 909 | no urine | blood | + | 2.5 | 13 |
| 916 | +/GC-MS | serum | + | 4.6 | 38 |

[a]All urine tests were positive for cannabinoid metabolites on two independent EMIT tests (nominal detection threshold was 50 ng/mL). Additional confirmatory tests were GC-MS or HPTLC; where present, these confirmatory tests are indicated by "+/GC-MS" or "+/HPTLC."

[b]Blood or serum samples were screened qualitatively by radioimmunoassay (RIA) and positive results were quantitated for THC and carboxy-THC by GC-MS in ng/mL (nominal detection threshold of 2.5 ng/mL).

TABLE 5—*Evidence of marijuana and cocaine use in blood samples corresponding to urine samples with positive results.*

| Drug | No. Confirmed Positive in Urine | No. of Corresponding Blood Samples | No. of Positives in Blood |
|---|---|---|---|
| Marijuana | 43 | 38 | 30 |
| Cocaine | 6 | 5 | 1 |
| Marijuana or cocaine | 46 | 41 | 31 |

*Sympathomimetic Amines (Stimulants)*

Central nervous system stimulants of the sympathomimetic amine class were detected and confirmed in the urine or blood of 48 (15%) of all 317 participating drivers (Table 6). Five percent had detectable concentrations in urine or blood of amphetamine, methamphetamine, or phentermine, drugs that are available only by prescription. Twelve percent had detectable levels of phenylpropanolamine, ephedrine, or pseudoephedrine, other sympathomimetic substances that are available in over-the-counter medications as well as by prescription.

The corresponding blood samples from 35 of the 39 drivers whose urine tested positive for

TABLE 6—*Tractor-trailer drivers with sympathomimetic amines (stimulants).*

| Drug | Positive Urine Analyses[a] | | Positive Urine and Blood Analyses[b] | |
|---|---|---|---|---|
| | No. | Percent | No. | Percent |
| Amphetamine, methamphetamine | 4 | 1 | 7 | 2 |
| Phenylpropanolamine, ephedrine, pseudoephedrine | 36 | 12 | 38 | 12 |
| Phentermine[c] | not tested | | 10 | 3 |
| Prescription-only Stimulants[d] | 4 | 1 | 16 | 5 |
| All stimulants | 39 | 13 | 48 | 15 |
| Total specimens | 299 | ... | 317 | ... |

[a]Urine samples for 299 drivers were screened initially by thin-layer chromatography with a nominal detection threshold of 1 μg/mL and confirmed by EMIT. Subsequently, 257 samples were rescreened by fluorescence polarization immunoassay with a detection threshold of 0.3 μg/mL and confirmed by GC-MS.

[b]Sympathomimetic amines were tested for and quantitated by GC-MS in the blood samples of 35 drivers with positive urine results (4 other drivers positive in urine did not provide sufficient blood for analyses). Nominal detection thresholds for these substances were 50 ng/mL. Blood samples for 18 drivers who provided insufficient urine and another 53 drivers with unconfirmed positive results on the urine TDx assay were screened for sympathomimetic amines by GC-MS. Positive findings were confirmed by gas chromatography-nitrogen phosphorus detection method for substances not detected in urine.

[c]Phentermine was not screened in the urine samples and may be underrepresented in the final results.

[d]Amphetamine, methamphetamine, and phentermine are central nervous system stimulants found only in prescription medications. No drivers reported medically prescribed use of these substances within the previous 48 h. Phenylpropanolamine, ephedrine, and pseudoephedrine are central nervous system stimulants found in many over-the-counter as well as prescription diet and cold preparations. About half of the drivers positive for these substances reported taking cold medications that could have accounted for their presence.

sympathomimetic amines were analyzed when available (Table 7). All of the drivers who provided blood and whose urine was positive for amphetamine or methamphetamine had detectable amounts of these substances in their blood. Eighteen of the thirty-three drivers whose urine was positive for phenylpropanolamine, ephedrine, or pseudoephedrine had one of these substances in their blood. As with marijuana and cocaine, these drugs are typically detectable in urine for longer periods after use than in blood; their absence in blood while present in urine suggests that they had not been taken in at least several hours.

Table 8 shows the extent to which sympathomimetic amines were found in blood, based on testing of three groups: drivers who had positive urine tests for these substances, drivers who provided blood only, and drivers whose blood was analyzed on the basis of unconfirmed positive tests for amphetamine or methamphetamine in urine.[5] Thirty drivers (9% of all 317 drivers) had one or more of these stimulants in their blood. Phentermine was found in 10 drivers; its presence among all 317 is probably underestimated because it is not included in SmithKline's urine test and was thus tested for only in the 106 drivers whose blood samples were analyzed for sympathomimetic amines.

*Reported Use of Sympathomimetic Drugs*—All of the drivers were asked whether they had used prescription or nonprescription drugs during the previous 48 h. Only one reported medically prescribed use of drug preparations containing amphetamine, methamphetamine, or phentermine during the previous 48 h, and he indicated he was using drugs to stay awake. However, of the drivers with only nonprescription sympathomimetic amines (32 drivers), about half (15) indicated they had used over-the-counter drug preparations for the treatment of cold or flu symptoms that might have accounted for the presence of the detected drug; this was judged to be the case if the reported medication contained the detected substance or another sympathomimetic substance that might have been contained in a medication similar to that named by the driver (this procedure allowed for unintentional mislabelling of drugs

TABLE 7—*Sympathomimetic amines (stimulants) detected in blood samples corresponding to urine samples with positive results.*

| Drug | No. Confirmed Positive in Urine | No. of Corresponding Blood Samples | No. of Positives in Blood |
|---|---|---|---|
| Amphetamine, methamphetamine | 4 | 3 | 3 |
| Phenylpropanolamine, ephedrine, pseudoephedrine | 36 | 33 | 18 |
| Phentermine | not tested | | |
| Prescription-only stimulants | 4 | 3 | 3 |
| All stimulants | 39 | 35 | 20 |

[5]The TDx fluorescence polarization immunoassay screening for amphetamine and methamphetamine produced a large number of positive indications of amphetamine or methamphetamine, as did the radioimmunoassay performed by CTI on 25 other urine samples. Although most of these results were not confirmed (in urine) by GC-MS, simultaneous analyses of corresponding blood samples did find and confirm the presence of other sympathomimetic drugs that are reported here. In addition, there were occasions when the blood of drivers whose urine was positive for phenylpropanolamine, ephedrine, or pseudoephedrine were negative for these substances, but positive for phentermine, or amphetamine/methamphetamine. These cases are also included. Individual results of the tests for sympathomimetic amines are shown in Table 9, including blood concentrations of detected substances.

TABLE 8—*Tractor-trailer drivers with sympathomimetic amines (stimulants) in blood.*[a]

| Drug | No. | Percent |
|---|---|---|
| Amphetamine, methamphetamine | 6 | 2 |
| Phenylpropanolamine, ephedrine, pseudoephedrine | 20 | 6 |
| Phentermine | 10 | 3 |
| Prescription-only stimulants | 15 | 5 |
| All stimulants | 30 | 9 |
| Total drivers | 317 | |

[a]Based on blood analyses of those with positive urine tests ($N = 35$), blood analyses of those drivers who provided only blood ($N = 18$), and blood analyses of 53 drivers who had unconfirmed positives in urine for amphetamine and methamphetamine (see text) but tested positive in the blood for other stimulants. All blood analyses were by GC-MS and confirmed by gas chromatography-nitrogen phosphorus detection method except in 13 cases with positive tests for phenylpropanolamine, ephedrine, or pseudoephedrine; confirmation was not obtained in these cases because the blood results were consistent with confirmed urine test results. In all, blood samples from 106 drivers were analyzed.

by the drivers). These drivers accounted for about a third of the drivers whose urine or blood had contained sympathomimetic amines, leaving about 10% of the total sample with detectable levels of sympathomimetic substances (prescription or nonprescription or both) whose use was not explained medically.

### *Other Drugs*

The other most commonly detected drugs were salicylates (aspirin) or acetaminophen, which were confirmed in 35 drivers (11%). No opioids or hallucinogens were detected, and only one case of a minor tranquilizer (diazepam-nordiazepam) and one case of a barbiturate (phenobarbital) were detected. Both of the latter drivers had reported medically appropriate use of preparations containing these substances, and the driver with diazepam claimed that he had last used the medication more than 48 h earlier (this claim is not refuted by the positive finding because diazepam and its metabolites are detectable for several days after therapeutic use).

Seventy percent of drivers said they had been drinking coffee and they probably had some caffeine in their urine or blood. However, for this study, the detection threshold for caffeine was set at 20 μg/mL in serum to identify drivers who might be using caffeine pills or consuming very large quantities of coffee to stay awake. Two drivers had such large quantities of caffeine, and one other driver had 13 μg/mL in serum; all three reported drinking large amounts of coffee (more than ten cups since they last slept) or using diet pills.

## Discussion

The effect of the detected drugs on the risk of crashes among truck drivers is difficult to estimate, even with information about the concentrations of the drugs in blood. Alcohol, the drug whose effects are best known, was found in less than 1% of the drivers, and in every case the concentration was well below state per se or presumptive limits and even below the 0.04 g/dL limit for commercial vehicle drivers currently under consideration by the National

TABLE 9—*Confirmed test results for sympathomimetic amines.*[a]

| Specimen No. | Urine Results[b] | | | | Blood/Serum Results[c] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A/MA | PPA | E | PE | A | MA | P | PPA | E | PE |
| 529 | – | + | – | – | no blood | | | | | |
| 531 | – | + | – | – | – | – | – | – | b = 283 | – |
| 532 | – | + | – | – | no blood | | | | | |
| 534 | – | + | – | – | – | – | b = 97 | – | – | – |
| 536 | – | + | – | – | – | – | – | b < 50 | b = 243 | – |
| 538 | – | + | – | + | – | – | – | – | – | – |
| 546 | – | + | – | – | – | – | – | – | – | – |
| 553 | + | – | – | – | b = 44 | – | – | – | – | – |
| 563 | – | + | – | – | – | – | – | – | – | – |
| 572 | – | + | – | + | – | – | – | QNS | – | s = 218 |
| 576 | – | + | – | + | – | – | – | – | s = 116 | – |
| 577[d] | – | – | – | – | – | – | b = 217 | – | – | – |
| 579[d] | – | – | – | – | – | – | b = 107 | – | – | – |
| 584[d] | – | – | – | – | – | – | b = 320 | – | – | – |
| 586 | | no urine | | | – | – | – | – | – | b < 50 |
| 588 | – | + | – | – | – | – | – | – | – | – |
| 594 | – | + | – | – | – | s = 56 | – | s = 99 | s = 110 | s < 50 |
| 637 | – | + | – | – | – | – | – | – | – | – |
| 644 | – | + | – | – | – | – | – | – | – | s = 243 |
| 646 | + | – | – | – | b = 295 | b = 118 | – | – | – | – |
| 648 | – | + | – | – | – | – | – | s = 59 | s = 59 | – |
| 651[d] | – | – | – | – | – | – | b = 397 | – | – | – |
| 653[d] | – | – | – | – | – | – | b = 80 | – | – | – |
| 680 | – | + | – | – | – | – | – | s = 61 | s < 50 | s < 50 |
| 681 | – | + | – | – | – | – | – | – | – | – |
| 701 | – | – | + | – | – | – | – | b = 38 | b = 401 | b = 41 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 779 | + | − | − | − | | | no blood | | | | |
| 782 | − | + | − | − | — | — | — | s = 220 | — | s < 50 | |
| 783 | | no urine | | | — | — | b = 118 | — | — | — | |
| 792 | − | + | − | − | — | — | — | — | — | — | |
| 795 | − | + | − | − | | | no blood | | | | |
| 799 | − | + | − | − | — | b = 58 | — | b = 58 | — | — | |
| 804 | − | + | − | − | — | — | — | — | — | — | |
| 807 | − | + | − | − | — | — | b = 117 | b < 50 | — | — | |
| 811 | − | + | − | − | — | — | — | — | — | — | |
| 815 | − | + | − | − | — | — | — | — | s = 86 | — | |
| 819 | − | + | − | − | — | — | — | s < 50 | — | — | |
| 836 | − | + | − | − | — | — | — | QNS | — | — | |
| 839 | − | + | − | − | — | — | — | — | s < 50 | — | |
| 843 | − | + | − | − | — | — | — | s < 50 | s = 197 | — | |
| 853 | − | + | − | − | — | — | — | — | — | — | |
| 855[d] | − | − | − | − | — | b < 50 | — | — | — | — | |
| 886 | − | + | − | − | — | — | — | — | — | — | |
| 888 | + | + | − | − | s = 120 | — | s = 83 | s < 50 | s = 73 | — | |
| 893 | − | + | − | − | — | — | — | — | — | — | |
| 906[d] | − | − | − | − | — | — | — | b < 50 | — | b < 50 | |
| 907 | − | + | − | − | — | — | — | — | — | — | |
| 913 | − | + | − | − | — | — | s = 55 | s = 84 | s = 86 | s < 50 | |

[a]Amphetamine (A), methamphetamine (MA), phentermine (P), phenylpropanolamine (PPA), ephedrine (E), or pseudoephedrine (PE).

[b]All positive urine results except one were obtained by thin-layer chromatography with a nominal detection threshold of 1 μg/mL and confirmed by EMIT (amphetamine, methamphetamine) or gas chromatography (phenylpropanolamine, ephedrine, and pseudoephedrine). Amphetamine in urine for driver 888 was detected by fluorescence polarization immunoassay (FPI) with a nominal detection threshold of 0.3 μg/mL and confirmed by GC-MS. Note that in some cases, PPA may have been detected as a metabolite of ephedrine or pseudoephedrine.

[c]Blood or serum samples were tested and quantitated by GC-MS; confirmation for substances not detected in urine was by gas chromatography-nitrogen phosphorus detection (GC-NPD). Positive results are quantitated in ng/mL (s = serum, b = blood). QNS indicates the quantity of serum or blood was insufficient to test for and confirm the presence of the indicated substance.

[d]Driver whose blood was analyzed on the basis of an unconfirmed finding of amphetamine or methamphetamine in urine by FPI.

Academy of Sciences.[6] Nevertheless, alcohol, even in low concentrations, has been shown to produce performance deficits in laboratory tasks [7]. Given the large distances typically driven by tractor-trailer drivers, the combination of even small amounts of alcohol and fatigue could increase crash risk.

Marijuana and cocaine, one or both of which were detected in 16% of the drivers who participated, are controlled substances that are legally available to the public only in very rare circumstances; they should not be present in any amount in truck drivers. The principal psychoactive constituent of marijuana, THC, was detected in the blood of 3% of the drivers, suggesting that they used marijuana frequently or had used it recently. The effects on driver behavior and crash risk at the concentrations detected are not known because psychological and behavioral effects of marijuana often occur after the blood concentrations of THC have peaked and returned to very low levels (see Ref *3* for more discussion regarding the complicated relationship between performance and THC concentrations).

It also is not known whether the incidence of marijuana and cocaine among these truck drivers is similar to that among other, similarly aged males in the general population. However, the presence of these drugs in truck drivers would still be of concern, because operators of commercial vehicles—airline crews, train operators as well as truck drivers—have special responsibilities for the safety of others. As described in the introduction, the serious consequences of tractor-trailer truck crashes occur overwhelmingly to the occupants of passenger vehicles and other road users, not to the truck drivers.

Estimating the effect of using stimulants such as amphetamine, phentermine, or their less potent relatives such as phenylpropanolamine is also complex. It is possible that the occasional use of such substances can enhance performance on some tasks by increasing alertness. However, tractor-trailer drivers may use these drugs to continue on the roads even under conditions of fatigue [2]. Use for that purpose is probably not occasional, but frequent and sustained. Such use is potentially dangerous, particularly for amphetamine and methamphetamine, because they have a high potential for abuse and the development of drug dependence. The *Physician's Desk Reference* [8] lists elevated blood pressure, restlessness, dizziness, euphoria, and headache as side effects, and warns that "amphetamines may impair the ability of the patient to engage in potentially hazardous activities such as operating machinery or vehicles." Cessation of use after prolonged use of large dosages of amphetamines or phentermine can result in extreme fatigue and depression, and overdosage may be accompanied by tremor, confusion, and hallucinations. Phenylpropanolamine can also have negative side effects such as nervousness, dizziness, headache, and elevated blood pressure when dosages exceed 75 mg per day, the dosage found in one timed-release capsule of Contac®, an over-the-counter cold medication, or one Dexatrim Extra Strength® capsule, an over-the-counter diet preparation [9]. Thus, although the use of sympathomimetic amines as stimulants may enable drivers to stay awake for long periods, the potential risk of such use seems quite high for both the safety of other road users and the health of the driver.

## Summary

This study has provided the first objective data regarding the use of potentially abusive drugs by tractor-trailer drivers. Altogether, 91 drivers, 29% of the 317 who participated in the survey, had alcohol, marijuana, cocaine, or prescription or nonprescription stimulants in their body fluids. Marijuana, alone or in combination with other drugs, was detected in 15% of the drivers; cocaine was detected in 2%, half of whom also had marijuana. Prescription stimulants such as amphetamine, methamphetamine, and phentermine were found in

[6]Section 12008 of the Commercial Motor Vehicle Safety Act of 1986 requires the National Academy of Sciences to study the appropriateness of reducing the blood alcohol concentration above which it is illegal for commercial drivers to operate. The Act requires the per se level to be reduced below 0.10 g/dL by 27 Oct. 1988. If a reduction is not in effect by then, the per se level for commercial drivers will automatically become 0.04 g/dL.

5% of the drivers, often in combination with similar but less potent stimulants such as phenylpropanolamine. Nonprescription stimulants were detected in 12% of the drivers, about half of whom gave no medical explanation for their presence. Alcohol was found in less than 1% of the drivers.

One limitation of these findings is that 12% of the randomly selected drivers refused to participate in the study or provided insufficient urine and blood for testing; the distribution of drugs among these 42 drivers is unknown. In addition, because phentermine was not included in the original comprehensive drug analysis, the incidence of prescription sympathomimetic amines, 5% in this study, is probably underestimated. Finally, the results apply to tractor-trailer drivers operating on a major east-west interstate route in Tennessee. Drug incidence among other truck-driver populations are unknown and may be higher or lower than reported here.

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