To: The Right Honourable Justin Trudeau, P.C., M.P., Prime Minister of Canada
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Brief in opposition to Bill C-46 House of Commons

Statistics Canada[1] reports that only 61% of drug OWI (Operation while impaired) cases are cleared by charge, compared with 81% of alcohol impairment cases. The time to complete a case was reported in 2015 to be 127 days for an alcohol case but 227 days for a drug case. These figures are prior to legalization of marijuana for recreational use which is not expected to improve the problem. Canada clearly must improve the way it deals with drug OWI.

C-46 proposes several improvements to OWI portions of the *Criminal Code.* C-46 also proposes to prepare for marijuana legalization by approving the use of oral fluid testing devices and establishing impairment-based drug *per se* limits to be defined by the Governor in Council.

Unfortunately, C-46 seeks to establish *per se* levels for drugs based upon a belief that the same kind of *per se* levels that have been successful in dealing with alcohol-impaired driving can work equally well with a range of drugs and drug classes. That belief cannot be supported by any scientific studies. In particular, cannabis is so unlike alcohol chemically, biologically and metabolically[2], that it is irrational to use a prescribed *per se* level for marijuana's Δ9-tetrahydrocannabinol (THC) as has been done successfully for alcohol.

The *per se* provision of C-46 perpetuates the myth that blood levels of Δ9-THC correlate with levels of impairment. The bill should be rewritten to support a tandem *per se* that can be supported by scientific research, as suggested in ¶ 7 which follows. Adoption of drug *per se* levels that cannot be scientifically supported threatens public credibility and acceptance of the law and can also prevent victims of impaired driving from seeing justice.

¶ 1A **The underlying premise of C-46 (impairment-based *per se* limits) is flawed**

George Smith pled guilty to drunk driving in London, England in 1897. Since then, countries around the world have employed technologies, law enforcement training, educational campaigns and stricter laws to eliminate impaired driving. Although these steps have not eradicated alcohol-impaired driving, they have moderated its prevalence. And just as important, drunk driving laws have ensured that victims of drunk driving see some semblance of justice when alcohol-impaired drivers who kill or maim innocent victims are convicted and appropriately sentenced.

Today, Canada relies upon blood and breath testing, plus the "driving while over 80" law to convict impaired drivers, since driving with a blood alcohol content above 80 mg/dl (milligrams of alcohol per 100 milliliters of blood) now carries the same penalty as driving while impaired.

These technologies and laws work reasonably well to deal with impaired driving cases *where alcohol is the only impairing substance* due to the following facts:

1. Alcohol leaves the body linearly and at a slow and predictable rate,
2. Levels of alcohol in blood are similar to levels in the brain, and
3. Blood levels of alcohol correlate very well with measured levels of impairment.

These facts are critical to the success of alcohol *per se* laws. Unfortunately, these facts are also unique to alcohol, don't always apply to other drugs, and don't apply at all to marijuana's THC.

1. Alcohol is cleared from blood linearly and at a slow and predictable rate; THC is not.

   An individual's blood alcohol level decreases as the alcohol is metabolized. Alcohol is metabolized in a straight line manner, typically at 10-30 mg/dl[3]. The median blood alcohol levels reported among drinking drivers in US fatal crashes is 140-160 mg/dl[4]. Therefore, most drinking drivers will still test above the 80 mg/dl limit if tested within two hours of the incident leading to the arrest for impaired driving. Even if the test is delayed beyond that time, retrograde extrapolation can be used to estimate the blood alcohol level at the time of the incident.

   On average, the maximum blood THC level is decreased by 73% from its peak level within 25 minutes of beginning to smoke a joint[5]. An individual's blood THC level decreases very rapidly not because it is being metabolized, but because the THC is being redistributed to highly perfused fatty tissues like the brain, liver, and lungs. The median time between first contact with a law enforcement officer and taking a blood sample is just over one hour in routine cases[6], two hours in cases of death or serious bodily injuries, and longer if a warrant is required[7]. Therefore, laboratory tests in impaired driving cases tell us <u>nothing</u> about the blood THC level at the time of the incident leading to the arrest for impaired driving. This is described more fully in ¶ 4.

2. Levels of alcohol in blood are similar to levels in the brain; this is not true for THC.
   This is important because alcohol does not impair blood; it impairs the brain. The same is true for marijuana's THC.

   We test blood levels for alcohol merely as a surrogate to learn what the alcohol level is in the brain, since testing the level in the brain requires an autopsy which at the very least is expensive and inconvenient. For alcohol, blood is an excellent surrogate to learn what is in the brain. Alcohol is a water-soluble molecule that rapidly establishes a concentration equilibrium across all highly perfused organs in the body. Therefore, the concentration in the blood is similar to that in the brain.

   Marijuana's THC is fat-soluble. It is very rapidly absorbed from the blood by highly perfused fatty tissues. Consequently, blood levels of THC tell us nothing about the levels of THC in the brain, which is the only place that really matters when trying to evaluate impairment. THC can even be found in the brain when none can be detected in blood[8].

3. Blood levels of alcohol correlate with levels of impairment; this is not true for THC.
   The dose-response affect of alcohol behaves as we would expect. As one drinks more alcohol in any given period of time, the blood alcohol level will rise accordingly. As the blood alcohol level increases, roadside sobriety test performance decreases, and the likelihood of causing a crash increases[9].

   There is a similar dose-response affect for marijuana's THC[10], but because of the above facts, that cannot be demonstrated with forensic blood levels. Forensically-determined blood levels of THC do not correlate at all with either brain levels of THC or impairment measurements. See ¶ 5 for confirmation and analysis.

¶ 1B **The underlying premise of C-46 is fundamentally flawed – additional issues**

- The nature of *per se* levels – exoneration of stoned drivers testing below the limit
  The beauty of *per se* levels is their lack of ambiguity; if you're above the limit, you're guilty of OWI *per se*, if you're below the limit, you're innocent of OWI *per se*. An impaired driver below the limit may still be prosecuted for OWI using an impairment theory, but that is quite difficult to accomplish and is therefore not commonly done.

  Most drivers arrested for driving under the influence of alcohol have a blood alcohol content well above Canada's alcohol *per se* limit of 80 mg/dl. Talpins reported in a study of 25,000 DUI arrest cases, only 11.5% tested below BAC .08 (80 mg/dl)[11].

  Blood THC limits are quite different. In Colorado, the median blood THC content of drivers arrested for DUI who were tested for drugs was reported to be 6.3 ng/ml[12], just slightly above the 5 ng/ml limit used in Washington and Colorado and the limit recommended for 320.14(1)(c). The vast majority of cannabinoid-positive drivers arrested for DUI who are drug tested have blood THC levels *below* 5 ng/ml. See Figures 1 & 2[13].

Fig. 1 Cannabinoid Positive Drivers
Impact of 5 µg/L THC *per se* Law

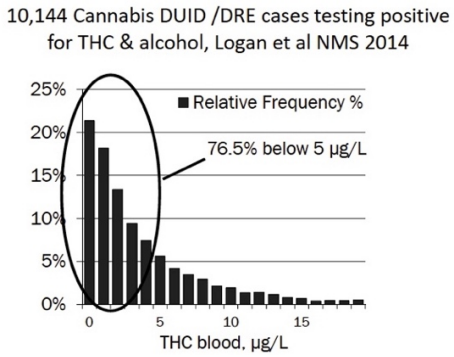
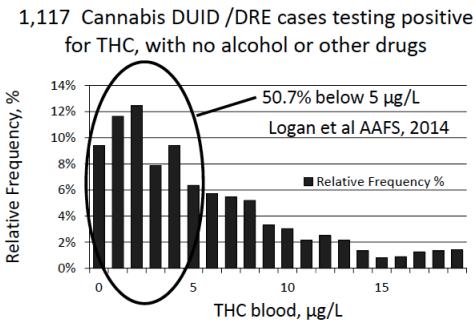


Fig. 2 THC-only Positive Drivers
Impact of 5 µg/L THC *per se* Law
National Medical Services Cases 5 yr



This means that the majority of stoned drivers arrested on suspicion of driving under the influence of drugs would escape OWI *per se* prosecution under a 5 ng/ml *per se* law, although they may be subject to administrative sanctions or summary offense sanctions if the 2 ng/ml limit were to be accepted for 320.14(4).

Having most stoned drivers escape prosecution may be an acceptable social policy for non-consequential OWI arrests, since it prevents those who merely drive unsafely from clogging up the court system. Unfortunately, many OWI arrests are for cases involving death or serious bodily injuries. Permitting the majority of those cases to escape prosecution is a miscarriage of justice that should not be tolerated. Victims should not be further victimized by a legal system.

- Two tier *per se* limits

  C-46 envisions two tiers of drug *per se* levels, Operation while impaired (Criminal Code 320.14(1)(c)) and Operation – low blood drug concentration (Criminal Code 320.14(1)(4)). This model is common for alcohol *per se* laws, for instance 80 mg/dl for impaired driving but 40 or 50 ng/dl for administrative sanctions, depending upon the province. Colorado has a BAC≥.08 *per se* limit for DUI, and a BAC≥.05 *per se* limit for DWAI (Driving While Ability is Impaired), sometimes referred to as a "baby DUI." For alcohol, this makes some sense because the level of alcohol in the blood correlates with the degree of impairment of the driver. A driver with a higher blood alcohol content is more impaired than one with a lower level, and stiffer sanctions are appropriate for such drivers.

  For THC, a two tier system makes no sense, because the level of THC in the blood has no correlation with the degree of impairment of the driver. Drivers with a blood THC content between 1-3 ng/ml can be just as impaired as one with a blood THC content above 20 ng/ml. See ¶ 5 for confirmation and analysis.

¶ 2 **DUID myths**

Myths firmly embedded in one's mind can prevent understanding and accepting the above facts, so let's deal with three of these major myths dealing with Driving Under the Influence of Drugs (DUID).

The myth of THC's persistence in the body

The ¶ 1 comments may appear fictitious to someone who has heard and believed that "traces of marijuana remain in the body for weeks after use." However:

- Marijuana doesn't enter the body, much less remain there. What does enter and remain for an extended period are the thousands of molecular entities extracted from the marijuana bud and then inhaled or ingested.
- The molecular entities of greatest reported interest are Δ9-tetrahydrocannabinol (THC) and 11-Nor-9 carboxy-tetrahydrocannabinol (carboxy-THC, or THC-COOH). THC is the principal psychoactive ingredient in cannabis, whereas carboxy-THC is the principal psycho-inactive metabolite of THC.
- Both THC and carboxy-THC do indeed remain in the *body* for weeks after consumption; but that doesn't mean that they remain in the *blood* that long. See Figure 3 in ¶ 4.
    - THC is rapidly removed from the blood as it is absorbed by highly perfused fatty organs like the brain, liver and lungs. THC stored in fatty tissues is gradually released back into the blood stream over time, but very gradually and at low levels. After a few hours, THC can be detected in blood only in heavy users that have built up substantial body stores of THC[14].
    - Carboxy-THC is water soluble and remains in both the body and the blood until it is removed by the kidneys and urine, or other metabolic processes. THC and its metabolites are primarily removed from the body in the feces, but a significant portion of carboxy-THC is also removed in the urine[15].
- The metabolism of THC is not a straight line process like alcohol. Its metabolism is best characterized by a half-life, like radioactive substances. The half life of THC is estimated to be about 4 days[16], so that about 10% remains in the *body* after two weeks; but because of redistribution to fatty organs and tissues, it is not in the *blood* for that long. See ¶ 4 for confirmation and analysis.
- Carboxy-THC is quickly eliminated in urine, and its metabolic half life is shorter than that of THC[17]. So if any carboxy-THC is found in the blood, that means that there is active THC remaining in the body, continuing to generate more carboxy-THC, even if no THC can be found in blood.

The myth of scientifically-determined *per se* levels

Many ask why "science" can't determine an impairing level of THC in the blood, just as was done for alcohol.

The above three facts in ¶ 1A that are unique to alcohol explain, in part, why that is so. But it is also important to realize that "science" never determined an impairing level of alcohol in blood.

Politicians determined alcohol *per se* levels, based upon scientific input and based on their society's tolerance for risk and values in personal freedom. That is why today we have alcohol *per se* levels around the world varying between 20 mg/dl to 100 mg/dl, all based on the same science.

The myth that cannabis makes one a better driver

This is a popular contention among some marijuana users, based more on wishful thinking than on data. Two very recent peer-reviewed papers should lay this myth to rest, at least for those with an open mind:

- Bondallaz[18] et al. performed a review published September 2016 analyzing worldwide publications identified by PubMed, Google Scholar and Web of Science databases, showing the overwhelming evidence that use of cannabis can impair safe driving skills. Of particular interest was the summary of DUIC (Driving Under the Influence of Cannabis) policies of 18 countries. Three types of policies were identified: impairment based (like Canada), Zero tolerance (like Switzerland and some US states), and Two-tier. Germany, France, Belgium and Finland are reported to have two-tier systems that combine *per se* limits with an impairment approach. See ¶ 7 for more on this approach.
- Li[19] et al. in 2017 reported an analysis of 14,742 culpable drivers and 14,742 nonculpable drivers in the same fatal two-vehicle crashes. Culpable drivers were more likely than nonculpable drivers to test positive for alcohol (28.3% vs 9.6%), cannabinoids (10.4% vs. 6.0%), and both substances (4.4% vs. 1.1%), all $p<.0001$, indicating a high level of significance. Relative to drivers testing negative for both alcohol and cannabinoids, the increased risk for causing a fatal crash while on marijuana was 62%, alcohol 437%, and both combined 539%. Marijuana, while deadly, is less so than alcohol, unless the two substances are combined.

¶ 3 What we don't know

There is a large body of peer-reviewed scientific research dealing with drug impaired driving in general and marijuana-impaired driving in particular. Some recent key findings are summarized below. But first, we must acknowledge some of the research limitations to date:

1. Most research has been conducted on cannabis with THC levels far below what is now commercially available. The THC potency of research-grade marijuana has rarely exceeded 8%, whereas it is difficult to find commercial marijuana less than 15% from today's drug dealers. Even higher grades are routinely sold and consumed that are above 20% THC concentration, and those are eclipsed by "shatter," "wax," and other forms of concentrates that are 60% THC and higher.

   The effect of low THC concentration research tests in a high THC concentration world is unknown. Colorado has begun to fund some research with high grade marijuana, but no results are yet available.

2. Most research has been conducted with smoked marijuana, and more recently vaped marijuana which appears to have similar results. Research on marijuana edibles is scant, but the results are very important for impaired driving policy since the intoxication and impairment response to edibles is slower than smoked marijuana. Furthermore, blood levels of THC from edibles are uniformly lower than blood levels of THC from smoked marijuana, rarely exceeding 5 ng/ml. See Figure 6 in ¶ 4.

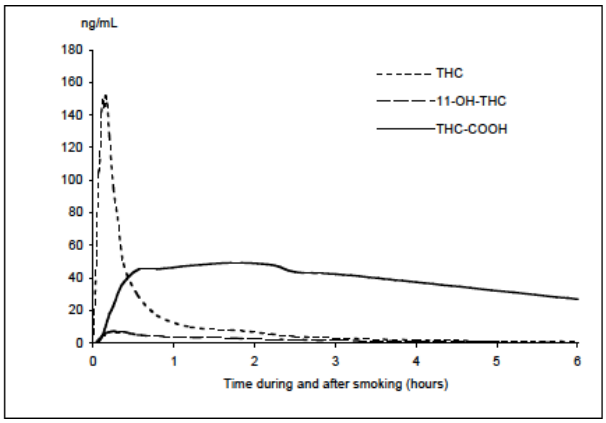
¶ 4 Why forensic blood tests have limited value

Hartman[20] tested 18 occasional marijuana smokers who received vaporized placebo, 2.9% or 6.7% THC marijuana. Blood THC levels were determined repeatedly during the process by use of

indwelling catheters. In the first 25 minutes after the start of active inhalation, THC decreased 73.5% (3.3%-89.5%). An hour later, only 9.7% (0% - 23.9%) of the maximum THC blood level could be detected.

This is consistent with earlier work showing the rapid decline in blood THC levels due to redistribution for both occasional users and chronic users. Note that Figures 3 & 4 show plasma or serum THC concentrations, not blood concentrations. To convert to an approximate equivalent blood concentration, divide by 1.7.

Fig. 3 Plasma concentrations from 6 subjects



Data from Huestis (1992)[21]

Fig. 4 Serum concentrations- chronic and occasional user

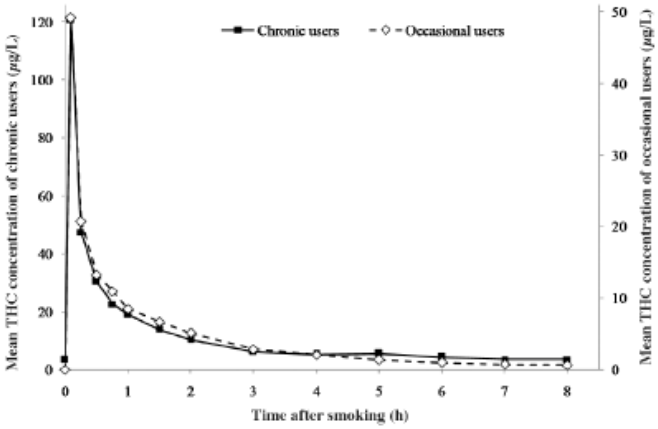


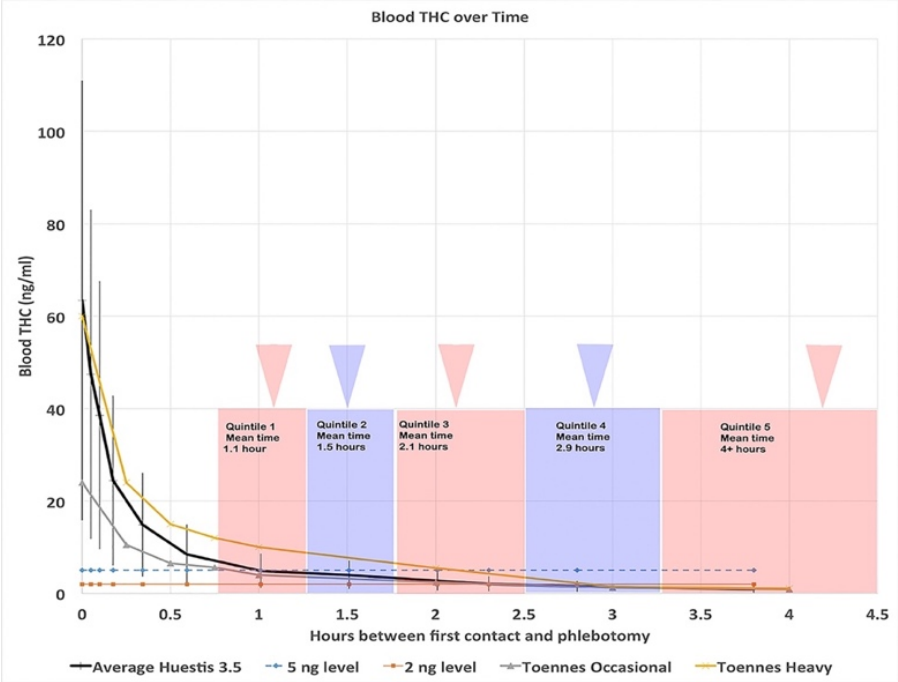
Figure 1. Overlay of the mean THC concentrations in occasional (n = 11) and heavy users (n = 12), each on a separate y-axis to normalize scaling.

Toennes et al (2008)[22]

Urfer[23] reported that in 2,323 cases tested for cannabinoids in Colorado, the median elapsed time between traffic stop and time of blood draw was 1.05 hours. Most of those cases were proactive traffic stops. Wood[24] studied all the vehicular homicide and vehicular assault cases in Colorado in 2012. The median time between dispatch of an officer to the scene of the crash and the time of blood collection was 2 hours. A study of similar cases in 2013[25] revealed that requiring a warrant extended the mean time to collect blood to over 3 hours.

Figure 5 superimposes the Fig 3 and Fig 4 data from Huestis and Toennes with the elapsed time to collect a blood sample data from Wood[26] in quintiles. So Figure 5 shows that in the theoretical worst case, for a driver smoking marijuana at the time of a crash, in over half of the cases the drivers would likely test below 5 ng/ml THC in whole blood – and that's for heavy users. The average level for occasional users is just 2 ng/ml.

Figure 5 Blood THC vs. time with superimposed time-to-collect quintiles



Whereas smoking or vaping cannabis results in a very rapid increase in blood THC levels followed by a very rapid decline as the THC is redistributed to fatty tissues, THC consumed as marijuana edibles enters the blood stream very gradually and never rises to the blood THC levels seen with smoked or vaped marijuana. Vandry[27] tested 18 subjects using three different doses (10, 25 and 50 mg) of THC edibles. A 10 mg dose is the standard recreational dose in Colorado. All subjects reported significant subjective "drug effect" that was positively correlated with blood levels of THC and two metabolites. None had a THC level above 3 ng/ml at any time during the test. See Fig 6. Compare users' subjective "high" ratings[28] over time to confirm the differences between oral and smoked marijuana. See Fig. 7

Fig. 6 Blood THC levels after consuming different doses of marijuana edibles

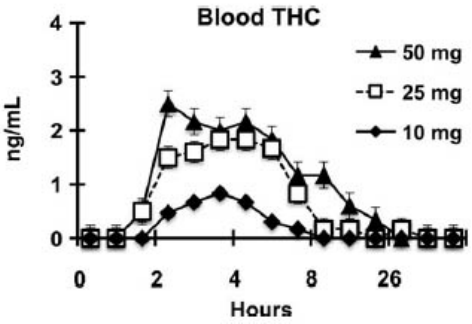
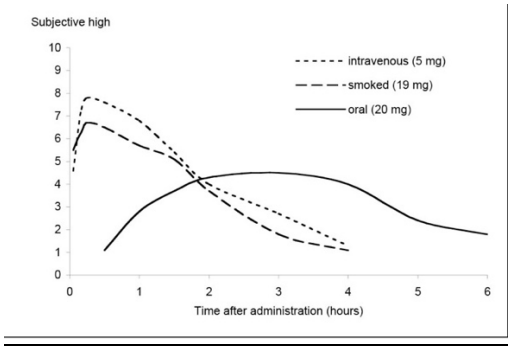


Fig 7 Subjective high from THC as a function of the mode of administration



¶ 5 Quantitative thresholds for drug impairment cannot be scientifically supported

The relationship between Blood Alcohol Content (BAC) and impairment has been well established, perhaps most convincingly by Robert Borkenstein in his 1964 Grand Rapids, Michigan study and the resulting Relative Risk curve, a version of which is shown in Figure 8. His study of 200 crashes of all types has been often replicated with similar results. Conducting a similar study for THC is difficult for the reasons described in ¶ 4. However, the European Union's DRUID project found no correlation between crash risk and blood levels of THC.

The European Union Driving Under the Influence of Drugs (DRUID) project[29] determined the following adjusted risks for being responsible for a fatal crash as a function of THC blood levels:

THC 1-3 ng/ml	OR 1.5 (1.0-2.3)
THC 3-5 ng/ml	OR 2.8 (1.4-5.6)
THC >5 ng/ml	OR 2.0 (1.2-3.3)

Fig. 8 Relative Risk of a crash vs BAC

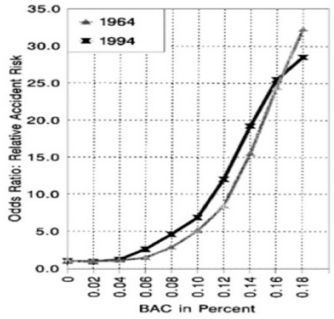
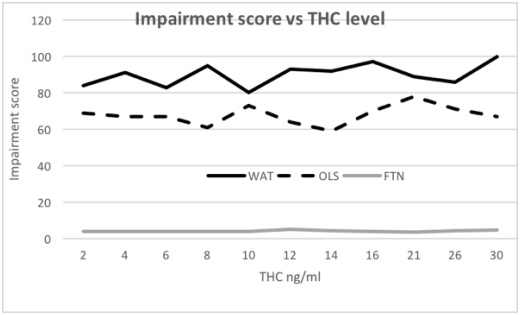


Fig. 9 Impairment score vs blood THC level



Of greater value are studies of several other impairment assessments versus blood THC levels. Declues,[30] for example, found no correlation between 3 commonly used field sobriety tests and blood THC levels. See Figure 9.

Logan[31] et al. compared DRE (Drug Recognition Expert) and laboratory assessments of 602 drivers arrested for DUI in which only THC was present, compared with 349 drug-free controls using a battery of 15 impairment assessments. Although there were clear differences in assessment results between those arrested for DUI and controls, none of the physiological, cognitive and psychomotor indicators could determine if a driver had tested above or below 5 ng/ml THC in whole blood. The authors concluded:

> "A quantitative threshold for *per se* laws for THC following cannabis use cannot be scientifically supported."

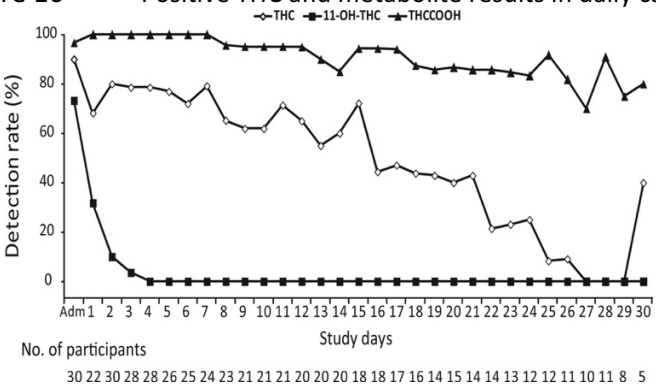
¶ 6 How do occasional users differ from chronic users?

Marijuana addicts and other heavy users frequently claim that they build up a tolerance to marijuana's impairing effects similar to tolerance to some of alcohol's impairing effects[32].

It is clearly true that frequent users maintain positive blood THC and THC-COOH concentrations for days and even weeks after last consumption. See Figure 10[33]. Occasional users maintain THC-COOH levels, but not THC levels, for an extended period of time. Chronic users may be less impaired than an occasional user at the same blood THC level, but whether or not they are unimpaired is an

unanswered question. Studies to determine development of tolerance to cannabis impairment have shown varied results, even studies done by the same scientific research team[34, 35, 36].

Figure 10 Positive THC and metabolite results in daily cannabis users after abstinence, LOQ .025 ng/ml



Development of tolerance is a principal reason that scientists caution, "while the idea of determining impairing drug concentrations is attractive, it is ultimately unattainable.[37]" As an extreme example, a 50 mg dose of methadone is potentially lethal to a naïve individual, but higher doses routinely given to heroin addicts on methadone maintenance treatment do not cause significant impairment.

But whereas users can develop tolerance for *some* of THC's effects, they don't develop tolerance for *all* of its effects. If they did, why would they continue using it?

The flip side of this issue is the observation that chronic users can become durably impaired and remain impaired even after several weeks of abstinence[38]. Therefore, studies using each subject as his own control will showing a lower impairment effect, and therefore higher tolerance than studies using naïve or occasional users as controls[39].

Per se standards should not be set to accommodate drug addicts at the expense of the public.

¶7 Recommendations

Statcan's data show the inadequacy of relying upon impairment-based OWI legislation[40]. This brief demonstrates the inadequacy of drug *per se* limits. What can work, however, is a combination of the two, which may be referred to as tandem *per se* legislation. Tandem *per se* requires a sequence of events to prove the crime of OWI *per se*. Using this approach, a person would be guilty of OWI *per se* under the following sequence of conditions:

- The driver was arrested by an officer who had probable cause, based on the driver's demeanor, behavior and observable impairment to believe that the driver was impaired; and
- Proof that the driver had any amount of an impairing substance in his/her blood, oral fluid, or breath.

The tandem *per se* approach is consistent with the recommendation of the American Automobile Association Foundation for Traffic Safety[41, 42]. It is similar to two-tier systems in place in Germany, France, Belgium and Finland[43].

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