Why a 5 ng/ml THC limit is bad public policy

Ed Wood May, 2016

Summary

Legalizing marijuana, whether for medical use, for recreation, or for recreation under the guise of medicine, has raised concerns about stoned drivers imperiling the safety of other drivers. In response, legislators have set legal limits for THC (Delta-9 tetrahydrocannabinol), the primary psychoactive component in marijuana[1]. Legislators in Washington and Montana have set a THC *per se* limit of 5 ng/ml in whole blood. Legislators in Colorado have set a THC permissible inference level of 5 ng/ml in whole blood. None of these states have legal limits for drugs other than marijuana and alcohol. Other states from California to Maine and Florida are considering similar legislation.

Although well-intended, these and other efforts to set a 5 ng/ml THC legal limit are badly flawed.

The marijuana lobby has consistently attacked 5 ng/ml THC level as being too low. They claim that people who self-medicate on marijuana have residual blood levels of THC well above 5 ng/ml without being impaired, that heavy users of marijuana develop a tolerance for marijuana's impairing effects, and that there is no scientific basis for a 5 ng/ml THC legal limit (Elliott, 2011).

Contrary to the marijuana lobby's stance, we assert that the 5 ng/ml THC level is far too high, but agree that there is no scientific basis for a 5 ng/ml THC legal limit. Furthermore, there is no scientific basis for any *impairment*-based THC *per se* limit. A THC *per se* limit may be established based on *public policy* beliefs, but not based upon proofs of *impairment*. A THC *per se* limit of 5 ng/ml is so high that it amounts to a license to drive stoned, since most marijuana-impaired drivers test well below 5 ng/ml THC in whole blood.

Understanding alcohol *per se* laws

States adopting or considering a 5 ng/ml THC limit seek to mimic the poorly understood .08 Blood Alcohol Content (BAC) alcohol *per se* limit.

The .08 BAC level now universal in the United States was not scientifically determined. It was politically determined, based upon input from science and a popular belief that it was a good number. Many countries have alcohol *per se* limits, ranging from .02 to .08, with most countries using .05 BAC. Yet all of these countries used the same scientific input to arrive at their *per se* limits. The fact that numbers vary so widely from one country to the next, all based upon the same scientific input is convincing evidence that these *per se* standards were set not by scientists, but rather by politicians to reflect their countries' concerns for public safety and beliefs in individual freedom and restraint.

Any *per se* limit cuts two ways. If someone tests above a *per se* limit, that person is guilty of a *per se* violation, even if no impairment has been proven or demonstrated. On the other hand, if someone tests below a *per se* limit, there is no *per se* violation, even if the defendant was demonstrably impaired. In the latter case, a prosecutor may be able to prove the driver was driving under the influence (DUI) of alcohol, but they cannot prove DUI *per se*. DUI and DUI *per se* are two separate issues. DUI requires proof of impairment, while DUI *per se* requires only a lab test above the limit. In some states, a DUI *per se* lab test also proves DUI.

Alcohol *per se* laws have been well accepted. Some credit alcohol *per se* laws for the 25% drop in DUI fatalities from 1996 to 2013/2014. Actually, much of the credit for this drop in fatalities belongs to safer roads, safer vehicles and better enforcement, since the percentage of fatalities caused by DUI barely budged during this same period, dropping from 32.0% to 30.9% (NHTSA). Nevertheless, alcohol *per se* laws have become an established model of how to deal with DUI.

[1] We follow the normal convention of referring to Delta-9 tetrahydrocannabinol as THC. THC's inactive metabolite is referred to as carboxy-THC or THC-COOH.

It is this established success that makes many people believe that the same approach can work for drugs like marijuana.

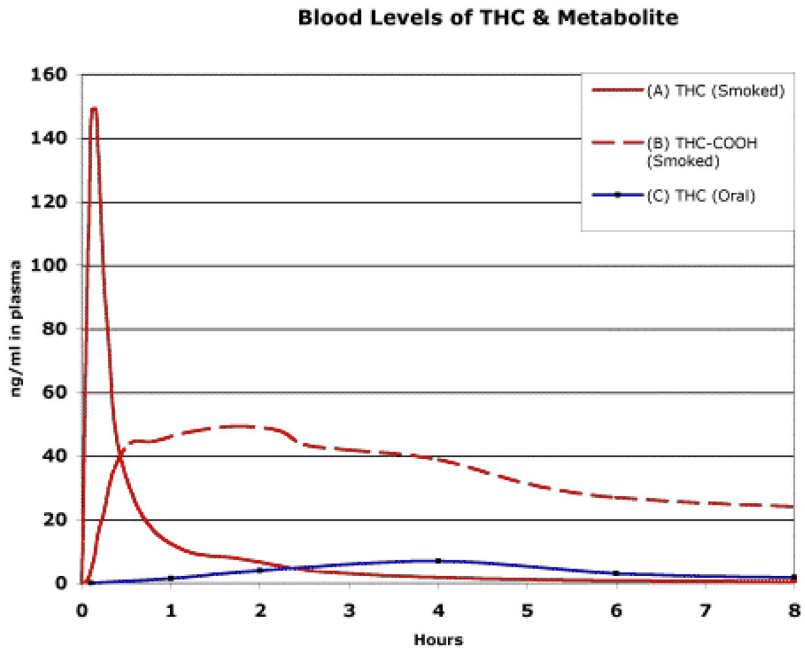
THC is not like alcohol

But marijuana's THC is unlike alcohol chemically, biologically, and metabolically. As a result, what works for alcohol does not necessarily work for THC. There is no level of THC in blood above which everyone is impaired and below which no one is impaired. This is not due to a lack of research. It is due to chemistry and biology. It is not due to politics. It is due to science.

Neither THC nor alcohol impair blood, breath, urine, or oral fluid. These drugs impair the brain. We test for alcohol in blood as a surrogate for testing the brain. Blood tests are very easy, and breath tests are even easier. Testing the brain requires an autopsy which is far less convenient, to say the least. For alcohol, blood is an excellent surrogate because it is a small water soluble molecule that rapidly establishes a concentration equilibrium in highly perfused tissues throughout the body.

For some drugs, especially marijuana's THC that is of great popular concern, blood is a terrible surrogate to learn what is in the brain. That is because THC is not highly soluble in blood. THC prefers fatty tissues like the brain, heart, lungs and liver. THC is quickly removed from the blood stream as it is absorbed into the brain and other fatty organs and tissues. Even though the metabolic half-life of THC is estimated to be over four days, more than 90% of THC is cleared from blood within the first hour after smoking marijuana (Huestis et al. 1992 ; Toennes et al. 2008). See Figure 1. Furthermore, that clearance rate is so highly variable from one individual to another than retrograde extrapolation to estimate blood levels of THC at a prior time cannot be done reliably, as is commonly done with alcohol. One study showed that on average, 73% of THC was cleared from blood within the first 25 minutes after smoking marijuana. But that number ranged from 3% to 90% from one subject to the next (Hartman, Brown et al. 2016).

Figure 1



Why blood levels of THC are forensically meaningless

1. *We cannot test blood at the time of arrest or crash*

It typically takes slightly over an hour after a traffic stop before a blood sample is taken (Urfer et al. 2014). The time is even longer in cases of crashes that result in death or injury. The median time to draw blood in those cases is over two hours (Wood, Brooks-Russell and Drum, 2016). And if a warrant is required to draw blood, that time extends to well over three hours.

So even if we knew the THC blood level determined by forensic laboratories, this tells us absolutely nothing about the THC blood level at the time of the incident, whether that incident be a simple arrest or a crash that kills or maims innocent victims.

2. *Blood levels of THC are lower than brain levels of THC*

Mura compared THC levels in blood and in the brain in a series of autopies. There was more THC in the brain than in the blood in 100% of the subjects. Significant levels of THC was found in the brain even when none could be detected in the blood (Mura et al.2005).

So even if we knew the blood level of THC at the time of the incident, this would tell us absolutely nothing about the drug level of THC in the brain, the only place where it really matters.

3. *Tolerance results in varying levels of impairment at the same blood level*

Drug users say that they can build up a tolerance to some of the impairing effects of drugs. Build up of tolerance is indeed a factor for many drugs, including alcohol, but can be more pronounced with non-alcoholic drugs. Scientists have shown that heavy users of marijuana have fewer cannabinoid receptors in their brain than non-users. Heroin addicts on a methadone maintenance therapy can be unimpaired with a level of methadone in their body that would be lethal to someone that has not become habituated to it. But be aware that heavy users don't build up a tolerance to all of drugs' impairing effects. If they did, why would they continue using them?

So even if we knew the drug level in the brain, this tells us nothing about the level of impairment of the individual.

4. *Polydrug impairment renders individual drug per se levels meaningless*

Most drug-impaired drivers responsible for vehicular homicide and assault are polydrug users (Wood and Salomonsen-Sautel 2016). That is, they have at least two drugs in their bodies at the same time. Drug combinations act differently than drugs individually, sometimes with additive effects, sometimes with synergistic effects, sometimes with complementary effects. For example, use of both cocaine and heroin in the popular "speedball" combines cocaine's stimulant effect with heroin's depressant effect. Alcohol extends the "high" experienced by cocaine users. Whereas studies confirm that alcohol impairment is much more dangerous than marijuana impairment, the combination of the two has been shown to be far more dangerous than either drug separately. The combined effect is at least additive and may be synergistic (Robbe & O'Hanlon 1999). Colorado has had cases of impaired drivers testing below .05 BAC and relatively low levels of THC (3-8 ng/ml), who have killed or maimed innocent victims. Due to Colorado's laws, these drivers were not convicted of DUI.

So even if we knew that levels of drugs *individually* in someone's brain were likely too low to cause impairment, combinations of those drugs can be profoundly impairing.

Similar problems are seen with testing a driver's oral fluid, sweat, or breath, all techniques currently in development or in limited use in the case of oral fluids. One primary benefit of testing substances other than blood is the reduction in delay time to take a biological sample. Another is that they provide roadside drug presence results, rather than quantitative results many weeks later. All these developments merit further investigation and adoption in some cases, but they don't solve all the problems of blood testing. Some also introduce cross-contamination problems not seen with blood testing.

Proving drug impairment

The best way to prove drug impairment is to focus on measurements of drug *impairment*, rather than measurements of drug *levels*. After all, impairment is what we're worried about, not lab tests. Impairment kills and maims people. Unfortunately, impairment measures are more subjective than laboratory tests.

The most common impairment measures are Standardized Field Sobriety Tests (SFSTs), a battery of three tests given primarily to suspected drunk drivers to determine impairment. A trained officer looks for 18 different clues of impairment during the testing sequence. Using SFSTs, properly trained and experienced officers can discriminate between drivers above and below .08 BAC over 90% of the time, according to studies in California and Florida. Some of what might be termed failures in these studies may come from drivers who are impaired below .08 BAC, and some might come from drivers who are not impaired at levels above .08 BAC; tolerance is a very real factor with alcohol, just as it is with other drugs.

Although SFSTs are highly effective identifying and documenting alcohol impairment, they are less successful in doing the same for drug impairment. This shouldn't be too surprising, since alcohol impairment symptoms differ from THC impairment symptoms, and only two of the three SFST tests have shown a significant correlation with THC impairment. The International Association of Chiefs of Police is now studying possible modifications to SFSTs that might be more sensitive to drug impairment (Hartman, Richman et al. 2016).

Drug Recognition Experts, DREs, use a wider battery of tests to identify drug impairment and even to classify the type of impairment as coming from stimulants, depressants, opiates, hallucinogens, cannabinoids, inhalants, or dissociative anesthetics.

Nevertheless, DREs have their limitations also. Few officers can successfully complete the rigorous training and few law enforcement agencies can afford the expense of DRE training. The DRE process cannot be completed at the roadside, and during the lengthy time required to transport the driver to an evaluation location and to complete the evaluation, the driver's blood level of drugs and level of impairment diminishes. Currently, taking a blood sample is defined as the last step in the DRE process that typically takes 45 minutes. Individual responses to drugs vary. Combinations of drugs can mask some symptoms. These can lead to faulty conclusions. During a crash, both the impaired driver and innocent victims may be injured. Injuries can and do prevent officers from performing many kinds of impairment assessments. DREs are excellent, but neither they nor their tools can be perfect.

The above limitations of impairment assessments are part of what drives jurists to demand objective laboratory measures to either prove impairment or to establish a *per se* violation.

Drug *per se* laws – Zero Tolerance

The most accepted drug *per se* laws are those that set zero tolerance for any illegal drugs in drivers, sometimes including prescription drugs that are used illegally. After all, the drugs are illegal, they do impair drivers, so why should *any* level be tolerated in drivers, thereby imperiling public safety? Eighteen states have one form or another of zero tolerance DUID laws. The federal Department of Transportation imposes zero tolerance drug standards on all commercial drivers in the U.S. Why should amateur drivers be held to a looser standard?

Some legislators resist zero tolerance laws, claiming there is no evidence that any non-zero level of a drug causes impairment. This, of course, demonstrates their lack of understanding of the difference between a *per se* violation level, and a level that proves impairment. A zero tolerance *per se* level is established not because it proves impairment, but simply because it is sound public policy.

Drug *per se* laws – Almost Zero Tolerance

A variant of zero tolerance is to set a *per se* limit at or close to the limits of quantification of competent forensic laboratories. This, for example, is the approach taken by Nevada, Ohio, and Virginia. These three states have established *per se* levels for a panel of impairing drugs, selecting those levels based upon standard laboratory quantification skills, rather than upon levels that demonstrate impairment. Nevada and Ohio chose 2 ng/ml of THC in whole blood for their THC *per se* limit. Virginia does not include THC in its panel of *per se* levels.

England and Wales recently did the same thing by establishing drug *per se* levels for a panel of drugs using two different criteria. For illegal drugs, such as marijuana's THC, they set the levels based upon laboratories' quantification abilities. For THC that was 2 ng/ml. For legal prescription drugs, they set the *per se* levels based upon impairment levels chosen by a panel of experts. They did not include opioids in their panel, which have a wide range of impairment levels, depending upon the level of tolerance the patient has developed.

Drug *per se* laws – impairment-based

Although some variation on zero tolerance is the preferred way of meeting the demands for drug *per se* levels, Washington, Colorado and Montana have taken the scientifically invalid approach of establishing what they believe are *impairment*-based *per se* levels.

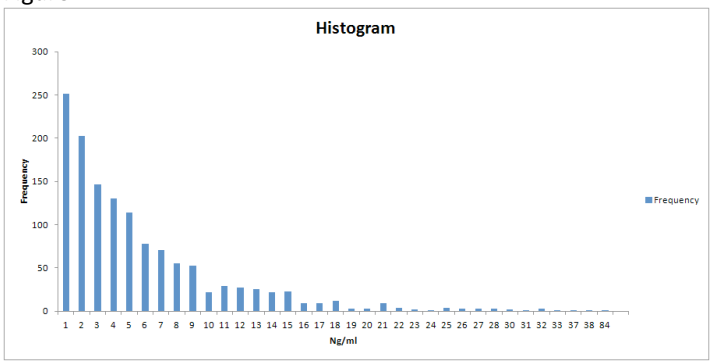
By ignoring all drugs other than marijuana, these states suggest a belief that drug-impaired driving is all about marijuana-impaired driving. Nothing could be further from the truth. For example, a court record study of Colorado's 2013 vehicular homicides and vehicular assaults due to DUI revealed that at least 30%, or 51 of those cases involved drugs. Yet only three of those cases identified marijuana as the sole intoxicant. The other 48 cases involved other drugs or more commonly combinations of drugs, the most common of which was alcohol combined with marijuana (Wood & Salomonsen-Sautel, 2016).

Colorado, Washington and Montana ignore the chemical, biological, and metabolic differences between drugs and alcohol. They ignore the fact that scientific evidence does not support *impairment*-based *per se* blood levels of drugs.

They are insensitive to the tragic consequences of passing a 5 ng/ml legal limit for marijuana's THC. These tragic consequences come from the fact that if the driver tests *below* 5 ng/ml, the prosecutor has an impossibly high hurdle to prove impairment. Few, if any, even attempt to do so.

Laboratories report that over 70% of all cannabinoid positive drivers arrested on suspicion of driving under the influence test *below* 5 ng/ml of THC. See Figure 2. With very few exceptions, these drivers will not be prosecuted for DUI. It's so difficult to prove impairment in the absence of a *per se* violation, and with so much of the jury pool believing (or perhaps hoping) that marijuana doesn't impair driving, it's simply a waste of judicial resources to prosecute this 70% of stoned driving cases.

Figure 2



Colorado Department of Health and Environment, 2012. 72% of the 2099 cannabinoid-positive cases below 5 ng/ml THC

As a result, any 5 ng/ml THC legal limit is simply a license to drive stoned.

Fallacies from 5 ng/ml THC supporters

1. *We wanted zero tolerance, but 5 ng/ml is a good compromise, isn't it?*

It's undeniably a compromise. But few believe it was a good compromise. Toxicologists who testified at Colorado's Drug Policy Advisor Committee advocated for zero tolerance, saying that a 5 ng/ml was so high that many impaired drivers would be missed (Elliott, 2011). The marijuana lobby advocated for a standard at 15 to 20 ng/ml so that residual THC in heavy marijuana users would not trigger a violation.

Colorado's 5 ng/ml "compromise" satisfied neither the public safety constituency or the marijuana lobby.

Only the following constituencies benefit from this poor compromise:

1. Stoned drivers who test below 5 ng/ml
2. Legislators who can convince poorly educated constituents that they did something.
3. In a 5 ng/ml *per se* state, prosecutors benefit by being able to notch prosecution victories without needing to prove impairment.

Although 5 ng/ml was certainly a compromise, only a handful can claim it was a good compromise.

2. *At least we'll convict 30% of stoned drivers. That's better than today, isn't it?.*

This claim for support for a 5 ng/ml law has many variants, including, "we wanted 2 ng/ml but at least we got something," or "it's better than nothing," and "we've got to start somewhere."

There may be merit to this argument, but we cannot know that without better data.

What is certain is that those drivers testing below 5 ng/ml will not be convicted of DUI, whereas at least in some cases, they were subject to conviction before passage of 5 ng/ml laws. For example, Stephen Ryan pled guilty to vehicular homicide due to DUI in Weld County, Colorado. Ryan's blood test result was 4 ng/ml THC, and no other impairing substance was found. His blood sample was drawn four hours after the crash that killed Tanya Guevarra and her infant son Adrian. This occurred before passage of Colorado's infamous 5 ng/ml THC permissible inference law.

Does a 5 ng/ml THC law convict more drivers of DUI than it exonerates? That's not likely since there are more stoned drivers testing below 5 ng/ml than those testing above 5 ng/ml. But we can't know the answer to this question unless we collect DUID data from citations through to judicial outcome, as is recommended by the Governor's Highway Safety Association (Hedlund, 2015). Few states do so, and so far, Colorado has refused to do so.

3. *We'll start with 5 ng/ml and then move down to a lower number, just like we did with alcohol.*

This idea is based more on wishful thinking than an understanding of the issues. Indeed, Indiana's first .15 BAC permissible inference law for alcohol has now morphed into a nationwide .08 BAC *per se* law. The politics behind that change was national shame over drunk driving led by Candace Lightner, who founded Mothers Against Drunk Driving after losing her daughter to a drunk driver. The science behind that change is the exponential relationship between relative crash risk and BAC level.

The case-controlled study that quantified the relationship between crashes and drivers' blood alcohol content was first done by Robert Borkenstein in 1962. His work has since been replicated and refined by other researchers who have been able to correct for potentially confounding factors such as gender and age. These early studies were done when alcohol was the only impairing substance of consequence found in drivers, making acquisition of test subjects relatively easy.

Performing similar studies for THC today could likely only be done with difficulty, since polydrug use in drivers is so prevalent, creating a whole new layer of confounding factors. Additionally, subjects for such a study would need to be confined to deceased drivers. Only THC blood test results from deceased drivers would reflect actual THC blood content at the time of the crash, rather than a dramatically lower THC concentration in surviving drivers resulting from metabolism and/or redistribution before a blood sample is taken.

But even if such a study were to be done, the results could not guide setting impairment-based *per se* levels, as has been done for alcohol. The above-noted dramatic and inconsistent decline in blood THC levels after smoking would prevent this. This is not a problem with alcohol. Delays incurred between a fatal or serious injury crash and collecting a driver's blood sample are such that, even if the driver had been smoking marijuana at the time of the crash, the level of THC of the tested blood could be not only below 5 ng/ml, but could be below a laboratory's limit of quantification (Wood, Brooks-Russell and Drum, 2016).

Carefully conducted experimental work using a sophisticated driving simulator found calculated THC blood levels that were equivalent to alcohol BAC levels of .05 and .08 BAC (Hartman, 2015). It is not known if the results are generalizable to different means of THC administration, different levels of THC potency, or different user experience levels. But even setting those questions aside, the authors cautioned that the results cannot be used to establish *per se* levels since THC levels at the time of an incident are much higher than those tested forensically.

Unless a means can be discovered to reliably perform retrograde extrapolation on laboratory-determined blood THC levels, it is difficult to see how any future epidemiological or experimental work could guide setting impairment-based THC *per se* levels, as was done with early alcohol *per se* levels. Without such scientific guidance, it is unlikely that once an impairment-based 5 ng/ml THC level is established, that it could be lowered.

<u>Conclusion</u>

Autopilot mentalities and a lack of scientific understanding are causing many state legislators to support scientifically-invalid 5 ng/ml THC *per se* laws. Such laws have the following flaws:

1. They are ineffective in dealing with marijuana-impaired drivers.
2. They victimize once again, victims of impaired drivers who test below this arbitrary level.
3. They ignore the more serious problem of alcohol combined with marijuana.
4. They set a bad precedent for how to deal with other drugs.
5. Their scientific invalidity discredits the credibility of our DUI laws.

Elliott M. Findings of the Marijuana DUID Workgroup. Colorado Drug Policy Task Force. Sept 6, 2011. http://www.leg.state.co.us/clics/clics2012a/commsumm.nsf/b4a3962433b52fa787256e5f00670a71/4b9e7f3447a29304872579b100713fa3/$FILE/SenState0227AttachB.pdf. Accessed May 3, 2016

Hedlund, J. Drug-Impaired Driving: A Guide For What States Can Do. Governors Highway Safety Association. 2015

Hartman, RL, Brown TL, Milavetz G, Spurgin A, Pierce RS, Gorelick DA, Gaffney GR, Huestis, MA. Cannabis effects on driving lateral control with and without alcohol. Drug and Alcohol Dependence (2015) In press. http://dx.doi.org/10.1016/j.drugalcdep.2015.06.015

Hartman, RL, Brown, TL, Milavetz, G, Spurgin, A, Gorelick DA, Gaffney, GR, Huestis, MA. Effect of Blood Collection Time on Measured Δ^9-Tetrahydrocannabinol Concentrations: Implications for Driving Interpretation and Drug Policy. Clinical Chemistry 62:2 367-377 (2016)

Hartman RL, Richman JE, Hayes CE, Huestis MA. Drug Recognition Expert (DRE) examination characteristics of cannabis impairment. Accident Analysis and Prevention 92 (2016) 219-229

Huestis MA, Henningfield JE, Cone EJ. Blood cannabinoids. I. Absorption of THC and formation of 11OH-THC and THCCOOH during and after smoking marijuana. J Anal Toxicol. 1992;16:276–282.

Mura P, Kintz P, Dumestre V, Raul S, Hauet T. THC Can Be Detected in Brain While Absent in Blood. Journal of Analytical Toxicology, 29 Nov/Dec 2005, 842-843

NHTSA FARS http://www-fars.nhtsa.dot.gov/Trends/TrendsAlcohol.aspx

Robbe, Hindrik W.J., O'Hanlon, James F. Marijuana/Alcohol Driving Study. DOT HS 808 939. 1999

Stough C, Boorman M, Ogden E, Papafoiou K. An evaluation of the Standardised Field Sobriet Tests for the detection of impairment associated with cannabis with and without alcohol. ISBN 0 642 47435 4

Toennes SW, Ramaekers JG, Theunissen EL,MoellerMR,KauertGF.Comparison of cannabinoid pharmacokinetic properties in occasional and heavy users smoking a marijuana or placebo joint. J Anal Toxicol. 2008;32:470–477.

Urfer S, Morton J, Beall V, Feldmann J, and Gunesch J. Analysis of Δ9-tetrahydrocannabinol driving under the influence of drugs cases in Colorado from January 2011 to February 2014. J Anal Toxicol. 2014;38:575–581.

Wood E, Brooks-Russell A & Drum P. (2016) Delays in DUI blood testing: Impact on cannabis DUI assessments, Traffic Injury Prevention, 17:2, 105-108, DOI: 10.1080/15389588.2015.1052421

Wood, E, Salomonsen-Sautel, S. Prevalence of DUID in Colorado's DUI Citations. Journal of Safety Research 57 (2016) 33-38. http://dx.doi.org/10.1016/j.jsr.2016.03.005