

HHS Public Access

Author manuscript Accid Anal Prev. Author manuscript; available in PMC 2017 July 01.

Published in final edited form as:

Accid Anal Prev. 2016 July ; 92: 122–129. doi:10.1016/j.aap.2016.03.015.

Differences in State Drug Testing and Reporting by Driver Type in U.S. Fatal Traffic Crashes

Megan E. Slater^a, I-Jen P. Castle^a, Barry K. Logan^b, and Ralph W. Hingson^c

^aCSR, Incorporated, 4250 Fairfax Drive, Suite 500, Arlington VA 22203

^bNMS Labs, 3701 Welsh Road, Willow Grove PA 19090

^cNational Institute on Alcohol Abuse and Alcoholism, 5635 Fishers LN, Rockville MD 20852

Abstract

Introduction—Driving under the influence of drugs, including marijuana, has become more prevalent in recent years despite local, state, and federal efforts to prevent such increases. The Fatality Analysis Reporting System (FARS) is the primary source of drugged driving data for fatal crashes in the United States but lacks the completeness required to calculate unbiased estimates of drug use among drivers involved in fatal crashes.

Methods—This article uses the 2013 FARS dataset to present differences in state drug testing rates by driver type, driver fault type, and state-level factors; discusses limitations related to analysis and interpretation of drugged driving data; and offers suggestions for improvements that may enable appropriate use of FARS drug testing data in the future.

Results—Results showed that state drug testing rates were highest among drivers who died at the scene of the crash (median = 70.8%) and drivers who died and were at fault in the crash (median = 64.4%). The lowest testing rates were seen among surviving drivers who were not transported to a hospital (median = 14.0%) and surviving drivers who were not at fault in the crash (median = 10.0%). Drug testing rates differed by state blood alcohol content (BAC) testing rate across all driver types and driver fault types, and in general, states that tested a higher percentage of drivers for BAC had higher drug testing rates.

Discussion—Testing rates might be increased through standardization and mandatory testing policies. FARS data users should continue to be cautious about the limitations of using currently available data to quantify drugged driving. More efforts are needed to improve drug testing and reporting practices, and more research is warranted to establish drug concentration levels at which driving skills become impaired.

Corresponding author: Megan E. Slater, Ph.D., ; Email: mslater@csrincorporated.com

Disclosure statement: None of the authors have a conflict of interest.

Disclaimers: The views and opinions expressed in this report are those of the authors and should not be construed to represent the views of the sponsoring agency or the Federal government.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Keywords

drugged driving; FARS data; drug testing rates; marijuana; state variation

1. Introduction

In recent years in the United States, government officials have become increasingly concerned about the issue of drugged driving. It has been characterized as a serious and growing threat to public safety (^{Compton and Berning, 2015}). In response to this concern in 2010, the Office of National Drug Control Policy (ONDCP) announced a 5-year goal of reducing drugged driving in the United States by 10% (^{ONDCP, 2010}). Results from the 2013–2014 National Roadside Survey (NRS) indicate that drugged driving has risen since 2007 (^{Berning et al., 2015}). This increase may have stemmed, in part, from changes in state policies on medical and recreational marijuana use. During the time between the 2007 and 2013–2014 surveys, seven states legalized medical marijuana, and two states legalized recreational marijuana. It is not possible, however, to compare or track state-by-state changes over time with NRS data.

Along with the NRS, the Fatality Analysis Reporting System (FARS) has been frequently used in attempts to quantify the extent and nature of drugged driving. The FARS dataset was developed in 1975 by the National Highway Traffic Safety Administration (NHTSA) and contains data derived from an annual census of fatal motor vehicle traffic crashes in the United States (Meier, 1985). Although the majority of FARS data are assumed to be relatively complete, certain variables, including alcohol and drug test results, are admittedly incomplete. In 2013, blood alcohol concentration (BAC) results were known for 71% of drivers who were killed and for only 28% of drivers who survived fatal crashes (U.S. DOT, ²⁰¹³). NHTSA uses multiple imputation to replace each missing BAC with 10 imputed values to allow further analysis to estimate alcohol involvement in fatal crashes where BAC tests were not conducted or reported. In 2013, drug test results were available for even fewer drivers, 57% for killed drivers, and 17% for surviving drivers. FARS only records up to three drugs for each driver and does not include any information on the amount of each drug detected. When four or more drugs are present, the first three drugs are reported based on FARS drug hierarchy (i.e., narcotics over depressants over stimulants over hallucinogens over cannabinoid over phencyclidine [PCP] over anabolic steroid over inhalant) (U.S. DOT, 2014). Unlike for BAC, no imputation for missing drug data is available in FARS, making data analysis and interpretation challenging.

In contrast to BAC, the missingness mechanism of drug data in FARS is nonignorable (i.e., missing not-at-random), which violates the general assumption of multiple imputation techniques (i.e., missing at random) and limits the feasibility of conducting valid imputation. The missing not-at-random means that the probability of missing drug data depends on drug tests per se in addition to various factors unknown or not observed in FARS. The 2009 NHTSA report to Congress indicated a considerable variation existed among laboratories in terms of equipment, procedures, and training of personnel conducting the tests (^{Compton et al., 2009}). The scope and sensitivity of drug testing were highly variable across laboratories

(Farrell et al., 2007; Logan et al., 2013). Berning and Smither (2014, p. 1) also brought several limitations of FARS drug data to the data users' attention "no consistent policy or set of procedures between, or sometimes even within, States"; "[c]onsiderable variation exist[ing] regarding who is tested; which drug is tested for; type of test, cut-off levels, and equipment; and which biological specimen (blood, urine, or oral fluid) is used"; and "unequal reporting to FARS from labs across jurisdictions." Additional limitations of the FARS dataset are the use of free-text fields to record drugs detected, resulting in misspellings and redundant drug names; the use of generic and product names for the drugs detected; and the fact that the FARS analysts often rely on word-of-mouth reporting of the drug findings and don't have access to printed copies of the toxicology reports.

To overcome insufficient drug data in FARS, researchers generally chose select subsamples for their analysis, such as drivers who died within 1 hour of a crash in a limited number of states that performed toxicological testing on more than 80% of their fatally injured drivers (Brady and Li, 2013) 2014. Keyes et al., 2015. Romano et al., 2014. Romano and Pollini, 2013) or drivers with known blood test results for drugs (Gates et al., 2013; Maxwell et al., 2010. Pollini et al., 2015; Reguly et al., 2014). These studies may have suffered from selection bias when using the trends observed in the selected states to represent national trends or when the risk factors of interest are associated with not only drugged driving but also the chance of being selected for drug testing. For example, states that have medical marijuana laws and higher rates of marijuana use have higher drug testing rates (Masten and Guenzburger, 2014), potentially artificially inflating drugged driving rates from analyses limited to states with high testing rates. Medical examiners/coroners (ME/C) and law enforcement officials may be more likely to request drug testing for drivers who appear more impaired or have characteristics known to be associated with drugged driving (e.g., male, younger) (SAMHSA, 2005), thus inflating associations by excluding many nonimpaired drivers from analyses.

Current limitations of the FARS drug data prevent the calculation or imputation of unbiased, reliable, and valid estimates of drug use among all drivers involved in fatal crashes in all 50 states and the District of Columbia (Berning and Smither, 2014; Compton and Berning, 2015). A better understanding of current drug testing practices across states could shed light on possible directions for improvements that may enable appropriate use of FARS drug testing data in the future. To this end, in this paper, we 1) present differences in state drug testing rates by driver type and various state-level factors; 2) discuss other limitations related to analysis and interpretation of drugged driving data; and 3) offer suggestions for improvements.

2. Methods

We obtained driver vital status, hospital transport information, fault criteria, and drug and BAC testing results from the 2013 FARS dataset for all 50 states and the District of Columbia. A total of 44,574 people were identified as being a driver of a motor vehicle intransport that was involved in a fatal crash in 2013. Due to missing information about vital status and/or transport to a hospital, 278 (0.6%) drivers were excluded, leaving 44,296 for analysis. For the purposes of this analysis, drug and BAC testing rates reflect the proportion

of drivers who had a valid test result reported in FARS (i.e., if a driver was tested but the results were not reported to FARS, the driver was not categorized as having been successfully tested).

We divided drivers involved in fatal crashes into the following four categories based on scenarios that dictate who is involved in the processes of obtaining and testing blood samples and reporting results to FARS (Casanova et al., 2012):

Type 1: Drivers who died at the scene of the crash or prior to the crash (n = 12,129)

Type 2: Drivers who died en route to or at a hospital (n = 8,678)

Type 3: Drivers who were transported to a hospital and survived (n = 9,379)

Type 4: Drivers who were not transported to a hospital and survived (n = 14,110)

For Type 1 drivers, the ME/C is responsible for deciding whether to draw blood and have it sent to a laboratory for drug testing (often in addition to BAC testing). For Type 4 drivers, law enforcement officers are responsible for deciding whether to have a blood sample drawn and sent to a laboratory for testing. For Types 2 and 3, the responsibilities and processes can vary and are a complex mix between those of Types 1 and 4. For example, responsibility for testing remains with law enforcement as long as the driver is alive, but it shifts to the ME/C if and when the driver dies. Most hospitals routinely draw a blood sample from seriously injured patients for medical purposes but can only release test results or a portion of the blood sample with specific authorization, such as a warrant from law enforcement, a subpoena or authorized request from the ME/C, or the driver's consent (if the driver is willing and able). Responsibility for reporting drug test results to FARS often lies with the law enforcement officers or ME/Cs who requested the tests. In some states, centralized state laboratories may report the results directly to FARS.

Additionally, we examined drivers by fault status (i.e., at fault in the crash or not at fault in the crash). Drivers were classified as "at fault" if they were involved in a single-vehicle crash or if they had one or more of the violations or related factors used to determine fault in a previous NHTSA report (see Appendix Table A.1 for details) (^{Stutts et al., 2009}). Drivers were divided into the following four driver fault types based on vital status and fault status:

Type A: Drivers who died and were at fault in the crash (n = 16,801)

Type B: Drivers who died and were not at fault in the crash (n = 4,006)

Type C: Drivers who survived and were at fault in the crash (n = 12,618)

Type D: Drivers who survived and were not at fault in the crash (n = 10,871)

We examined the following state-level factors thought to potentially affect state drug testing rates for one or more driver/driver fault types for 2013. Definitions of these terms follow in the paragraph below; for factors with continuous values, arbitrary category cut points were predetermined to minimize unbalanced distributions of states across categories: 1) prevalence of illicit drug use (> 8.75% or 8.75%), 2) drugged driving per se laws in effect, 3) medical marijuana legalized, 4) implied consent laws for drugs in effect, 5) laws requiring a driver to be under arrest before law enforcement can request chemical tests, 6) ME/C

systems (centralized state ME, county coroner, county ME, or mixed), 7) number of fulltime law enforcement employees per fatal crash (i.e., total number of employees divided by total number of fatal crashes), 8) BAC testing rates for drivers of the same type (i.e., Type 1 through 4 or Type A through D, described above), and 9) number of drivers of the same type involved in fatal crashes.

Prevalence of past month illicit drug use among people ages 18 or older by state was obtained from published estimates based on the 2012 and 2013 National Survey on Drug Use and Health (SAMHSA, 2014). Drugged driving per se laws make it illegal to operate a motor vehicle with a defined level (either above zero or above a nonzero threshold, depending on the state) of a controlled substance in the body. When people apply for a driver's license in states with implied consent laws, they give consent to field sobriety tests and chemical tests and risk automatic license suspension and other possible penalties if they refuse such tests. ME/C system categorization was provided by an online report (Larson et al., 2011), and the number of full-time law enforcement employees by state was obtained from the Federal Bureau of Investigation's annual *Crime in the United States* publication (U.S. DOJ, 2013).

We placed each state into one category for each state-level factor. For a state to be categorized as having a particular state law or policy, the law/policy had to be in effect by December 31, 2012, or earlier. To account for time since law enactment, we considered using three categories (law enacted prior to the median date, law enacted on or after the median date, and no law in effect) for the per se laws and medical marijuana legalization and found no statistically significant differences between categories. In addition, all of the states with implied consent laws and all but one state (Connecticut) with the arrest laws were enacted prior to November 2002 (Walsh et al., 2002); as this was more than 10 years ago, it was far enough in the past for all to be grouped into one category. Therefore, two categories (e.g., law in effect and law not in effect), rather than three, were used for all of the state law factors in this analysis.

We generated box plots to display the distributions of state drug testing rates by categories of state-level factors for each driver type. Outliers were labeled with their state's abbreviation. We used the non-parametric Kruskal-Wallis (KW) test combined with pairwise Mann-Whitney (MW) tests with Bonferroni-Holm correction for multiple comparisons (when appropriate) to test for differences in state drug testing rates between the four driver types and between categories of state-level factors within each driver type. Post hoc, we used robust linear regression models to confirm observed associations while controlling for other state-level factors and accounting for outliers. The level of significance was set at 0.05. All graphics and statistical calculations were generated with SAS Version 9.3 (SAS Institute Inc., Cary, NC).

3. Results

State drug testing rates for driver types 1 through 4 are shown in Appendix Table A.2. Overall, drug testing rates varied by driver type (KW, p < 0.0001). Testing rates were highest among drivers who died at the scene of the crash or prior to the crash (Note: median =

median of states) (Type 1 drivers, median = 70.8%, highest = 100% in Maryland and Rhode Island, and lowest = 0% in Maine), followed by drivers who died en route to or at a hospital (Type 2 drivers, median = 52.7%, highest = 90% in Nevada, and lowest = 0% in Maine). The lowest testing rates were seen among surviving drivers who were transported to a hospital (Type 3 drivers, median = 22.0%, highest = 75.4% in Montana, and lowest = 0% in Massachusetts) or not transported to a hospital (Type 4 drivers, median = 14.0%, highest = 71.7% in Montana, and lowest = 0% in Rhode Island). According to pairwise tests, the difference between Type 3 and 4 drivers was not statistically significant (MW, p = 0.052), but all other differences between driver types were significant (MW, all p < 0.01).

Appendix Table A.3 presents state drug testing rates for driver fault types A through D. Overall, drug testing rates varied by driver fault type (KW, p < 0.0001). The highest testing rates were seen among fatally injured drivers who were at fault in the crash (Type A drivers, median = 64.4%, highest = 92.7% in West Virginia, and lowest = 0% in Maine) or not at fault in the crash (Type B drivers, median = 62.8%, highest = 100% in the District of Columbia, New Hampshire, Vermont, and West Virginia, and lowest = 0% in Maine). Testing rates were lowest among surviving drivers who were not at fault in the crash (Type D drivers, median = 10.0%, highest = 73.9% in Montana, and lowest = 0% in Colorado, Maine, Maryland, and Virginia), followed by surviving drivers who were at fault in the crash (Type C drivers, median = 24.3%, highest = 83.3% in New Hampshire, and lowest = 0% in Rhode Island). Pairwise tests indicated the difference between Type A and B drivers was not statistically significant (MW, p = 0.70), but all other differences between driver types were significant (MW, all p < 0.01).

Figure 1 depicts relationships between state-level factors and state drug testing rates for driver types 1 through 4. Corresponding p values and numbers of states for each state-level factor by driver type are shown in Table 1. States with a higher prevalence of illicit drug use had higher drug testing rates among Type 1 (KW, p = 0.02) and Type 2 (KW, p = 0.007) drivers. In post hoc robust linear regression models, however, these associations were no longer statistically significant after adjusting for the other state-level factors (Appendix Table A.4). State drug testing rates differed by BAC testing rate across all four driver types (KW, all p 0.0002). In general, states that tested a higher percentage of drivers for BAC had higher drug testing rates as well. Post hoc robust linear regression models confirmed that state BAC testing rates were associated with state drug testing rates for each driver type after adjusting for the other state-level factors. All pairwise differences between categories of BAC testing rate were statistically significant, with the exception of the difference between the greater than 40% and 20%–40% categories among Type 4 drivers (MW, p = 0.13). States requiring an arrest before law enforcement can request chemical tests had higher drug testing rates than states in which an arrest is not required among Type 3 drivers (median = 27.3% vs. 11.3%; KW, p = 0.03) and Type 4 drivers (median = 18.1% vs. 8.0%; KW, p =0.04), respectively. States with less than 75 Type 3 drivers involved in fatal crashes had higher drug testing rates (median = 35.3%) compared with states with 75 to 200 Type 3 drivers (median = 17.6%; KW, p = 0.04; MW, p = 0.01) but not compared with states with more than 200 Type 3 drivers (median = 20.5%; MW, p = 0.07). Post hoc robust linear regression models confirmed that the arrest laws were associated with state drug testing rates for Type 3 and Type 4 drivers after adjusting for the other state-level factors. For all other

state-level factors examined by driver type, no statistically significant differences were detected between state drug testing rates based on presence/absence or level of a certain factor.

Figure 2 depicts relationships between state-level factors and state drug testing rates for driver fault types A through D. Table 2 provides corresponding p values and numbers of states for each state-level factor by driver fault type. States with a higher prevalence of illicit drug use had higher drug testing rates among Type A (KW, p = 0.01) and Type B (KW, p =0.007) drivers. In post hoc robust linear regression models (Appendix Table A.4), these associations were no longer statistically significant after adjusting for the other state-level factors. State drug testing rates differed by BAC testing rate across all four driver fault types (KW, all p 0.0002). States that tested a higher percentage of drivers for BAC generally had higher drug testing rates. As confirmed by post hoc robust linear regression models, state BAC testing rates were associated with state drug testing rates for each driver fault type after adjusting for the other state-level factors. All pairwise differences between categories of BAC testing rate were statistically significant except for the difference between the greater than 85% and 70%–85% categories among Type A drivers (MW, p = 0.09) and the difference between the greater than 60% and 30%–60% categories among Type C drivers (MW, p = 0.08). States requiring an arrest before law enforcement can request chemical tests had higher drug testing rates than states in which an arrest is not required among Type C drivers (median = 33.3% vs. 13.4%; KW, p = 0.01). Post hoc robust linear regression models confirmed that the arrest laws were associated with state drug testing rates for Type C drivers after adjusting for the other state-level factors. For all other state-level factors examined by driver fault type, no statistically significant differences were detected between state drug testing rates based on presence/absence or level of a certain factor.

4. Discussion

Results of this analysis showed that state drug testing rates differed by driver type, by driver fault type, by state BAC testing rate, and by arrest laws. Our findings underscore the need for improved drug testing practices, especially for drivers who survive fatal crashes and drivers who are not transported to a hospital. Of particular concern is the low testing rate for surviving drivers who were at fault in the crash (Type C). Their driving behaviors such as speeding, risk taking, aggression, and inattentiveness could result from drug use or intoxication, and this cause might have been missed without proper testing. In agreement with our results, prior reports using FARS data have indicated that drivers who died in crashes were tested at higher rates for both drugs (Berning and Smither, 2014) and BAC (Casanova et al., 2012) compared with surviving drivers. This may be partially explained by the fact that the window of time to perform valid testing is narrower for law enforcement officials than for ME/Cs because of significant loss of drug due to drug metabolism in the living, compared with low rates of drug degradation or redistribution in the dead. Previous evidence also showed that surviving drivers who were transported to hospitals were tested for BAC at a higher rate (38%) than those who were not transported (28%) (Casanova et al., 2012).

Page 8

drug testing rates with several exceptions, such as North Carolina and Maine for Types 1, 2, A, and B drivers. Lengthy backlogs for drug testing may partially account for the observed differences in outlier states such as these. Although state testing rates for alcohol and drugs were highly correlated, drug testing rates were generally lower than alcohol testing rates (data not shown). This deserves some discussion, especially in light of recent statements acknowledging the widespread and counterproductive practice of omitting drug testing if a driver's BAC exceeds the legal limit (Berning and Smither, 2014; Logan et al., 2013). Because most state statutes do not distinguish between alcohol and drug impairment and do not have greater penalties for alcohol-plus-drugs as opposed to alcohol alone, and because state criminal justice data systems do not distinguish between alcohol- and drug-related driving offenses, there is little incentive to spend resources on drug testing when alcohol tests are positive. This issue applies primarily to surviving drivers who have the potential to face criminal charges for alcohol- and/or drug-impaired driving based on these state statutes.

To improve drug testing rates in the future, states might consider expanding existing policies on BAC testing to include drugs. By law, 25 states require BAC testing for all or almost all fatally injured drivers, and 7 states require BAC testing for surviving drivers. Compared with states without such laws, in 2009, the median BAC testing rates were between 13 and more than 30 percentage points higher for states with testing laws for fatally injured drivers and surviving drivers, respectively (Casanova et al., 2012). However, there were several exceptions to these improved testing rates that highlight the need for effective implementation of such laws within and across jurisdictions.

A somewhat surprising result was observed for arrest requirements in this study. We anticipated drug testing rates would be lower in states that require an arrest before law enforcement can request chemical tests, but these states actually had higher testing rates, especially among drivers who were at fault in the crash. One possible explanation is that drivers in states with arrest requirements are arrested more frequently (due to the requirements) and therefore have lower refusal rates because they may feel more compelled to cooperate when they are under arrest. In fact, 7 of the 10 states with the highest driving under the influence (DUI) arrest rates had arrest requirements (^{Briones, 2012}). Alternatively, states with arrest requirements could have other unknown factors in common that are influencing testing rates.

States that have medical marijuana laws have both higher rates of marijuana use and higher drug testing rates (Masten and Guenzburger, 2014). This may help explain why prevalence of illicit drug use was no longer associated with drug testing rates after adjusting for medical marijuana laws and other state-level factors in this study.

It is important to note that high testing rates for some states do not necessarily indicate that these states tested for all major drug types. For example, Maryland had 100% testing rates for Type 1 drivers in 2013 but does not routinely test for marijuana use (Logan et al., 2013). In addition, some states might have tested for drugs but did not report the results to FARS; testing rates in such states would therefore be underestimated (Berning and Smither, 2014).

In the case of drug testing, it will be important to address differences that exist both within and between states regarding types of drugs and metabolites tested, use of autopsies, biological specimens (e.g., 93% and 88% of positive marijuana tests in 2013 FARS used blood among fatally injured and surviving drivers, respectively; 7% and 12% used urine or other known/unknown specimens), laboratory equipment, test sensitivity and cut-off levels, use of confirmatory tests after positive screening tests, and procedures for reporting results to FARS (Berning and Smither, 2014). Because it may not be feasible to test for all potentially impairing drugs due to financial and time constraints, marijuana and other commonly used drugs may be initially prioritized over less prevalent ones. A set of recommendations for toxicological investigation of drug-impaired driving was published in 2007 (reviewed and updated in 2013) in an effort to establish a common standard of practice among forensic toxicology laboratories in the United States (Farrell et al., 2007, Logan et al., 2013). The recommendations included analytical cutoffs for screening and confirmation of drugs in blood and urine samples and the following list of drugs that should at a minimum be tested for in all suspected drugged driving cases: cannabis, methamphetamine, amphetamine, cocaine/metabolite, benzodiazepines (lorazepam, clonazepam), carisoprodol, zolpidem, barbiturates, methadone, opiates, oxycodone, and PCP. As of 2012, these recommendations were generally being observed by between 50% and 95% of responding laboratories, depending on the drug class and sample type. Reasons given by laboratories for lack of greater alignment with the recommendations included disagreement with some aspect of the recommendations, lack of interest/voluntary nature of the recommendations, and/or limitations in staffing, technology, and funding (Logan et al., 2013).

It is crucial to acknowledge that even if drug testing and reporting procedures were standardized across all states and results were available for all drivers, the current evidence still is not sufficient to reliably equate a specific drug concentration level with a specific degree of driving impairment (Berning et al., 2015). For example, many drugs can be detected in the body long after potential impairment has ended. In chronic daily marijuana users, 11-OH-THC or THC can be detected in blood samples for several days or up to 1 month, respectively, after use has been discontinued (Bergamaschi et al., 2013). Unfortunately, THC, 11-OH-THC, and its nonpsychoactive metabolites (11-nor-9-carboxy-THC and 11-nor-9-carboxy-THC-glucuronide) all fall under the same category in the FARS coding system (Hartman and Huestis, 2014). Some drugs, including THC, are metabolized very quickly in living people; consequently, THC or other drugs detected in the blood at the time of driving are likely much higher than at the time of sampling (approximately 30 to 90 minutes later) (Jones et al., 2008). Despite the lack of a scientific consensus on impairment levels, state laws have established non-zero THC blood concentrations at which it is illegal to drive a motor vehicle in Colorado (5 ng/mL), Montana (5 ng/mL), Nevada (2 ng/mL), Ohio (2 ng/mL), Pennsylvania (1 ng/mL), and Washington (5 ng/mL). An additional 11 states have zero tolerance laws in place that make it illegal to drive with any detectable amount of THC (or any metabolite in 7 of these states) in the body unless medical marijuana exemptions apply (6 states).

In the current atmosphere of rapidly changing marijuana policies, there is a sense of urgency for states to improve methods of understanding, detecting, and preventing drugged driving. At least 10 states are considering legalizing recreational marijuana by 2016, which would

bring the total number of jurisdictions (including the District of Columbia) with legal recreational marijuana to 15 (Ferner, 2015). The 74% reduction in the alcohol-impaired driving fatality rate between 1982 to 2011 (National Transportation Safety Board, 2013) has been partly attributed to the adoption of scientific advances in BAC testing methods and the use of that information in programs and policies to reduce drunk driving (Voas and Fell, 2011). The goal is that similar advances in drug testing methods through standardization and mandatory testing policies will lead to reductions in drug-impaired driving fatalities. In addition, more research will be needed to determine if scientifically reliable drug concentrations can be established to detect when driving skills become impaired in most or all drivers. Furthermore, there is a need to strengthen the data-gathering fields in FARS to collect more useable information about drug use. For example, FARS should collect: 1) which drugs were tested for, 2) the quantitative results, 3) the time between the crash and collection of the biological specimens, and 4) whether an autopsy was conducted. Finally, FARS analysts should endeavor to obtain a copy of the toxicology report rather than rely on word of mouth information or summaries of drug findings in the police report, which are often incomplete. Until many of the aforementioned improvements are made, FARS data users should continue to be cautious about the limitations of using available drug testing data when making comparisons over time and across states and driver types.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This article is based on a study conducted for the Alcohol Epidemiologic Data System project funded by the National Institute on Alcohol Abuse and Alcoholism through contract No. HHSN275201300016C to CSR, Incorporated. The authors wish to thank Chiung M. Chen (CSR, Incorporated) for providing insights and Hunter Barrat (CSR, Incorporated) for editorial assistance in the preparation of the manuscript.

References

- Bergamaschi MM, Karschner EL, Goodwin RS, Scheidweiler KB, Hirvonen J, Queiroz RHC, Huestis MA. Impact of prolonged cannabinoid excretion in chronic daily cannabis smokers' blood on per se drugged driving laws. Clinical Chemistry. 2013; 59(3):519–526. DOI: 10.1373/clinchem. 2012.195503 [PubMed: 23449702]
- Berning, A.; Compton, R.; Wochinger, K. Results of the 2013–2014 National Roadside Survey of alcohol and drug use by drivers. Washington, DC: National Highway Traffic Safety Administration; 2015. (No. DOT HS 812 118). Traffic Safety Facts Research Note
- Berning, A.; Smither, DD. Understanding the limitations of drug test information, reporting, and testing practices in fatal crashes. Washington, DC: National Highway Traffic Safety Administration; 2014. (No. DOT HS 812 072). Traffic Safety Facts Research NoteRetrieved from http://wwwnrd.nhtsa.dot.gov/Pubs/812072.pdf
- Brady JE, Li G. Prevalence of alcohol and other drugs in fatally injured drivers. Addiction (Abingdon, England). 2013; 108(1):104–114. DOI: 10.1111/j.1360-0443.2012.03993.x
- Brady JE, Li G. Trends in Alcohol and Other Drugs Detected in Fatally Injured Drivers in the United States, 1999–2010. American Journal of Epidemiology. 2014; 179(6):692–699. DOI: 10.1093/aje/kwt327 [PubMed: 24477748]
- Briones, D. States with the Highest DUI Arrest and Alcohol Consumption Rates. 2012. Retrieved from http://www.lawyershop.com/2012/10/05/states-with-high-dui-arrest-alcohol-consumption-rates

- Casanova, T.; Hedlund, J.; Tison, J. State blood alcohol concentration (BAC) testing and reporting for drivers involved in fatal crashes: current practices, results, and strategies, 1997–2009. Washington, DC: National Highway Traffic Safety Administration; 2012. No. DOT HS 811 661
- Compton, RP.; Berning, A. Drug and alcohol crash risk. Washington, DC: National Highway Traffic Safety Administration; 2015. (No. DOT HS 812 117). Traffic Safety Facts Research Note
- Compton, R.; Vegega, M.; Smither, D. Drug-impaired driving: understanding the problem and ways to reduce it: a report to Congress. Washington, DC: National Highway Traffic Safety Administration; 2009. No. DOT HS 811 268Retrieved from http://www.nhtsa.gov/staticfiles/nti/pdf/811268.pdf
- Farrell LJ, Kerrigan S, Logan BK. Recommendations for toxicological investigation of drug impaired driving. Journal of Forensic Sciences. 2007; 52(5):1214–1218. DOI: 10.1111/j. 1556-4029.2007.00516.x [PubMed: 17680796]
- Ferner, M. Recreational marijuana now legal in D.C. Huffington Post. 2015 Feb 26. Retrieved from http://www.huffingtonpost.com/2015/02/26/marijuana-legalization-dc_n_6753554.html
- Gates J, Dubois S, Mullen N, Weaver B, Bédard M. The influence of stimulants on truck driver crash responsibility in fatal crashes. Forensic Science International. 2013; 228(1–3):15–20. DOI: 10.1016/j.forsciint.2013.02.001 [PubMed: 23597733]
- Hartman RL, Huestis MA. Re: "Trends in Alcohol and Other Drugs Detected in Fatally Injured Drivers in the United States, 1999–2010. American Journal of Epidemiology. 2014; 180(8):862–863. DOI: 10.1093/aje/kwu251 [PubMed: 25245042]
- Jones AW, Holmgren A, Kugelberg FC. Driving under the influence of cannabis: a 10-year study of age and gender differences in the concentrations of tetrahydrocannabinol in blood. Addiction (Abingdon, England). 2008; 103(3):452–461. DOI: 10.1111/j.1360-0443.2007.02091.x
- Keyes KM, Brady JE, Li G. Effects of minimum legal drinking age on alcohol and marijuana use: evidence from toxicological testing data for fatally injured drivers aged 16 to 25 years. Injury Epidemiology. 2015; 2(1)doi: 10.1186/s40621-014-0032-1
- Larson, J.; Day, L.; Lupkin, S.; McNeill, S.; Bennett, K.; Bennion, J.; Van Woerkom, B. Map: Death in America. ProPublica, FRONTLINE, NPR. 2011. Retrieved from http://www.pbs.org/wgbh/pages/ frontline/post-mortem/map-death-in-america/
- Logan BK, Lowrie KJ, Turri JL, Yeakel JK, Limoges JF, Miles AK, Scarneo CE, et al. Recommendations for toxicological investigation of drug-impaired driving and motor vehicle fatalities. Journal of Analytical Toxicology. 2013; 37(8):552–558. DOI: 10.1093/jat/bkt059 [PubMed: 23943437]
- Masten SV, Guenzburger GV. Changes in driver cannabinoid prevalence in 12 U.S. states after implementing medical marijuana laws. Journal of Safety Research. 2014; 50:35–52. DOI: 10.1016/j.jsr.2014.03.009 [PubMed: 25142359]
- Maxwell HG, Dubois S, Weaver B, Bédard M. The additive effects of alcohol and benzodiazepines on driving. Canadian Journal of Public Health = Revue Canadienne De Santé Publique. 2010; 101(5): 353–357. [PubMed: 21214047]
- Meier, GW. Alcohol, drugs, and traffic safety: proceedings of the ninth International Conference on Alcohol, Drugs, and Traffic Safety, San Juan, Puerto Rico, 1983, Part 2. U.S. Department of Transportation, National Highway Traffic Safety Administration; 1985.
- National Transportation Safety Board. Reaching zero: actions to eliminate alcohol-impaired driving. Washington, DC: NTSB; 2013. No. NTSB/SR-13/01Retrieved from http://www.ntsb.gov/safety/ safety-studies/documents/sr1301.pdf
- Office of National Drug Control Policy. National drug control strategy, 2010. Washington, DC: Executive Office of the President; 2010. Retrieved from https://www.whitehouse.gov/sites/default/ files/ondcp/policy-and-research/ndcs2010_0.pdf
- Pollini RA, Romano E, Johnson MB, Lacey JH. The impact of marijuana decriminalization on California drivers. Drug and Alcohol Dependence. 2015; doi: 10.1016/j.drugalcdep.2015.02.024
- Reguly P, Dubois S, Bédard M. Examining the impact of opioid analgesics on crash responsibility in truck drivers involved in fatal crashes. Forensic Science International. 2014; 234:154–161. DOI: 10.1016/j.forsciint.2013.11.005 [PubMed: 24378316]
- Romano E, Pollini RA. Patterns of drug use in fatal crashes. Addiction (Abingdon, England). 2013; 108(8):1428–1438. DOI: 10.1111/add.12180

- Romano E, Torres-Saavedra P, Voas RB, Lacey JH. Drugs and alcohol: their relative crash risk. Journal of Studies on Alcohol and Drugs. 2014; 75(1):56–64. [PubMed: 24411797]
- Stutts, J.; Martell, C.; Staplin, L. Identifying behaviors and situations associated with increased crash risk for older drivers. Washington, DC: Office of Behavioral Safety Research, National Highway Traffic Safety Administration; 2009. No. DOT HS 811 093Retrieved from http:// www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/ 811093.pdf
- Substance Abuse and Mental Health Services Administration (SAMHSA). The NSDUH report: driving under the influence among adult drivers. Rockville, MD: 2005.
- Substance Abuse and Mental Health Services Administration (SAMHSA), Center for Behavioral Health Statistics and Quality. 2012–2013 National Survey on Drug Use and Health: Model-Based Prevalence Estimates (50 States and the District of Columbia). 2014. Retrieved from http:// www.samhsa.gov/data/sites/default/files/NSDUHStateEst2012-2013-p1/Tables/ NSDUHsaePercents2013.pdf
- U.S. Department of Justice, Federal Bureau of Investigation, Criminal Justice Information Services Division. Crime in the United States, 2013: Table 77, Full-time Law Enforcement Employees by State, 2013. 2013. Retrieved from http://www.fbi.gov/about-us/cjis/ucr/crime-in-the-u.s/2013/ crime-in-the-u.s.-2013/tables/table-77/ table_77_full_time_law_enforcement_employees_by_state_2013.xls
- U.S. Department of Transportation, National Highway Traffic Safety Administration. 2013 FARS/ NASS GES coding and validation manual. Washington, DC: National Highway Traffic Safety
- Administration; 2014. No. DOT HS 812 094Retrieved from http://www-nrd.nhtsa.dot.gov/Pubs/ GES13.pdf
- U.S. Department of Transportation, National Highway Transportation Safety Administration. Fatality Analysis Reporting System (FARS) Encyclopedia. 2013. Retrieved from http://wwwfars.nhtsa.dot.gov
- Voas RB, Fell JC. Preventing impaired driving opportunities and problems. Alcohol Research & Health. 2011; 34(2):225–235. ResU-AR&H-09. [PubMed: 22330222]
- Walsh, JM.; Danziger, G.; Cangianelli, LA.; Koehler, DB. Driving under the influence of drugs (DUID) legislation in the United States. Robert Wood Johnson Foundation, Substance Abuse Policy Research Program; 2002. Retrieved from http://www.walshgroup.org/MANUAL %20FINAL.pdf

Appendix A. Supplementary data

Supplementary data associated with this article are presented in Appendix Table A.1 to A.4, which can be found in the online version at [*the link to the* supplementary file].

HIGHLIGHTS

• Limitations of FARS data prevent unbiased estimation of drugged driving.

- Drug testing rates varied across states and differed by driver types.
- Drug testing rates were lowest for surviving drivers not transported to a hospital.
- States testing higher percentages of drivers for BAC had higher drug testing rates.
- States with vs. without arrest laws had higher testing rates for surviving drivers.



Fig 1.

State drug testing rates for drivers in fatal crashes who (a) died at the scene of or prior to the crash (Type 1 drivers), (b) died en route to or at the hospital (Type 2 drivers), (c) were transported to a hospital and survived (Type 3 drivers), or (d) survived and were not transported to a hospital (Type 4 drivers), FARS 2013.



Fig 2.

State drug testing rates for drivers in fatal crashes who (a) died and were at fault (Type A drivers), (b) died and were not at fault (Type B drivers), (c) survived and were at fault (Type C drivers), or (d) survived and were not at fault (Type D drivers), FARS 2013.

Table 1

Pvalues and numbers of states for each state-level factor by driver type, FARS 2013

			Drive	er type ^a	
State-level factor (categories)	# of States	Type 1 p	Type 2 p	Type 3 p	Type 4 <i>p</i>
Illicit drug use prevalence (> 8.75% / 8.75%)	25/26	0.02^{*}	0.007*	0.35	0.43
Drugged driving per se (yes/no)	18/33	0.82	0.62	0.53	0.55
Medical marijuana (yes/no)	18/33	0.14	0.13	0.81	0.75
ME/Coroner system (centralized state ME/county coroner/county ME/mixed)	17/11/7/16	0.62	0.52	1	1
Alcohol testing rates (high/medium/low)	varies by type	0.0002^{*}	0.0002^{*}	< 0.0001	<0.0001*
Drivers in fatal crashes (low/medium/high)	varies by type	0.31	0.92	0.04	0.50
Implied consent (yes/no)	46/5	I	ł	06.0	0.85
Arrest prior to testing required (yes/no)	27/24	I	1	0.03 *	0.04
Police employees per crash (>35/25–35 /<25)	15/18/18	I	ł	0.44	0.45

^aType 1: Drivers who died at the scene of the crash or prior to the crash. Type 2: Drivers who died en route to or at a hospital. Type 3: Drivers who were transported to a hospital and survived. Type 4: Drivers who were not transported to a hospital and survived.

* Statistically significant at the 0.05 level. Author Manuscript

2	
Ð	
ο	
, m	
-	

Pvalues and numbers of states for each state-level factor by driver fault type, FARS 2013

			Driver 1	ault type"	
State-level factor (categories)	# of States	Type A p	Type B p	Type C P	Type D <i>p</i>
Illicit drug use prevalence (>8.75% / 8.75%)	25/26	0.01^{*}	0.007*	0.32	0.26
Drugged driving per se (yes/no)	18/33	0.77	0.78	0.43	0.48
Medical marijuana (yes/no)	18/33	0.14	0.07	0.98	0.98
ME/Coroner system (centralized state ME/county coroner/county ME/mixed)	17/11/7/16	09.0	0.41	1	1
Alcohol testing rates (high/medium/low)	varies by type	0.0002^{*}	0.0001^{*}	<0.0001 *	<0.0001*
Drivers in fatal crashes (low/medium/high)	varies by type	0.81	0.81	0.26	0:30
Implied consent (yes/no)	46/5	I	1	0.80	0.80
Arrest prior to testing required (yes/no)	27/24	I	ł	0.01	0.13
Police employees per crash (>35/25–35 /<25)	15/18/18	I	ł	0.32	0.58

"Type A: Drivers who died and were at fault in the crash. Type B: Drivers who died and were not at fault in the crash. Type C: Drivers who survived and were at fault in the crash. Type D: Drivers who survived and were at fault in the crash. Type D: Drivers who

* Statistically significant at the 0.05 level.