

Oral fluid testing for marijuana intoxication: enhancing objectivity for roadside DUI testing

Mitchell L Doucette, Shannon Frattaroli, Jon S Vernick

Department of Health Policy and Management, Center for Injury Research and Policy, The Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA

Correspondence to

Mitchell L Doucette, MS, 624 Broadway St., Hampton House, Rm #509, Baltimore, MD 21202, USA; mdoucet3@jhu.edu

Received 28 October 2016

Revised 23 January 2017

Accepted 29 March 2017

ABSTRACT

Reducing marijuana-impaired driving is an important part of any strategy to prevent motor vehicle traffic injuries. In Colorado, the first of eight US states and the District of Columbia to legalise marijuana for recreational use, drivers with positive tests for the presence of marijuana accounted for a larger proportion of fatal MVCs after marijuana commercialisation. The use of blood tests to screen for marijuana intoxication, in Colorado and elsewhere in the USA, poses a number of challenges. Many high-income countries use oral fluid drug testing (OF) to provide roadside evidence of marijuana intoxication. A 2009 Belgium policy implementing OF roadside testing increased true positives and decreased false positives of suspected marijuana-related driving under the influence (DUI) arrests. US policy-makers should consider using roadside OF to increase objectivity and reliability for tests used in marijuana-related DUI arrests.

INTRODUCTION

In 2015, 35 092 Americans were killed in motor vehicle traffic crashes.¹ While fatal MVCs decreased between 2005 and 2014, the number of fatal crashes increased substantially in 2015 (7.0%).¹ Motor vehicle traffic injuries are associated with very substantial economic costs, including lost productivity, medical expenses, emergency medical services and property damage. In 2010, the estimated direct economic losses associated with motor vehicle traffic crashes was US\$242 billion. Accounting for quality-of-life measures, that number rises to US\$836 billion.² MVCs are widely acknowledged as a global public health problem, as more than 1.3 million people are killed each year in traffic-related incidents throughout the world.³

Reducing impaired driving, specifically alcohol-impaired and drug-impaired driving, is essential for preventing motor vehicle traffic injuries.⁴ In the USA, alcohol-impaired driving accounted for 31% of traffic-related fatalities in 2014.⁵ In 2009, the Fatality Analysis Reporting System reported 33% of drivers killed in a crash, who were tested for drugs, tested positive for drug involvement.⁶

The positive link between marijuana use and driving impairment has been examined through small experimental studies,⁷ roadside surveys⁸ and case control studies.^{9–10} A 2013 systematic review of the effect of marijuana on driving skills found a significant relationship between acute marijuana use and MVC risk. Recent marijuana use, indicated by either blood tetrahydrocannabinol (THC, the primary pharmacologically active component of marijuana) concentrations or self-reported

measures, is associated with significant driving impairment, and that risk is elevated among non-habitual users.¹¹ A 2013 case-control study examining the association between drug use and fatal crash risk found a 1.83 times greater risk (OR=1.83; 95% CI 1.39 to 2.39) of fatal crash involvement for drivers testing positive for marijuana compared with marijuana-negative drivers.¹⁰ Oral fluid tests were used to determine marijuana intoxication for controls, using a minimum detection threshold of 4 ng/mL.^{10–12}

MARIJUANA COMMERCIALISATION AND INTOXICATED DRIVING

As of December 2016, eight states (Massachusetts, Maine, Colorado, Washington, Oregon, California, Nevada and Alaska) and the District of Columbia have legalised marijuana for recreational use.¹³ An additional 28 states have medical marijuana laws.¹⁴

A study of the impact of Colorado's initial medical marijuana law, which made medical marijuana available for widespread use, found the proportion of fatal MVCs involving a marijuana-positive driver increased post marijuana commercialisation (July 2009). States with unchanged marijuana policies included in the analysis during the time period examined (1994–2011) did not experience similar changes in marijuana-related DUI fatalities.¹⁵

Under Colorado law, THC blood concentration levels above 5 ng/mL constitute impaired driving.¹⁶ Colorado DUI statutes specify law enforcement officers establish probable cause of marijuana intoxication using visual assessments at roadside and collect blood evidence of intoxication to establish THC concentration levels post detainment.¹⁶

Recent evidence suggests that for severe MVCs in Colorado, delays in DUI blood testing exist. The average time from law enforcement dispatch to blood sample collection was 2.32 hours,¹⁷ which is outside the 2-hour window of legal sample collection under Colorado law¹⁶ and peak THC detectability.¹⁷ Additionally, as of March 2015, Colorado had 207 law enforcement officers trained as drug recognition experts who are qualified to recognise, document and testify to drug impairment. For comparison, at that same time, Colorado had approximately 13 000 law enforcement officers trained to recognise, document and testify to alcohol impairment.¹⁷

ORAL FLUID TESTING FOR MARIJUANA INTOXICATION

Oral fluid (OF) testing, which involves swabbing the inside of an individual's mouth, is a common mechanism for drug testing. Currently, OF testing is used for workplace drug testing,¹⁸ forensic

To cite: Doucette ML, Frattaroli S, Vernick JS. *Inj Prev* Published Online First: [please include Day Month Year] doi:10.1136/injuryprev-2016-042264

Brief report

toxicology, establishing evidence in non-DUI criminal justice cases and monitoring medication intake for pain management.^{19 20} OF testing provides a minimally invasive and observable sample collection procedure with a rapid analysis time capable of establishing drug intoxication on-site.

Nine European countries, Australia and New Zealand permit on-site OF testing for driving under the influence of drugs.²¹ Research from the mid-2000s suggested OF screening devices were not scientifically reliable for on-site drug testing.²² However, a more recent study of 1025 randomly stopped Italian drivers found a sensitivity of 92.3% and specificity of 96.7% for one OF testing machine, the Dräger Drugtest 5000, at a minimum detection of 5 ng/mL of THC.²³ An evaluation of a 2009 policy change in Belgium requiring OF testing on-site provides useful evidence for the possible application of this policy to the USA.

EVIDENCE FOR ORAL FLUID TESTING: LESSONS FROM BELGIUM

From January 2008 to May 2010, a hospital-based prevalence study using blood samples drawn from Belgian drivers injured in a traffic crash found almost 5% of severely injured drivers had used an illicit drug, with marijuana representing half of all illicit drugs used.²⁴ In 2009, the Belgian government updated its intoxicated driving laws to incorporate a limited field sobriety test consisting of visual and behavioural-based indicators of drug intoxication followed by an OF on-site screening test to determine the need for blood sample collection. Prior reliance on a comprehensive field test and urine screening was determined to be both less efficient and less accurate compared with OF testing.²⁵ Prior to the 2009 law change, the allowable cut-off of drug intoxication, measured in blood plasma, was 2 ng/mL. The cut-off was reduced to 1 ng/mL as part of the legislation.²⁵

A pre-post evaluation of this policy change concluded that the new testing protocol provided lower percentages of false positives for marijuana compared with urine screening alone.²⁵ The study compared approximately 4100 blood and urine samples collected from January 2008 until the law took effect in October 2010, with approximately 3900 blood and OF samples collected after the law went into effect through March 2013. Using blood samples for confirmation analysis, and considering the legal cut-offs for blood THC, OF testing post 2009 legislation had a per cent true positive of 91.4% and a per cent false positive of 8.6%. This was statistically different ($p < 0.001$) from the per cent true positive (75.2%) and per cent false positive (24.8%) of urine screening prior to the 2009 legislation. While the comparison with the USA is not direct, as on-site urine testing is not used for drug intoxication screening, the per cent true positive and per cent false positive of the OF testing protocol are promising for use in the criminal context. However, specificity and sensitivity for the new OF testing protocol could not be ascertained as per cent true negative and per cent false negative were not reported.

LEGAL ISSUES ASSOCIATED WITH OF TESTING

OF testing also has implications for acquiring evidence given the 2016 US Supreme Court decision in *Birchfield v. North Dakota* that warrantless blood tests incident to arrest for drunk driving violate the Fourth amendment, while warrantless breath tests, considered less invasive than blood tests, are generally permissible.²⁶ If a suspected marijuana DUI operator were to refuse a blood test until a warrant could be obtained, that delay might compromise the integrity of the sample as measurements of

blood THC concentrations become less reliable over time.¹⁷ In *Maryland v. King*, however, the Supreme Court concluded that a cheek swab to collect a DNA sample incident to a lawful arrest for a serious offence did not require a warrant, and described the intrusion as 'negligible.'²⁷ Therefore, OF testing may provide a constitutionally permissible alternative to blood testing.

NEXT STEPS FOR THE USA

Policy-makers in states where marijuana is legal, being considered for legalisation, decriminalised or available for medical use, should be familiar with Belgium's marijuana-related DUI procedures. Policy-makers in states that restrict marijuana-related DUI sample collection to blood should consider OF testing as a permissible alternative for establishing intoxication in the field. Police officers could use OF testing to confirm suspected instances of marijuana-related DUI, increasing objectivity of the arrest process. Additionally, policy-makers will need to consider the implications of making a positive OF test a per se violation for driving under the influence of marijuana given the per cent false positive of 8.6%.

Researchers should study the implementation and effectiveness of these policies as well as investigate how other countries address increased marijuana availability and the implications for drugged driving. Costs associated with OF tests should be considered. No research exists to suggest the cost of OF testing is prohibitive, especially if juxtaposed against the high cost of providing drug recognition training to police officers.²¹ However, researchers will need to determine if the use of OF is cost-effective compared with blood sample collection.

CONCLUSION

As US states consider legalising marijuana for recreational use, policy-makers should take steps to guard against foreseeable injury risks associated with this policy change. There is a need for an objective and timely field test to ascertain marijuana-related DUI. State DUI statutes that identify marijuana-related DUI by establishing probable cause using field sobriety tests and requiring a blood sample as evidence of intoxication could potentially benefit from the use of OF testing. Policy-makers should consider lessons from Belgium and enhance objectivity in marijuana-related DUI procedure.

What is already known on the subject

- ▶ Recent marijuana use is associated with diminished driving ability.
- ▶ Colorado's use of blood tests to screen for marijuana intoxication poses a number of challenges.

What this study adds

- ▶ Many high-income countries use oral fluid testing to provide immediate on-site testing for marijuana-related DUI.
- ▶ Results from a Belgium policy change indicate that oral fluid testing can provide high rates of true positives and low rates of false positive for suspected marijuana-related DUI arrests.
- ▶ Oral fluid drug testing at roadside is likely constitutionally permissible and stands to enhance objectivity in US marijuana-related DUI arrests.

Twitter Follow Mitchell Doucette @ML_Doucette

Acknowledgements MLD would like to thank Dr James Fratantonio for his input in conceiving this article.

Contributors MLD conceived the study and carried out the literature review. MLD, SF and JSV drafted the manuscript and provided critical revisions to the manuscript.

Funding MLD is supported in part by the National Institute of Occupational Health and Safety's Education and Research Center at the Johns Hopkins Bloomberg School of Public Health (T42-OH 008428).

Competing interests None declared.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Department of Transportation. *Traffic safety facts: 2015 Motor Vehicle Crashes: Overview*. <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812318> (accessed 10 Aug 2016).
- 2 Department of Transportation. *Traffic safety facts: Summary of Motor Vehicle crashes (Final)*. <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812263> (accessed 6 Sep 2016).
- 3 Secondary Global Road Safety Facility, The World Bank; Institute for Health Metrics and Evaluation. *Transport for health: the global burden of disease for motorized road transport*. Seattle, WA: IHM; Washington DC: The World Bank, 2014. <http://documents.worldbank.org/curated/en/984261468327002120/pdf/863040IHME0T4H0ORLDOBANK0compressed.pdf> (accessed 8 Sep 2016).
- 4 Office of National Drug Control Policy. *Drugged Driving*. <http://www.whitehouse.gov/ondcp/drugged-driving> (accessed 10 Sep 2016).
- 5 Department of Transportation. *Traffic safety facts: Alcohol-impaired*. From: <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812231>. (accessed 1 Nov 2016).
- 6 Department of Transportation. *Traffic Safety Facts: Drug Involvement of Fatally Injured Drivers*. <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/811415> (accessed 1 Nov 2016).
- 7 Ramaekers JG, Robbe HW, O'Hanlon JF. Marijuana, alcohol and actual driving performance. *Hum Psychopharmacol* 2000;15:551–8.
- 8 Bramness JG, Khiabani HZ, Mørland J. Impairment due to cannabis and ethanol: clinical signs and additive effects. *Addiction* 2010;105:1080–7.
- 9 Gerberich SG, Sidney S, Braun BL, *et al*. Marijuana use and injury events resulting in hospitalization. *Ann Epidemiol* 2003;13:230–7.
- 10 Li G, Brady JE, Chen Q. Drug use and fatal motor vehicle crashes: a case-control study. *Accid Anal Prev* 2013;60:205–10.
- 11 Hartman RL, Huestis MA. Cannabis effects on driving skills. *Clin Chem* 2013;59:478–92.
- 12 Lacey JH, Kelley-Baker T, Furr-Holden D, *et al*. 2007 National roadside survey of alcohol and drug use by drivers: methodology. In: Transportation UDo, ed. Washington DC: National Highway Traffic Safety Administration, 2009;24.
- 13 NORML. *Legalization*. <http://norml.org/legal/legalization> (accessed 6 Sep 2016).
- 14 Medical Marijuana. *28 Legal medical marijuana states and DC: Laws, fees, and possession limits*. <http://medicalmarijuana.procon.org/view.resource.php?resourceID=000881> (accessed 30 Dec 2016).
- 15 Salomonsen-Sautel S, Min SJ, Sakai JT, *et al*. Trends in fatal motor vehicle crashes before and after marijuana commercialization in Colorado. *Drug Alcohol Depend* 2014;140:137–44.
- 16 C.R.S.A. § 42-4-1301.
- 17 Wood E, Brooks-Russell A, Drum P. Delays in DUI blood testing: impact on cannabis DUI assessments. *Traffic Inj Prev* 2016;17:105–8.
- 18 Desrosiers NA, Milman G, Mendu DR, *et al*. Cannabinoids in oral fluid by on-site immunoassay and by GC-MS using two different oral fluid collection devices. *Anal Bioanal Chem* 2014;406:4117–28.
- 19 Øiestad EL, Øiestad AM, Gjelstad A, *et al*. Oral fluid drug analysis in the age of new psychoactive substances. *Bioanalysis* 2016;8:691–710.
- 20 Desrosiers NA, Lee D, Schwoppe DM, *et al*. On-site test for cannabinoids in oral fluid. *Clin Chem* 2012;58:1418–25.
- 21 Watson TM, Mann RE. International approaches to driving under the influence of cannabis: a review of evidence on impact. *Drug Alcohol Depend* 2016;169:148–55.
- 22 Verstraete AG, Raes E. *Rosita-2 Project: Final Report*. 2006.
- 23 Strano-Rossi S, Castrignanò E, Anzellotti L, *et al*. Evaluation of four oral fluid devices (DDS®, Drugtest 5000®, Drugwipe 5+® and RapidSTAT®) for on-site monitoring drugged driving in comparison with UHPLC–MS/MS analysis. *Forensic Sci Int* 2012;221:70–6.
- 24 Legrand SA, Silverans P, de Paepe P, *et al*. Presence of psychoactive substances in injured Belgian drivers. *Traffic Inj Prev* 2013;14:461–8.
- 25 Van der Linden T, Wille SM, Ramirez-Fernandez M, *et al*. Roadside drug testing: comparison of two legal approaches in Belgium. *Forensic Sci Int* 2015;249:148–55.
- 26 *Birchfield v. North Dakota*, 579 S. Ct. ____ (2016).
- 27 *Maryland v. King*, 133 S Ct 1958 (2013).



Oral fluid testing for marijuana intoxication: enhancing objectivity for roadside DUI testing

Mitchell L Doucette, Shannon Frattaroli and Jon S Vernick

Inj Prev published online June 1, 2017

Updated information and services can be found at:
<http://injuryprevention.bmj.com/content/early/2017/04/26/injuryprev-2016-042264>

References

These include:

This article cites 14 articles, 2 of which you can access for free at:
<http://injuryprevention.bmj.com/content/early/2017/04/26/injuryprev-2016-042264#BIBL>

Email alerting service

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections

Articles on similar topics can be found in the following collections

[Press releases](#) (38)

Notes

To request permissions go to:
<http://group.bmj.com/group/rights-licensing/permissions>

To order reprints go to:
<http://journals.bmj.com/cgi/reprintform>

To subscribe to BMJ go to:
<http://group.bmj.com/subscribe/>