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Alcohol- and Drug-Involved Driving in the United States: Methodology for the 2007 National Roadside Survey

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Abstract

This article describes the methodology used in the 2007 U.S. National Roadside Survey to estimate the prevalence of alcohol- and drug-impaired driving and alcohol- and drug-involved driving. This study involved randomly stopping drivers at 300 locations across the 48 continental U.S. states at sites selected through a stratified random sampling procedure. Data were collected during a 2-hour Friday daytime session at 60 locations and during 2-hour nighttime weekend periods at 240 locations. Both self-report and biological measures were taken. Biological measures included breath alcohol measurements from 9,413 respondents, oral fluid samples from 7,719 respondents, and blood samples from 3,276 respondents.

Keywords

roadside survey; impaired driving; drug-involved driving; alcohol-involved driving

Introduction

Roadside Breath-Test Surveys

Most studies of the drug involvement in crashes include only crash data (e.g., Ramaekers et al. 2004, Soderstrom et al. 2001, Terhune et al. 1992), so they only give an indication of the possible role of the substance in the crash event and provide a means of tracking involvement over time. They do not, however, provide a measure of the risk presented by the drug or drugs of interest. To determine the risks posed by alcohol and other drugs in highway crashes, it is necessary to determine both the extent to which crash-involved drivers have been using the substances and the prevalence of use among the drivers exposed to but not involved in crashes. The classical approach to meeting this requirement has been to conduct case-control studies in which crash-involved drivers are measured for drugs at the crash site and compared with a random sample of drivers recruited at the same time and

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location (Blomberg et al. 2009; Borkenstein et al. 1974; Dussault et al. 2002; Movig et al. 2004).

Several methods have been developed to collect control data for crash studies. A popular method is to determine crash culpability (Robertson and Drummer 1994). This system, commonly termed "induced exposure," generates a non-crash-involved group by assuming that nonresponsible drivers are a random sample of the exposed population. The system, however, only samples the prevalence of crash-involved drivers; exposed drug-using drivers not involved in crashes are not measured. Drummer et al. (2004) provides an example of such a study.

Another method for gathering information on drug and alcohol use by drivers is through telephone, Web, or household surveys. (e.g., the National Household Survey on Drug Abuse; Townsend et al. 1998). Such surveys collect large amounts of information, relatively inexpensively, but they are limited by the respondents' ability to assess their alcohol and drug use and to recall driving events. For example, in a study that collected drug samples from drivers (Lacey et al. 2007), only a third of the subjects testing positive for drugs other than alcohol reported drug use within the past year, and only 2% reported drug use on the night of the survey. Thus, self-reported data may be useful in tracking trends over time but may underestimate the prevalence of drug use by drivers.

The roadside survey procedure—in which a random sample of motorists was stopped, interviewed, and tested for blood alcohol concentration (BAC)-grew out of the classic case-control methodology used for crashes and is the principal procedure for directly sampling the at-risk driver population. Since the first roadside survey by Holcomb (1938), researchers have provided the control data for relative-risk studies involving crashes-most notably, Borkenstein et. al.'s classic Grand Rapids study in 1964 (Borkenstein et al. 1974) that gave a strong push to the adoption of per se illegal drinking-and-driving laws (which specify the impaired-driving offense in terms of a specific BAC) in the United States and around the world. Beginning in 1973, the roadside survey method has been adapted to tracking the progress in the reduction of the prevalence of drivers on U.S. roadways that are at risk for alcohol-related crashes. National roadside surveys (NRSs) have been conducted each decade—1973, 1984, 1996, and 2007—and have documented a steady decline in the number of high BAC drivers on U.S. roads (Lacey, Kelley-Baker, Furr-Holden, Voas, Moore, et al. 2009). The 1996 and 2007 surveys provided an opportunity to conduct relativerisk studies involving crashes by using the NRS results as controls for crash cases in the Fatality Analysis Reporting System (FARS) (Zador, Krawchuk, and Voas 2000), which have documented a significant increase in the risk level for underage females over the last decade.

The 2007 NRS, the procedures for which are described in this report, initiated the collection of oral fluid for measurement of drug use by drivers. The survey documented a surprisingly high 14.4% prevalence of drugs in nighttime drivers, which stimulated the Office of National Drug Control Policy (ONDCP) to make the enactment of per se drugged-driving laws a priority in its 2010 program (ONDCP 2010). Given ONDCP's indication of national concern and the probability that state legislatures will be considering new drugged-driving legislation over the next decade, there is a need for additional information on the relative risk of crash involvement presented by the large number of substances that can potentially impair drivers. Because the NRS studies provide the primary basis for determining the trends in prevalence and (in combination with the FARS) relative risk of alcohol- and drug-impaired driving, the National Highway Traffic Safety Administration (NHTSA) has decided to move up the next NRS to 2013.

This paper describes the extensive augmentation of the 1996 methodology (published in this journal: Lestina et al. 1999) required to measure the driver's drug use and alcohol-and-drug dependence in the 2007 NRS. The 2007 NRS was the fourth in the series of NRS studies of drivers on our nation's roads conducted over the last four decades, beginning in 1973 (Wolfe 1974); followed by a second NRS in 1986 (Lund and Wolfe 1991); and a third, in 1996 (Voas et al. 1998). The success of these decennial surveys, combined with the lack of information about the prevalence of drugs in vehicle operators, led to the decision to expand the 2007 NRS to include information on drug use by drivers.

The Development of New Technologies for Collecting and Analyzing Oral Fluid

Since 1996, the technology for collecting and analyzing oral fluid (saliva) to detect drugs (including alcohol) has greatly improved. In recent years, new oral fluid collection devices for collecting samples have become available, along with new methods for analyzing the drug concentrations in those samples. Although tests yielding immediate screening results at the roadside or in police stations have not proven sufficiently accurate for scientific studies (Verstraete and Raes 2006), devices that collect and store oral fluid specimens that can then be sent to a laboratory for subsequent analysis are now available. These tests yield more valid and reliable results than immediate screening results and are comparable to established blood-testing technologies (Lacey et al. 2007). Additionally, we used blood analyses, the gold standard of drug testing, for evaluating oral fluid results and for ongoing validation of the utility of oral fluid testing.

Motivation for the 2007 National Roadside Survey

Missing from the three earlier NRS studies was information on the prevalence of drugs other than alcohol in drivers exposed to crashes and information on the clinical drinking and drug use of drivers with high BACs who were most at risk for crash involvement. With the recent advancement of field methods for oral fluid collection, it became possible to include drug testing in the 2007 NRS. Because of the interest in the role of addiction and abuse in alcohol-and drug-impaired driving crashes, we enhanced the value of collecting alcohol- and drug-use data by collecting information on the driver's alcohol- and drug-use disorder status. Thus, we decided to undertake the substantial tasks involved in adding to the 2007 survey (1) the collection of oral fluid backed by blood collection to measure drug use in drivers and (2) an extended interview to include the clinical signs of alcohol- and drug-use disorders. This involved several challenges, not the least of which was whether the public would cooperate with longer, more intrusive interviews. This paper describes the procedures developed to obtain official support for and public cooperation with this complex survey and the data collection, recording, and analytical methods needed to ensure accurate and valid data. The validation of these procedures on 11,120 motorists contacted in the 2007 NRS provides a methodology for conducting similar surveys to evaluate federal, state, and community impaired-driving programs.

Pilot Study

In 2005, NHTSA sponsored a pilot study (Lacey et al. 2007) as a precursor to the full decennial 2007 NRS. The primary objective of the pilot test was to develop and test methods for the collection and analysis of biological samples to determine the presence of drugs other than alcohol in the weekend nighttime driving population and to determine the feasibility of collecting such data. The pilot study's success led to the funding of the 2007 NRS that, in addition to the traditional collection of breath-test data, collected oral fluid and blood samples to measure the presence of substances other than alcohol in drivers on U.S. roads on weekends. We describe the methods used in the 2007 NRS, including the sampling plan and the data-collection and analytical procedures. More details are provided in the NHTSA

report covering the 2007 NRS methods (Lacey, Kelley-Baker, Furr-Holden, Voas, Moore, et al. 2009).

Overview of the 2007 National Roadside Survey

For the 2007 NRS, we implemented a stratified random sampling plan of the 48 contiguous U.S. states similar to that used in the three previous surveys. Data collection proceeded in a series of steps beginning with a police officer directing a random sample of drivers into the off-road survey site where a research assistant greeted the potential participant and obtained his or her consent to participate in the survey. The interviewer then asked the traditional NRS questions used in previous surveys and conducted a breath test. We then offered the participant \$10 to provide an oral fluid sample and answer a few additional questions on drug use. Those agreeing to the oral fluid collection were also offered an additional \$5 to complete a 14-item alcohol- and drug-use disorder questionnaire. Using a paper-and-pencil response form, we asked participants to answer 14 questions on alcohol- and drug-use disorders during the 5 minutes he or she held the oral fluid collection device in his or her mouth. Finally, we offered a \$50 incentive to participants for providing a blood sample, to which approximately half of the participants agreed.

National Survey Sampling Plan

The primary objective of the sampling plan was to select a representative sample of locations in the 48 contiguous U.S. states that would provide (1) an adequate number of drivers for analysis and (2) a safe environment for both the drivers and the research team to collect roadside survey data. Generally, the basic sampling plan of the 2007 study mirrored that of the 1996 survey (Lestina et al. 1999). However, the 1996 survey collected data from 24 primary sampling units (PSUs) from NHTSA's National Automotive Sampling System/ Crashworthiness Data System¹ (NASS/CDS), whereas the 2007 study was based on the 60 PSUs from NHTSA's larger National Automotive Sampling System/General Estimates System (NASS/GES; NHTSA, 1991), because it provided a more comprehensive sample of the 48 continental U.S. states (the 24 PSUs of the NASS/CDS are a subset of the NASS/ GES). Further, although the 1996 survey did not include counties with populations of fewer than 20,000 people and, in larger counties, included only roadways with 2,000 to 4,000 average daily traffic counts, the 2007 survey did include these because the number of drivers who could feasibly be surveyed at the sites was smaller. We did, however, consider traffic flow when identifying survey site locations. Additionally, unlike the previous surveys, motorcycles were included in the sampling frame.

We conducted site identification and recruitment for this survey in four stages:

- 1. *Selection of PSUs.* The 60 NASS/GES PSUs were comprised of cities, large counties, or groups of counties of three levels of population density from within four regions of the country. We attempted to recruit police cooperation in all 60 PSUs; however, if cooperation was impossible, we substituted another PSU from the same geographical and population stratum.
- 2. *Selection of square-mile-grid area.* We identified square-mile-grid areas for every square mile within each PSU; from these, we randomly selected 30 specific areas that were then examined in sequential order for feasibility as survey sites.
- **3.** *Identification of survey sites.* For each randomly selected grid area, we sequentially identified appropriate survey sites that were safe, were large enough to

¹The NASS/CDS is a nationwide crash data-collection program sponsored by the U.S. Department of Transportation. It is operated by the National Center for Statistics and Analysis of the NHTSA.

4. *Recruitment of vehicles.* We randomly selected vehicles from the traffic stream using police officers. After notification that a survey bay was available, an officer directed the first available vehicle into our survey site.

Selection of Primary Sampling Units

The major barrier to carrying out this staged sampling scheme for the 2007 NRS was obtaining local law enforcement support. In some localities, city attorneys or police leadership stated that state laws against randomly stopping vehicles or potential crash liability prevented participation in the surveys. Additionally, some police departments reported that they lacked personnel resources to support the effort. Because of lack of police support, 28.3% of the 60 NASS/GES PSUs had substitutes in the 2007 NRS. This substitution percentage fell within the range of those experienced by the three previous NRS studies: 5 of 24 PSUs in the 1973 survey (20.8%), 9 of 24 in the 1986 survey (37.5%), and 5 of 24 in the 1996 survey (20.8%) (Lestina et al. 1999). The effect of these departures from the original structure of the sample was minimized by:

- **1.** Ensuring that the substitute was selected from the same geographical and population stratum;
- **2.** Selecting a substitute with a similar average population density and the percentage of PSU population that was contained within an urban area;
- **3.** Selecting a substitute with a similar number of fatal crashes occurring over the most recent 5-year period;
- 4. Selecting a substitute with a similar number of injury crashes and property-damageonly crashes; and
- **5.** Selecting a substitute with similar socioeconomic conditions (e.g., median household income, unemployment rate).

Figure 1 shows the locations of the 60 PSUs selected for the 2007 NRS. Further detail on the site selection process is provided in the NHTSA report by Lacey, Kelley-Baker, Furr-Holden, Voas, Moore, et al. (2009).

Selection of Square-Mile-Grid Area

Our goal was to identify and select geographic locations within the PSU that were representative of the PSU as a whole. We divided the map of each PSU into a grid of approximately 1-square-mile squares. Using a simple random sampling procedure, we identified 30 possible square-mile-grid areas for potential survey site locations. If the law enforcement agency with jurisdiction over a selected grid area could not cooperate, we excluded that area and moved to the next grid area that was served by a different police department within the selected PSU. The practice was to identify one survey site location from each sampled grid area if feasible.

Identification of Survey Sites

Once the grid areas were selected and reviewed, the survey managers and local police officers found a safe and effective survey site within the selected grid area (with a backup survey site, if available). To be considered safe, the site had to provide enough viewing distance down the roadway to permit an officer to signal oncoming vehicles to stop. The best locations were well-lit, off-road parking areas into which selected drivers could be directed (e.g., gas station, church parking lot). Sites to be used for daytime data collection

were identified based on whether the parking area would be vacant during the day. If more than one such location was available within a grid area, the survey manager exercised his or her judgment to select the optimal location for safe data collection. For all survey sites, it was necessary to have police department approval.

Recruitment of Vehicles

Once our interviewers were ready and the survey manager gave the "go-ahead," a uniformed officer or traffic director stationed at the roadway began driver selection for the survey. The officer's role was to direct drivers from the traffic flow and safely into the site. To ensure unbiased selection of the first vehicle at each site, the officer waved in the third vehicle passing the site after initiation of the survey. Thereafter, each time an interviewer completed a survey, the officer was notified and would then signal the next vehicle approaching the survey site. This procedure was used in the three previous NRS studies to ensure an unbiased, random selection of eligible vehicles. Our one departure from the random sampling procedure was for motorcycles. Because motorcycles were rarely encountered, traffic directors were instructed to direct every motorcyclist into the survey site. If an interviewer was not immediately available, the survey manager asked the rider if she or he was willing to wait for the next available interviewer.

Police officers were provided with handheld counters to record all vehicles passing the site during an interview period so that driver selection probabilities could be estimated. We endeavored to recruit as many drivers as possible during each data-collection period; that is, interviewers were encouraged to be productive while being courteous to the drivers, informing the drivers about their right to refuse participation, and recording data accurately. We set a goal of obtaining a minimum of 25 oral fluid samples per survey site or an overall sample size of 7,500 oral fluid specimens. Including both daytime and nighttime surveys, we collected 7,719 oral fluid samples, and because breath samples were also obtained from drivers who did not participate in other portions of the survey, we collected a total 9,413 breath samples. On the other hand, because we attempted to collect blood samples only in the nighttime surveys and because participants were less willing to provide blood, we obtained only 3,276 blood samples.

Survey Schedule

We collected data from July 20 to December 1, 2007. Our goal was to have a minimum of four teams in the field on each survey weekend. (We did not schedule four surveys on two weekends—Labor Day and Thanksgiving—when the NHTSA-sponsored *National Crackdown on Impaired Driving* campaign was underway.) Our schedule depended on securing jurisdiction approval, securing local law enforcement agency support, and having reasonable weather.

General Operations

In keeping with the three prior roadside surveys, sampling was conducted on Fridays and Saturdays from 10 p.m. to midnight and from 1 a.m. to 3 a.m. Because we expected drug use to be different among daytime drivers, however, we also added a Friday daytime data-collection period (9:30 a.m. to 11:30 a.m. or 1:30 p.m. to 3:30 p.m., randomly selected by site).

Survey managers arrived onsite on Thursday to meet with local police officers and to scout survey locations for the five survey periods (one on Friday during the day, and two each on Friday and Saturday nights), with backup sites as alternatives in case of unexpected events. Survey managers sketched the layout of each site to facilitate later setup. The sites were chosen for safety of the public, the police, and the interviewers. Thus, although the squaregrid areas had been randomly selected, the final site selections within these areas had to offer an adequate off-road area to conduct interviews, easy access from the roadway, good lighting, and appropriate traffic volume. The team, along with police officers, arrived at survey sites 1 hour before the start of the survey to set up the site and handle any issues or concerns that may have arisen.

Collection Site Setup

Upon arrival at a site, team setup was facilitated by the survey manager's earlier sketches of the site. Interviewers set up bays demarcated with orange traffic cones and unpacked supplies. Interviewers wore uniforms (khaki pants, white shirts, white lab coats, reflective safety vests, and reflective "Research Team" hats). At the evening setup (blood samples were collected only during the nighttime data-collection periods), the phlebotomist arranged the blood draw station in the phlebotomy van in a well-lit work area away from traffic flow and ensured that all materials necessary for safe and sanitary blood draws were within reach.

The survey staff tied a large banner sign saying "NATIONAL ROADSIDE SURVEY" across one of the rental vans, and a uniformed police officer positioned a sign that said "VOLUNTARY SURVEY" at the side of the road, approximately 200 feet ahead of the survey location. Another officer positioned a police vehicle at the side of the road, with its overhead lights flashing visibly for approaching traffic and with the vehicle's headlights illuminating the officer. Although local law enforcement was always present during data-collection activities, some jurisdictions would not turn on flashing lights or direct traffic into the site. In those cases, interviewers with traffic wands motioned traffic off the roadway and into the site.

Survey Procedures

Table 1 lists the 17 steps in the 2007 survey process for motorists who agreed to complete the full survey including a blood test. Motorists who refused to participate were assisted out of the site immediately after requesting a verbal informed consent (step 5). Others remained on the site for varying lengths of time, depending on how many steps they agreed to do. A major difference between previous surveys and the 2007 survey was completion time for a full interview. In previous roadside surveys, a breath test and a brief interview took approximately 5 minutes for each participant; in the 2007 survey, three additional questionnaires—two drug questionnaires and an alcohol use disorder (AUD) screening—and an oral fluid sample and a blood sample were added, lengthening the interview by 5 to 20 minutes or longer if there was a waiting line at the phlebotomy van. These additional components required more time; therefore, incentives were offered for providing an oral fluid sample (\$10), responding to the AUD questions (\$5), and providing a blood sample (\$50).

A list of the equipment and questionnaires used in the 2007 survey is provided in Table 2. These items were carefully researched and field-tested in the 2005 pilot study in preparation for the 2007 NRS (Lacey et al. 2007).

1. Officer Directs Motorist into Site—To ensure selection of a random sample of motorists for the survey, when an interviewer was ready for a subject, the officer directed the next available vehicle into the survey site. In practice, some of the selected motorists turned away from the site and the officer was unable to signal them in time, or despite the survey protocol, the officer allowed the individual, after speaking with him/her, to proceed without entering the site—for example, if the driver indicated that he/she was in a hurry (e.g., en route to a hospital or to a job, a situation that occurred more frequently during the daytime surveys than the nighttime surveys). A count was maintained of the vehicles

signaled to enter but did not do so. Once the officer directed the driver into the survey site, the officer had no further contact with the driver. Traffic assistants then directed vehicles into interview bays.

2. Traffic Assistant Directs Motorist into Interview Bay—At some sites, as many as six interview bays were set up. A research assistant was therefore assigned to direct incoming motorists to the interviewer prepared to accept them.

3. Interviewer Observes Demographic Characteristics as Motorist Approaches

—As the motorist came to a safe stop in the bay, the interviewer recorded basic demographics based on observation. These initial observational assessments included the driver's age (within specified ranges), gender, ethnicity, race, signs of driver impairment, vehicle type, seat belt use by driver, number of passengers, seat belt use by front passenger, and whether any passengers were younger than age 16. These observations were captured for every vehicle that entered the bay, which provided basic information for analyzing the characteristics of those refusing to participate in any or all of the survey elements. In addition to the observational data, the interviewer recorded responses to the traditional survey questions and results from a passive alcohol sensor (PAS). All these data were recorded into a Tungsten E2 personal digital assistant (PDA) manufactured by Palm, Inc. (see Figure 2).

4. Initial Passive Alcohol Sensor Reading—To obtain valid data on alcohol-involved driving and to ensure public safety, we obtained as high a percentage of alcohol tests as possible. If the active breath test was refused or if some subjects could not blow sufficient air to provide a valid breath sample, we obtained a PAS reading, using the small handheld PAS Vr. manufactured by PAS International, Inc. (see Figure 3), which detects alcohol in the mixed expired air around the face (Kiger, Lestina, and Lund 1993). This model, based on the same technology as the larger flashlight-based passive sensors used in the previous roadside surveys, was less obvious and intimidating, particularly when attached to the PDA with Velcro[®]. When the subject spoke, the interviewer held the PAS within 6 inches of the subject's face, and the unit displayed an estimated BAC on a color-coded nine-element LED bar graph and numeric display.

Correlating PAS readings with the BACs of drivers whose preliminary breath-test (PBT) measure was also obtained provided a basis for imputation of BAC measures for subjects whose PBT readings were not obtained. The PAS reading was collected immediately on all motorists entering the site, and if a high reading resulted, it was used as a signal that we should implement the impaired-driver protocol (described herein).

5. Interviewer Requests Verbal Informed Consent—After recording observational data, the interviewer approached the vehicle and initiated contact with the driver using a basic protocol. In accordance with human subjects' protection procedures, we informed all subjects about the nature of the research, that participation was voluntary and anonymous, and that they had the right to end the interview at any time. If a motorist declined the interview, we asked for a breath test before leaving the site. For those who appeared younger than age 25, the interviewer asked "Are you at least 16 years of age?" If the answer was yes, the survey continued. To protect the random driver selection procedure for the survey, all drivers were asked "Did you hear about this survey before you were waved in?" If drivers indicated that they had sought out the survey, they were told that they were ineligible to participate in the study.

6. Traditional National Roadside Survey Interview—After obtaining consent to do an interview and a breath test, the interviewer proceeded with the traditional questions used in the three previous roadside surveys. The 22 questions (Lacey, Kelley-Baker, Furr-Holden, Voas, Moore, et al. 2009, p. 22) covered topics such as annual mileage, the origin and destination of the current trip, drinking, drinking and driving, demographics, and designated driving.

7. Second Passive Alcohol Sensor Measure (During the Interview)—To ensure that a PAS measure was available for as many participants as possible, a second PAS sample was collected while the individual answered the fourth question of the traditional survey.

8. Breath Sample Collection—After completion of the traditional questionnaire, a breath sample was obtained using a PBT (the CMI, Inc. Intoxilyzer 400; Figure 4). This device has been tested by NHTSA and placed on its *Conforming Products List for Evidential Breath-Test Devices* (NHTSA, 1993). To ensure anonymity and to avoid any possibility of embarrassing the participant, the PBTs were programmed to store test results internally and, thus, did not display BACs at the survey site. Results were downloaded later, after data-collection activities ended. (insert Figure 4)

9. Informed Consent to Oral fluid Sample Collection (\$10 Cash Incentive)—

After the verbal survey and breath sample collection, the interviewer offered a \$10 cash incentive for an oral fluid specimen, and obtained verbal informed consent from the participant. The verbal consent included questions covering drug use and drug use disorders (DUD).

10. Informed Consent to Complete the Alcohol Use Disorder Survey (\$5 Cash Incentive)—Before collecting oral fluid, the interviewer asked a screener question to determine eligibility for the AUD survey. To avoid taking the time of nondrinkers, the AUD survey was limited to those who reported drinking in the last year. If the subject was eligible, the interviewer offered him/her a \$5 cash incentive to participate in this part of the study. If the subject consented, then he or she moved to the next steps.

11. Oral fluid Collection—We used the Quantisal (manufactured by Immunalysis Corporation) oral fluid collection device. The participant placed the device under the tongue. When the specified 1 mL (+/–10%) of clear oral fluid had collected (in 3 to 5 minutes), a small tab protruding from the mouth turned blue. The subject then removed the collection unit from his or her mouth and placed it into a tube containing 3 mL of a stabilizing buffer solution. The interviewer capped the tube tightly so that no fluid would be lost in storage or transit (Figure 5) and applied a preprinted chain-of-custody label containing a unique identifier documenting the link between sample and subject. The interviewer then placed the oral fluid sample vial in a zip lock bag, which the survey manager or the phlebotomist periodically collected throughout the data-collection activity and stored in a central cooler with blue ice.

While the oral fluid collection device was in the participant's mouth, he or she filled out a printed four-page booklet containing three surveys—the drug questionnaire, the DUD questionnaire, and the AUD questionnaire. Coupling of these tasks streamlined the interview and minimized the time burden to participants. All completed booklets were confidential and anonymous.

12. Drug Questionnaire—The drug questionnaire collected self-reported data on drug use (Lacey, Kelley-Baker, Furr-Holden, Voas, Moore, et al. 2009). The first 23 questions

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dealt with tobacco and cough medicine, and other over-the-counter, prescription, and illegal drugs. Subjects indicated the last time they used a particular medication/drug by responding "tonight," "past 2 days," "past month," past year," "over a year ago," or "never." Items 24 through 27 were specific to drug use and driving. Items 28 through 32 were related to the subject's interaction with the criminal justice system and any previous treatment experiences.

13. Drug Use Disorder Questionnaire—A screening question about drugs indicated whether an individual could take the DUD. Only participants who reported using marijuana, cocaine, or painkillers in the past year were eligible (Lacey, Kelley-Baker, Furr-Holden, Voas, Moore, et al. 2009, p. 30). The DUD was based on the Alcohol Use Disorders and Associated Disabilities Diagnostic Interview Schedule (AUDADIS) (Grant and Dawson 1997; Cottler et al. 1997; Pull et al. 1997). The AUDADIS is a structured assessment that has one item per symptom on the Diagnostic and Statistical Mental Disorders (DSM) DSM-IV (American Psychiatric Association 1994) section on Alcohol Abuse and Dependence. Similarly, the DUD was constructed to have one item per symptom on the DSM-IV section on Substance Abuse and Dependence. Diagnosis of substance (or drug) use disorders requires a separate assessment for each drug of abuse. To minimize respondent burden and still capture information on more than one substance, we assessed abuse and dependence for three primary drugs of abuse: marijuana, cocaine, and extra-medical use of prescription painkillers.

14. Alcohol Use Disorder Questionnaire—The AUD included 19 items (Lacey, Kelley-Baker, Furr-Holden, Voas, Moore, et al. 2009). The first three items (screener plus items 1 and 2) were derived from the Alcohol Use Disorders Identification Test (AUDIT) and represent the AUDIT consumption subscale, also known as the AUDIT-C (Chung et al. 2002; Conley 2001; Babor et al. 1992). The multiple-choice responses to the AUDIT-C were coded as 0, 1, 2, 3, and 4, with the first option receiving a score of 0 and the last response receiving a score of 4, so for the three-item AUDIT-C "heavy drinking" scale, the maximum score was 12.

Items 3 through 14 on the AUD were derived from the AUDADIS (Grant and Dawson 1997; Cottler et al. 1997; Pull et al. 1997). The AUDADIS was constructed so that there was one item per symptom on the DSM-IV section on Alcohol Abuse and Dependence. A positive response to any of these items signaled alcohol abuse. Items 7 and 8 both tapped into the domain of tolerance, and items 9 through 14 each represented one DSM-IV diagnostic symptom. Thus, seven diagnostic symptoms were represented across the eight items. A positive response to three of the seven symptoms signaled alcohol dependence (Grant and Dawson 1997). The remaining five items were not part of the formal AUD; they queried the subject about contact with the medical system and treatment services for drinking issues.

15. Blood Sample Collection—After the subject completed the oral fluid sample, the drug questionnaire, and the DUD and AUD surveys (if applicable), the interviewer offered the participant an additional \$50 money order as an incentive to provide a blood sample. A licensed phlebotomist drew one gray-top tube (10 mL) of the participant's blood. The gray-top tube contained oxalate and EDTA (ethylene diamine tetraacetic acid), anticoagulants that prevented the blood from clotting, and sodium fluoride as an antibacterial stabilizer. These preservatives reduced the need for refrigeration but did not affect the ability to detect and quantify drugs. Additionally, gray-top tubes were helpful in conducting ethanol analysis because the sodium fluoride is an effective antibacterial agent that helps inhibit endogenous alcohol production. For this study, glass tubing was used for collection of blood samples because we believed it was better for marijuana preservation (Christophersen 1986) and because the Federal Aviation Administration (FAA) recommends the gray-topped tube for

drug and alcohol testing of blood specimens (Toennes and Kauert 2001). All participants who agreed to the blood draw were observed by the phlebotomist for a short period to ensure they were fit to drive before being escorted back to their vehicles.

16. Traffic Assistant Directs Motorist Out of Interview Area—When a motorist was ready to leave the interview bay, the interviewer signaled the traffic assistant who, equipped with a lighted wand, assisted the driver's safe passage from the off-road interview area to the roadway.

17. Interviewer Completes Driver Information Card (Blue Card)—The interviewer completed a driver information card for each subject who drove into his or her bay. To ensure that all data components for each subject were properly assigned and stored together, we used a card (printed on blue cardstock) to track the NRS components in which a subject participated, and we recorded detailed key information necessary to link all the different data provided by a subject.

Survey Manager Role

Survey managers were the team leaders. They oversaw all aspects of team supervision and interaction with law enforcement, and ensured that data were collected according to established procedures of research protocol. At the conclusion of the data-collection activity, the survey manager supervised the disassembly of the off-road interview site and the packing of all equipment, records, and biological samples. The survey manager also completed a report form about each site, including date, time, and address; names and identifications of the survey manager, interviewers, phlebotomist, and officers; the weather; and a sketch of the site layout. The survey manager included in the site report all attempts to convert refusers and all instances of when the impaired-driver protocol had to be used.

Human Subjects/Institutional Review Board

The PIRE Institutional Review Board reviewed all staff training and operational procedures. A "Human Subjects Protection Training Module" was compiled for project staff. Among the precautions taken were steps to intervene with impaired drivers (persons with BACs higher than .05) and others at special risk (e.g., underage drinkers and possibly pregnant drinkers). All research staff completed these training requirements. Additionally, all personnel who interacted with participants, including law enforcement officers, received training on the Office of Human Research Protection requirements for protecting human subjects.

Impaired-Driver Protocol

To protect the participants and the driving public, we established an impaired-driving protocol for use with drivers who appeared impaired or produced a high PAS reading. For these situations, the interviewer signaled the survey manager who dealt with the possibly impaired driver by requesting that the individual take a breath test with a PBT that displayed the result. If the driver's BAC was .05 or higher, the manager attempted to arrange a ride home for him or her, so that he or she would not be released onto the roadway. Alternate transportation included having another licensed occupant of that vehicle take the driver's seat if their BAC was lower than .05; calling a friend or relative of the driver to the site to pick up the driver; calling a local taxicab company for a ride (at no cost to the participant); arranging for a hotel room for out-of-town drivers (at no cost to the participant); or having a member of the research team member followed in the team's rental van to drive the first team member back to the survey site. If the driver refused all of these options, the interviewer requested that the police officer suggest that the subject accept the offer.

Additionally, interviewers handed out informational brochures to all subjects younger than 21 years and to all pregnant women because of the special risk they face if they consume alcohol.

Analysis of the Biological Samples

The drugs we tested by bioassay (Table 3) and self-reports represent a list of over-thecounter, prescription, and illegal drugs that were judged as having the potential to impair driving performance and that we expected to appear in the driver population. The first five categories of drugs listed constituted the National Institute on Drug Abuse's (NIDA's) list of prevalent drugs of abuse (coined the "NIDA 5") and were of universal interest in the study of drug involvement. The NIDA 5 are routine components of a drug-screening panel. The other drugs (with the exception of barbiturates) appeared in the NHTSA publication titled *Drugs and Human Performance Fact Sheets* (NHTSA, 2004) and were of interest because an expert panel had earlier identified those drugs as presenting potential traffic safety risks. We further refined that list by selecting drugs that were most likely to appear in the driving population, including both prescription and over-the-counter drugs.

Oral fluid and blood samples were screened and confirmed at the noted concentrations for the drug categories listed in Table 3. We screened using enzyme-linked immunosorbent assay (ELISA) micro-plate technology. Of all tests, 14.08% required confirmation for drugs and 4.6% for alcohol. Confirmation was performed using gas chromatography-mass spectrometry (GC/MS) or liquid chromatography-mass spectrometry (LC/MS/MS) technology. The Immunalysis Corporation provided all necessary confirmations.

Passenger Survey

Our experience in the pilot study (Lacey et al. 2007) indicated that drivers with passengers in the vehicle were less likely to complete the entire study, sometimes because passengers encouraged drivers to leave. Therefore, if the AUD survey was activated for the driver, we then engaged passengers in a survey activity as a means of retaining eligible drivers in the data-collection activities. Front-seat passengers aged 16 and older were offered a cash incentive of \$5 to participate. The only passengers we approached were those in vehicles in which the driver had agreed to provide oral fluid and complete the AUD inventory. We surveyed 1,940 of the 2,538 (76%) eligible passengers. Questions on the passenger survey included date of birth, sex, race, and driving habits; relationship to the driver; and drinking habits (Lacey, Kelley-Baker, Furr-Holden, Voas, Moore, et al. 2009, p. 33). We also provided small incentives (e.g., candy, lollipops, coloring pages, and crayons) for children, and we offered dog biscuits to drivers with a dog in the vehicle.

Daytime Surveys

Unique to the 2007 NRS study was the inclusion of daytime hours (Fridays from 9:30 to 11:30 a.m. or from 1:30 to 3:30 p.m.). Friday hours were included primarily because of the interest in drug prevalence and the limited knowledge (in comparison to alcohol) about the hours of the day when drug use was the greatest and the patterns of drugs used at different times of the day. The daytime surveys included all the elements of the nighttime surveys except blood draws.

Response Rates

Table 4 summarizes the response rates to the 2007 NRS. The drivers initially selected to participate were those who entered the survey bays and were eligible to participate (total n =10,909), plus those who entered a bay but were not eligible to participate (i.e., too young, language barrier, or commercial vehicle; n=202), plus those who failed to follow the

directions of the police and/or refused to participate before entering the data-collection site (n=1,949). Altogether, 13,069 vehicles were signaled to enter the site, some inattentive motorists probably failed to see the police signal in time to stop, so many of those not responding to the police did so for reasons unrelated to the survey.

Overall, the participation rate for the 2007 NRS was fairly high (83.4% of the eligible drivers). A priority for our interviewers was to collect a BAC reading for all drivers, so we requested breath samples from all who refused. Though some drivers who agreed to participate in the survey could not provide a valid breath sample, we still captured breath samples from 86% of all eligible drivers. However, these high response rates were lower than those recorded in the previous roadside surveys, as indicated by the comparison with the 1996 survey in Table 5.

To explore the possibility of nonresponse bias, we tried to determine whether this lower response rate reflected the increased complexity of the 2007 protocol that required 20 minutes from each participant compared to only 5 minutes for the 1996 protocol or whether the lower rates reflected national changes in the culture and attitudes toward survey participation, such as litigation concerns and greater sensitivity to participation rights, resulting in the public becoming increasingly resistant to survey activities over the last decade. To determine whether these might be nonresponse bias, we (a) attempted to elicit a reason for driver's refusal; (b) examined what might have happened if we had conducted the survey under the shorter 1996 NRS protocol; (c) provided monetary incentives to those who refused to reverse their decisions and evaluated the outcome of those decisions; and (d) performed sensitivity analysis with the refusing population.

Analysis of the reasons for refusals provided by the refusing drivers showed that about 48% claimed not having time to get to work or needing to go to work; 6% claimed dislike for surveys; 19% gave some other reason; 18% did not provide any reason; and 9% were urged by their passengers to refuse and leave. Although the veracity of these reasons cannot be confirmed (e.g., for some, "not having time" could have been an excuse to avoid confessing their reluctance to be tested for substance use), because 9% of the cases were passengers not wanting the driver to stay indicates that test avoidance was not the only cause for refusal.

We also examined what might have happened if we had conducted the 2007 NRS survey under the shorter 1996 NRS protocol. We performed this comparative experiment in Knox County, Tennessee. As indicated in Table 5, the response rate to the 1996 protocol in the Knox County sample was very similar to that obtained from the 2007 protocol. We interpret this as indicating that these response rates reflect a trend in which the driving public has become more resistant to survey participation, an interpretation that receives support from the 6% of drivers who claimed disliking surveys as their reason for refusal. We speculate that some of those who claimed "not having time" may have also refused because of survey saturation but opted to give a less confrontational reason.

As mentioned, in another attempt to investigate possible nonresponse bias, we randomly offered monetary incentives to those who refused to participate, a technique that has been shown to be effective in increasing response rate and data quality (e.g., Church 1993; Singer et al. 1999).

A total of 351 nighttime drivers who initially refused were approached and offered \$100 to change their minds. Forty-eight percent of those drivers accepted the incentive and provided at least a breath test. A comparison of the demographics and the BACs of those who accepted initially without the incentive indicated no significant differences, and the converted group actually had a lower percentage with a BAC equal to or greater than .08

(2.4% versus 3.0%). The similarity between these groups gives further support to the hypothesis that many of those who refuse did so for reasons unrelated to substance use.

Finally, we also applied sensitivity analysis to investigate how much our findings would change if those who refused had indeed consumed alcohol. More precisely, we estimated that for the prevalence of impaired drivers in the 2007 NRS to be similar to that obtained from the 1996 NRS, 20% of those who refused should have had a BAC .08. Although certainly a possibility, we believe that such a possibility is unlikely, for it would imply that the proportion of BAC .08 drivers among those who refused was 10 times larger than that among the participant drivers, a magnitude that is not supported by other evidence. Most evidence suggests that lack of time and survey saturation were the most common reasons for refusal. Our interpretation is supported in the literature. For instance, a 2003 National Science Foundation report points out that the public's increasing reluctance to participate in surveys is due, among other reasons, to less free time, heightened concern about privacy, a greater mistrust of the government, a decline in civic engagement, and receiving more survey requests than ever before (Tourangeau 2003).

Regardless of how unlikely it is, nonresponse bias due to substance use being the main reason for drivers' refusal remains a possibility, and it is recognized as a limitation in the discussion section.

Discussion

Challenges to the Implementation of the 2007 National Roadside Survey

Mounting a national roadside survey designed to collect drug-use information involved some major challenges, which we met by developing or validating several new survey and data management procedures. The new or modified data-collection methods that performed successfully in the 2007 NRS provide a tested model for use in future drug and alcohol prevalence driver surveys.

Ensuring a High Response Rate

The first challenge involved recruiting a high percentage of drivers contacted to participate in the survey. The three previous national roadside surveys were limited to a brief questionnaire with relatively routine questions and a breath test. The 2007 survey not only included the previous surveys' protocol, but also added collection of oral fluid and blood, plus an extended, more intrusive self-report questionnaire, which lengthened the time required from approximately 5 minutes to 20 minutes. Consequently, we deemed it necessary to provide an incentive to maintain a high response rate in 2007, although prior surveys did not provide a participation incentive. Thus, our recruiting system, though somewhat convoluted by the necessity of offering multiple incentives at different times, was generally successful. For the basic survey and breath test, our response rates were more than 80%; for the AUD and oral fluid collections, our response rates were more than 70%; and for the blood sample portion, we collected from nearly 40% of the eligible nighttime drivers. Although, as mentioned, we found evidence suggesting that most drivers who refused participation in the 2007 NRS did so for reasons unrelated to substance use (therefore minimizing the likelihood of nonresponse bias), the possibility of bias cannot be ruled out and remains a limitation of this study.

Adapting Clinical Measures of Alcohol Use Disorders for the Roadside

We had to adapt existing alcohol and drug use disorder screening devices (AUDIT and AUDADIS) for use in the field and determine whether motorists could and would respond to these devices accurately in the roadside survey environment. To encourage candor,

questions on drug use and the AUD and DUD assessments were printed on a four-page response form and given to participants on a clipboard, allowing subjects to respond while sitting in the privacy of their vehicles. Front-seat passengers were diverted with their own questionnaire. Most respondents answered all of the questions on the response form. A substantial number of respondents admitted to heavy drinking, drug use, and drinking problems. During the 2006 pilot study, we conducted a small test of the validity of participants' responses to the AUD questions by inviting subjects to participate in a telephone survey in the 48 hours following the survey, during which the AUD questions were repeated along with administration of the full AUDADIS instrument. Telephone responses to the AUD questions were substantially similar to roadside responses, with one exception: the question about being arrested for an alcohol offense was less likely to be endorsed at the roadside (Furr-Holden et al. 2009).

Refining Human Subjects Protection Procedures

We established new ground in the area of human subjects protection, with an impaireddriver protocol calling for the use of a PAS, which measured the alcohol in the breath when held within 6 inches of the face and provided a rough indication of the intoxication level. We collected PAS readings on all drivers entering the interview site, regardless of whether they agreed to participate in the survey. These data, along with other behavior signs of intoxication, were used to alert the interviewer about possible driver impairment. If impairment was evident, the interviewer signaled the survey manager who initiated a procedure to ensure that the subject did not drive away from the site impaired. This system worked well, as evidenced by the absence of crashes or arrests resulting from the survey.

Accommodating Limitations in Police Support

As in the three previous surveys, about a quarter of the originally selected primary sampling areas had to be replaced because the police departments either had legal issues with the random stopping of motorists or lacked resources to provide officers to direct traffic at the survey sites. The collection of oral fluid and blood samples heightened the concern of the possibility of legal challenges. The percentage of changes in sampling was within the range of prior NRS programs, suggesting that the provisions for protecting the participants and ensuring that impaired drivers were not returned to the road in the 20007 NRS were generally convincing. One complication of recruiting and training police officers was the requirement of the Office of Human Research Protection (OHRP) that all officers had to receive the standard human subjects protection training even though their role only called for them to direct potential respondents into the site and not to speak to them. Because officers available for the survey were generally not determined until the day of the survey, officers had to arrive early so that they could review and sign a printed copy of the requirements before the data-collection activity. However, this system worked well.

Methods for Record Keeping and Protecting Anonymity

The increased intrusion caused by the collection of biological samples and the more intimate questions on alcohol and drug use heightened the concern for obtaining informed consent; therefore, a critical feature of the roadside survey procedure was the assurance of anonymity. With multiple measures using three different media (biological samples, interview responses, and written response forms) to be collected (Table 1), maintaining accurate records was critical. Record numbers for the separate samples and documents had to be tied together to ensure a chain of custody that would ensure a valid data set while maintaining anonymity. This system, described in more detail in Lacey et al. (2009), provided an effective model for maintaining data control.

Summary

The 2007 NRS provided, for the first time, national prevalence estimates for drug use by drivers on U.S. roadways (Lacey, Kelley-Baker, Furr-Holden, Voas, Romano, Ramirez, et al. 2009 and Lacey, Kelley-Baker, Furr-Holden, Voas, Romano, Torres, et al. 2009) and information on AUDs of at-risk drivers (Furr-Holden et al. 2011). We found that on weekend nights, 10.5% of the drivers were using illegal drugs, and 3% were positive for medications. Marijuana present in 6.1% of the drivers was the most prevalent drug. Of those drivers with illegal BACs of .08 or greater, 45.3% had been using drugs. These data, though limited to weekends, will allow comparisons with the prevalence of alcohol that has been studied over the last four decades. These comparisons must be made carefully because roadside surveys measure the presence of the substance, not its affects. For alcohol, the relative risk of a crash at a given BAC has been reasonably determined (Borkenstein et al. 1974; Blomberg et al. 2005) and has led to the NHTSA Fatality Analysis Reporting System (FARS) switching from reporting any fatal crash involving a driver with a positive BAC as alcohol-related to counting only fatal crashes involving drivers with BACs of .08 or greater. Comparable relative risk data for substances other than alcohol does not exist, so the presence of a drug in the body of a driver in this study cannot be inferred as impairing the driving skills of the participant without separate behavioral information that supports that conclusion. An important feature of this prevalence study is that it has laid the foundation for conducting a relative-risk case control study for drugs other than alcohol similar to that conducted for alcohol by Zador, Krawchuk, and Voas (2000) that used the fatal crash data in the FARS to compute the relative risk for alcohol. It has also stimulated NHTSA and the National Institute on Alcohol Abuse and Alcoholism (NIAAA) to sponsor a classical casecontrol study for drugs, which is about to be completed in Virginia Beach, Virginia.

Acknowledgments

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Figure 1. Map of the 2007 National Roadside Survey Primary Sampling Unit Locations



Figure 2. The Tungsten E2 Personal Digital Assistant(PDA)

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Figure 3. The PAS Vr. Passive Alcohol Sensor(PAS)







Figure 5.

Collecting an Oral Fluid Sample with the Quantisal Oral Fluid Collection Device (The Quantisal saliva collecting device is distributed by Immunalysis, Inc., Pomona, CA. www.immunalysis.com/quantisal_procedure.htm)

Table 1

Overall Field Data Collection Process for 2007 National Roadside Survey

- 1 Officer directs motorist into site
- 2 Traffic assistant directs motorist into interview bay
- 3 Interviewer observes demographic characteristics as motorist approaches
- 4 Initial passive alcohol sensor reading
- 5 Interviewer requests verbal informed consent
- 6 Traditional National Roadside Survey interview
- 7 Second passive alcohol sensor reading (during the interview)
- 8 Breath sample collection
- 9 Informed consent to oral fluid sample (\$10 cash incentive)
- 10 Informed consent to Alcohol Use Disorder (\$5 cash incentive)
- 11 Oral fluid collection (while items 12–14 collected)
- 12 Drug questionnaire self-reported on paper by subject
- $13 \quad \ \ {\rm Drug\ use\ disorder-self-reported\ on\ paper\ by\ subject}$
- 14 Alcohol use disorder self-reported on paper by subject
- 15 Blood sample collection (\$50 money order incentive)
- 16 Traffic assistant directs motorist out of interview area
- 17 Interviewer fills out driver information card (blue card)

Equipment and Questionnaires Used in the 2007 National Roadside Survey

Equipment	Questionnaires
PDA: Personal digital assistant	Traditional NRS questions
PAS: Passive alcohol sensor	Drug questions
PBT: Preliminary breath tester	DUD: Drug use disorder questions
Oral fluid collection device Phlebotomy instruments	AUD: Alcohol use disorder questions

Drugs with Minimum Detection Concentrat	tions Analyzed	in Blood and (Dral Fluids		
	Minimum Con Fluid (centration Oral ng/mL)	Minimum Con (ng	centration Blood (mL)	
Drug Class	Screen	Confirm	Screen	Confirm	Self-Report Item
Cocaine (Cocaine, benzoylecgonine)	20	8	25	10	Cocaine (e.g., crack or coke)
Opiates (6-AM, codeine, morphine, hydrocodone, hydromorphone)	40	10	25	10	Heroin Morphine or Codeine (e.g., Tylenol $^{\circledast}$ with codeine)
Amphetarnine/Methamphetarnine (MDMA, MDA, MDA, MDEA, Ephedrine, Psuedoephedrine)	50 50	50	20 20	10	Amphetamine or Methamphetamine (e.g., speed, crank, crystal meth)
Cannabinoids (THC, THC-COOH [THCA])	4	2	10	1	Marijuana (e.g., pot, hash, weed)
Phencyclidine	10	10	10	10	PCP (e.g., angel dust)
Benzodiazepines (oxazepam, nordiazepam, bromazepam, fluriazepam, flunitrazepam, lorazepam, chlordiazepoxide, temazepam, diazepam, clonazepam, alprazolam, triazolam, midazolam, nitrazepam)	20	10	20	01	Benzodiazepines (e.g., Valium [®] or tranquilizers)
Barbiturates (Phenobarbital, pentobarb, secobarbital, butalbital)	50	50	500	200	Barbiturates (e.g., phenobarbital)
Methadone	50	25	50	10	Methadone
Ethyl alcohol	.02%	.02%	.02%	.02%	Alcohol
Oxycodone (Percocet [®])	25	10	25	10	
$\operatorname{Propoxyphene}(\operatorname{Darvon}^{\otimes})$	10	10	10	10	
Tramadol (Ultram [®])	50	25	50	10	Prescription pain killers (e.g., Percocet [®] , OxyContin [®] , oxvcodone, Demerol [®] , Darvon [®])
Carisoprodol (Soma [®])	100	50	500	200	
Meperidine (Demerol [®])					
Sertraline (ZoloftR)	50	25	50	10	
Fluoxetine (Prozac [®])	50	25	50	10	Antidepressants (e.g., $Prozac^{\oplus}$, $Zoloft^{\oplus}$)
Tricyclic anti-depressants (amitryptiline, nortriptyline)	25	25	25	10	
Zolpidem (Ambien [®])	10	10	10	10	$\operatorname{Ambien}^{\otimes}$ or other sleep aids
Methylphenidate (Ritalin $^{\otimes}$)	10	10	10	10	ADHD medications (e.g., Ritalin [®] , Adderall [®] , Concerta [®])
Dextromethorphan	50	20	50	20	Cough medicines (e.g., Robitussin [®] , Vicks $44^{@}$)
Ketamine	10	10	10	10	Ketamine/Special K

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Table 3

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Table 4

2007 Participating Drivers

	Daytime	2007 Nighttime	Total
Signaled to enter site	3,516	9553	13,069
Did not enter site	933	1,016	1,949
Stopped and entered site	2,583	8,537	11,120
Eligible	2,525	8,384	10,909
Entered site and interviewed	2,174 (86.1%)*	6,920 (82.5%)*	9,094 (83.4%)*
Valid breath sample	2,254 (89.3%)*	7,159 (85.4%)*	9,413 (86.3%)*
Oral fluid sample	1,850 (73.3%)*	5,869 (70.0%)*	7,719 (70.7%)*
Blood sample	NA	3,276 (39.1%)*	NA
AUD and/or drug questionnaire	1,889 (75.2%)*	5,983 (71.4%)*	7,882 (72.2%)*
Passenger questionnaire	220 (8.7%)*	1,393 (16.6%)*	1,613 (14.8%)*

* Percentage of those eligible to participate.

Table 5

Participation Rates: Replication of 1996 Survey and 2007 NRS Eligible and Refusals Comparing the Replication with All Other 2007 NRS Sites

		Replication of 1996 NRS in 2007 in Knox County	Standard 2007NRS Protocol	
	1996 NRS	Nighttime	Nighttime Only	
	6,045	149	6,920	
Participated	95.9%	83.7%	82.5%	
	253	29	1,464	
Refused	4.1%	16.3%	17.5%	
Eligible drivers	6,298	178	8,384	

Note: All percentages are computed with respect to "eligible drivers."

NRS = National Roadside Survey