

Are THC Concentrations Predictive of Psychomotor Impairment?

*Committee to Conduct an Interim Study Related to Driving Under the Influence of Marijuana
Las Vegas, NV*



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About NORML

- ▶ NORML is a non-profit advocacy organization
- ▶ NORML advocates for changes in law so that the responsible, private use of marijuana by adults is no longer subject to criminal or civil sanctions
 - ▶ NORML does not opine that cannabis is without potential risks, but maintains that these risks are best mitigated by legalization, regulation, and evidence-based public education
 - ▶ Regulations include: age limits, enforcement traffic safety laws, prohibitions on public use, etc.



NORML's Principles of Responsible Use

- ▶ Adults only
- ▶ No driving
 - ▶ *The responsible cannabis consumer does not operate a motor vehicle or other dangerous machinery while impaired by cannabis. ... Public safety demands not only that impaired drivers be taken off the road, but that objective measures of impairment be developed and used.*
- ▶ Set and setting
- ▶ Resist Abuse
- ▶ Respect the rights of others



Per Se Limits for THC/Carboxy-THC Are Uncommon

- While all 50 states impose *per se* limits for the presence of alcohol in blood, few impose similar standards for THC or other controlled substances
 - "The alcohol laws are based on evidence concerning the decreased ability of drivers across the population to function safely at these BACs. ... **Such evidence is not currently available for concentrations of other drugs.**" (NHTSA, [*Understanding the Limitations of Drug Test Information, Reporting, and Testing Practices in Fatal Crashes*](#), 2014)




Alcohol Possesses a Consistent PK Profile; THC Does Not

- Alcohol possesses linear, consistent absorption patterns
 - Greater ingestion correlates with higher BAC
 - Maximal BAC levels correlate with maximal impairment of performance
- THC does not share these characteristics
 - THC blood levels may be influenced by route of administration, past use history, THC potency, etc.
 - Maximal THC levels may not be consistently correlated with maximal impairment of performance




How Do Police Identify DUI-Marijuana Drivers?

- ▶ In most states, traffic safety (so-called 'effect-based) laws require evidence of recent drug exposure and demonstrable evidence of impaired performance
- ▶ A totality of available evidence is considered
 - ▶ Officer's observations
 - ▶ Defendant's admissions
 - ▶ Subject's FST performance
 - ▶ DRE observations
 - ▶ Toxicological assessment
 - ▶ Blood (typically) or urine




Is the Presence of THC in Blood Evidence of Impairment? What Do the Experts Say

- ▶ “Research studies have been unable to consistently correlate levels of marijuana consumption, or THC in a person's body, and levels of impairment. ... **[U]sing a measure of THC as evidence of a driver's impairment is not supported by scientific evidence to date.**”
(Congressional Research Service, [*Marijuana Use and Highway Safety*](#), 2019)




Is the Presence of THC in Blood Evidence of Impairment? What Do the Experts Say

- ▶ [B]ecause there is a poor correlation between $\Delta 9$ -THC bodily content and driving impairment, **the Commission recommends against the establishment of a threshold of delta-9-THC bodily content** for determining driving impairment." ([*Report of the Michigan Impaired Driving Safety Commission*](#), 2019)
- ▶ "A quantitative threshold for *per se* laws for THC following cannabis use cannot be scientifically reported." (AAA, [*An Evaluation of Data from Drivers Arrested for Driving Under the Influence in Relation to Per Se Limits for Cannabis*](#), 2016)



Is the Presence of THC in Blood Evidence of Impairment? What Do the Experts Say?

- ▶ **"There is no one blood or oral fluid concentration that can differentiate impaired and not impaired.** It's not like we need to say, 'Oh, let's do some more research and give you an answer.' We already know. We've done the research." ([Statement](#) of Dr. Marilyn Huestis, former Chief of Chemistry and Drug Metabolism, US National Institute on Drug Abuse, 2018)
- ▶ **"There is no direct correlation between driving impairment and THC concentration."** (Huestis and Hartman, 2013. [Cannabis effects on driving skills](#), Clinical Chemistry)



Is the Presence of THC in Blood Evidence of Impairment? What Do the Experts Say?

- ▶ "It is difficult to establish a relationship between a person's THC blood or plasma concentration and performance impairing effects. ... **It is inadvisable to try and predict effects based on blood THC concentrations alone**, and currently impossible to predict specific effects based on THC-COOH (metabolite) concentrations." (NHTSA. [*Drugs and Human Performance Facts Sheets*](#))



Is the Presence of THC in Blood Evidence of Impairment? What Does the Science Say?

- ▶ "One of the program's objectives was to determine whether it is possible to predict driving impairment by plasma concentrations of THC and/or its metabolite, THC-COOH, in single samples. The answer is very clear: it is not. Plasma of drivers showing substantial impairment in these studies contained both high and low THC concentrations; and, drivers with high plasma concentrations showed substantial, but also no impairment, and even some improvement." (NHTSA, *Marijuana and Driving Performance*, 1993)



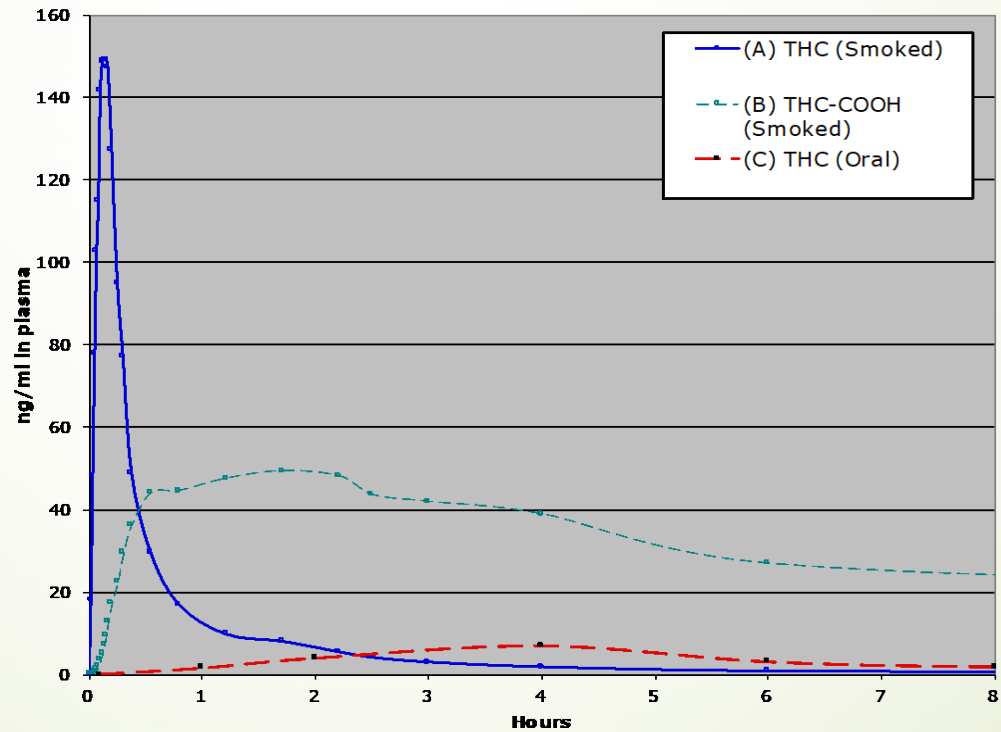
Why is the Presence of THC in Blood an Inconsistent Predictor of Impairment?

- ▶ Cannabinoids possess unique pharmacokinetics
- ▶ Residual THC levels may be present for extended periods of time following cannabis exposure absent any psychoactive effects
 - ▶ Not possible to delineate past exposure from more recent exposure
 - ▶ Back-extrapolation is not an option
- ▶ Habitual consumers become tolerant to drug effects

THC Possesses Unique Pharmacokinetics

- THC is metabolized differently depending on whether it is inhaled or orally consumed

Blood Levels of THC & Metabolite THC-COOH





THC Possesses Unique Pharmacokinetics

- ▶ Counter-clockwise hysteresis
 - ▶ In contrast to alcohol, peak THC/blood levels do not positively correspond with subjects' maximum degree of behavioral impairment
 - ▶ Acute cannabis impairment typically occurs some 20 to 60 minutes following cannabis inhalation, during which time THC concentrations in blood are rapidly declining



THC Possesses Unique Pharmacokinetics

- ▶ Residual THC levels may be present for extended periods of time following last exposure
 - ▶ THC is lipid soluble
 - ▶ THC may be redistributed from fatty tissues into the blood for several days following cannabis use
 - ▶ THC/blood levels may spike on subsequent tests even absent new use
 - ▶ Blood tests cannot distinguish between recent cannabis use and past use based on the presence of THC



THC Possesses Unique Pharmacokinetics

- ▶ “Substantial whole blood THC concentrations persist multiple days after drug discontinuation in heavy chronic cannabis users. ... These findings may impact the implementation of *per se* limits in driving under the influence of drugs legislation.” (Karschner et al., 2009. *Do THC concentrations indicate recent use in chronic cannabis users?* Addiction)



THC Possesses Unique Pharmacokinetics

- ▶ “In some subjects, THC was detectable in blood for several days. ... There were also subjects who showed a ‘double hump’ pattern with an initial fall in levels followed by a transient rise on the third or fourth day of abstinence. ... The high daily variation makes it challenging to interpret these [THC] levels in the usual forensic situation.” (Odell et al., 2015. *Residual cannabis levels in blood, urine, and oral fluid following heavy cannabis use*. Forensic Science International)



THC Possesses Unique Pharmacokinetics

- ▶ Back extrapolation is not feasible based on the presence of THC in a single blood sample
 - ▶ “**Back-extrapolation is not an option due** to the complex pharmacokinetic profile of THC.” (Willie et al, 2010. [*Conventional and alternative matrices for driving under the influence of cannabis*](#), Bioanalysis)
 - ▶ “**It is frequently impossible to differentiate occasional from chronic frequent cannabis use** when considering a single blood specimen.” (Huestis and Smith, 2018. [*Cannabinoid markers in biological fluids and tissues: Revealing intake*](#). Trends in Molecular Medicine)



Habitual Users Become Tolerant to the Acute Effects of Cannabis

- ▶ Literature review of “all human studies examining tolerance to the acute effects of cannabis ... or THC”
 - ▶ 36 studies, 1,047 participants
 - ▶ **“Overall, this review demonstrates that cannabis has less prominent or no effects on regular users. Also, the behavioral and physiological effects of cannabis lessen over repeated exposure and often become no longer distinguishable from placebo.”**
(Colizzi et al., 2018. [*Cannabis use and the development of tolerance: a systematic review of human evidence.*](#) Neuroscience & Behavioral Reviews)



Habitual Users Become Tolerant to the Acute Effects of Cannabis

- ▶ This tolerance is more pronounced in the domain of driving ability
 - ▶ “Experienced cannabis consumers who drive on a set course “**show almost no functional impairment** under the influence of marijuana.”
(Sewell et al., 2009. [*The effect of cannabis compared to alcohol on driving*](#), The American Journal on Addictions)



Patients Are Most Likely to Exhibit Cannabis Tolerance

- ▶ This tolerance is most significant in patients taking cannabis habitually to address a chronic condition
 - ▶ Subjects “who take cannabinoids at a consistent dosage over an extensive period of time often develop tolerance to the impairment of psychomotor performance, so that they can drive vehicles safely.” (Grotenhermen and Muller-Vahl, 2012. *The therapeutic potential of cannabis and cannabinoids.* Journal of the German Medical Association)



Patients Are Most Likely to Exhibit Cannabis Tolerance

- ▶ This tolerance is acknowledged by FDA
 - ▶ FDA: “Patients receiving treatment with MARINOL Capsules should be specifically warned not to drive, operate machinery, or engage in any hazardous activity **until it is established that they are able to tolerate the drug and to perform such tasks safely.**” ([FDA.GOV.](https://www.fda.gov/oc/ohrt/dronabinol-warnings), dronabinol – warnings)



Concluding Remarks

- ▶ Most states do not impose *per se* limits for cannabinoids
- ▶ Most experts in the field, including AAA and NHTSA, opine against the use of *per se* limits for cannabinoids
- ▶ Because of THC's lipid solubility and unique PK profile, the detection of THC in blood, regardless of quantity, is not necessarily indicative of either recent cannabis exposure or impairment of psychomotor performance



Public Policy Recommendations

- ▶ Nevada should abolish its arbitrary THC/carboxy-THC *per se* limits, as these thresholds are not evidence-based, and they may inadvertently lead to the criminal prosecution of those who are not impaired – particularly patients
 - ▶ At a minimum, an exemption to the *per se* limits should exist for state-registered patients mandating there be demonstrable evidence of impaired driving performance; such exemptions exist in other states




Public Policy Recommendations

- ▶ Prosecutors ought to move away from relying drug detection tests and instead promote the greater use of performance-based assessments
 - ▶ Modified FSTs – using measures validated for cannabis
 - ▶ More expansive DRE training – again, using validated measures
 - ▶ Handheld performance testing technology, such as DRUID, etc.



Public Policy Recommendations

- ▶ Public education/awareness campaigns
 - ▶ Provisional use of rapid response roadside drug detection testing, e.g. oral fluid testing or breath testing, which possess a more narrow detection time-frame (as long as such test results are not treated as *prima facie* evidence of impairment)
 - ▶ Enactment/enforcement of 'open container' prohibitions for cannabis
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Relevant Resources: Learn More

- Armentano. 2012. Cannabis and psychomotor performance: A rational review of the evidence and implications for public policy. *Drug Testing and Analysis* 5: 52-56.
- Armentano. 2013. Equating cannabinoid blood concentrations with actual driver impairment: practical limitations and concerns. *Humboldt Journal of Social Relations* 35: 41-51.
- Armentano. 2015. Are THC concentrations appropriate for presuming psychomotor impairment? In. Tiftickjian. Medicolegal Aspects of Marijuana: Colorado Edition. Tucson: Lawyers & Judges Publishing Company.
- NORML. 2017. Marijuana and Psychomotor Impairment fact-sheet: <http://norml.org/marijuana/fact-sheets/item/marijuana-and-psychomotor-impairment>



About Me

- ▶ Paul Armentano's writing and research on cannabis policy has appeared in over 1,000 publications, including in several peer-reviewed publications, and in over a dozen academic textbooks.
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