Pot, Psychomotor Performance, and Public Policy

Paul Armentano
Deputy Director
NORML | NORML Foundation
June 2, 2011
Aspen Legal Seminar

Acute Cannabis Intoxication May Impair Psychomotor Performance

- Changes in performance are typically dose-related

- Changes in performance are typically short-lived

    o 70 percent of subjects manifest psychomotor impairment 20-40 minutes following cannabis inhalation (Berghaus et al., 1998 as cited by Gieringer)

    o Peak acute effects following cannabis inhalation are typically obtained within 10 to 30 minutes (NHTSA. 2004. *Drugs and Human Performance Facts Sheets*)

    o "Experimental research on the effects of cannabis have produced mixed results indicating that any effects ... dissipate quickly after one hour." (NHTSA. 2003. *State of Knowledge of Drug-Impaired Driving: FINAL REPORT*)

Acute Cannabis Intoxication May Impair Psychomotor Performance

- Changes in performance are typically subtle

    o "No differences were found during the baseline driving segment (and the) collision avoidance scenarios. ... Participants receiving active marijuana decreased their speed more so than those receiving placebo cigarette during (the) distracted section of the drive. ... **[N]o other changes in driving performance were found**." (Anderson et al., 2010. *Sex differences in the effects of marijuana on simulated driving performance*)

    o "THC … has significant, **yet not dramatic**, dose-related impairing effects on driving performance." (Robbe. 1993. *Marijuana and actual driving performance: Final report for DOT*)

    o "In terms of road safety, it cannot be concluded that driving under the influence of cannabis is not a hazard. … **However, in comparison with alcohol, the severe effects of alcohol on the higher cognitive processes of driving are likely to make this more of a hazard**." (Sexton et al., 2000. *The influence of cannabis on driving: A Report Prepared for Road Safety Division, UK Department of the Environment, Transport and the Regions*)

Acute Cannabis Intoxication May Impair Psychomotor Performance

- Combining alcohol with cannabis may increase psychomotor impairment in a synergistic manner

    o "This study demonstrates that cannabis impairs driving ability in a concentration-related manner. The effect is smaller than for ethanol. **The effect of ethanol and cannabis taken simultaneously is additive**." (Bramness et al., 2010. *Impairment due to cannabis and ethanol: clinical signs and additive effects*)

    o "Experimental studies have shown alcohol and THC combined can produce severe performance impairment even when given at low doses. The combined effect of alcohol and cannabis on performance and crash risk appeared additive in nature, i.e. the effects of alcohol and cannabis combined were always comparable to the sum of the effects of alcohol and THC when given alone." (Ramaekers et al., 2004. *Dose related risk of motor vehicle crashes after cannabis use*)

Manifestations of Psychomotor Impairment Following Cannabis Use

- Increase in break latency (Ligouri et al., 1998. *Effects of marijuana on equilibrium, psychomotor performance, and simulated driving*)

- Increase in variability of lateral position (sdlp/weaving) (Robbe. 1993. *op. cit.*)

- Decreased performance in critical tracking test (eye-hand coordination) (Ramaekers et al. 2006. *Cognition and motor control as a function of Delta9-THC concentration in serum and oral fluid: limits of impairment*)

- Increased reaction time (Ronen et al., 2008. *Effects of THC on driving performance, physiological state and subjective feelings relative to alcohol*)

- Changes in peripheral vision, steadiness of speed, decision making

How Does Cannabis Impairment Differ From Alcohol?

- Less aggressive driving
    - "In contrast to the compensatory behavior exhibited by subjects under marijuana treatment, subjects who have received alcohol tend to drive in a more risky manner." (Smiley, 1999. *Marijuana: On-Road and Driving-Simulator Studie*s. In: Kalant et al. The Health Effects of Cannabis.)

- Slower speed
    - "After THC administration, **subjects drove significantly slower than in the control condition**, while after alcohol ingestion, subjects drove significantly faster than in the control condition." (Ronen et all., 2008. op. cit.)

- Increased distance between vehicles
    - "Coefficient of headway variation increased slightly following THC." (Robbe, 1993. op. cit.)

How Does Cannabis Impairment Differ From Alcohol?

- Overestimation of time
    - "While alcohol causes an underestimate of time, marijuana causes an overestimate of time" (NHTSA. 2003. op. cit.)

- Subjects are aware of their impairment and try to compensate accordingly
    - "*S]ubjects in the marijuana group were not only aware of their intoxicated condition, but were … attempting to compensate for it. These … findings … support … the common belief that drivers become overconfident after drinking alcohol and … that **they become more cautious and self-critical after consuming low doses of THC, as smoked marijuana**." (Robbe. 1993. op. cit.)

- Refusal to drive altogether
    - "The willingness to drive was influenced by the importance of the requested task. Under significant cannabinoids influence, the participants refused to drive." (Menetrey et al. 2005. *Assessment of driving capability … following oral administration of 20 mg dronabinol or of a cannabis decoction made with 20 or 60 mg Delta9-THC*.)

How Do LEOs Detect Suspected DUI Cannabis Drivers?

- Personal observations
    - erratic driving
    - smell of burnt marijuana in the vehicle
    - bloodshot eyes
    - marijuana in plain view
    - driver's admission of having consumed cannabis

How Do LEOs Detect Suspected DUI Cannabis Drivers?

- Field Sobriety Tests
    - "The results of this sobriety testing clearly show a strong correlation between cannabis dose received and whether impairment was judged to be present." (Sexton et al., 2000. op. cit.)

    - "*T]here was a positive relationship between the dose of THC administered and the number of participants classified as impaired based on the SFSTs. **These findings suggest that impaired performance on the SFSTs is positively related to the dose of THC administered and that the inclusion of HMJ [head movements or jerks] improves their predictive validity when testing for THC intoxication**." (Papafotiou et al., 2004*. An evaluation of the sensitivity of the Standardised Field Sobriety Tests (SFSTs) to detect impairment due to marijuana intoxication*)

## How Do LEOs Detect Suspected DUI Cannabis Drivers?

- "The percentage of participants whose driving performance was correctly classified as either impaired or not impaired based on SFSTs ranged from between 65.8 and 76.3% across the two THC conditions. **These results suggest that performance on the SFSTs may provide a moderate predictor of driving impairment following the consumption of THC**." (Papafotiou et al., 2004. *The relationship between performance on the SFSTs, driving performance and the level of THC in the blood*)

- "Overall, the roadside application of the Field Impairment Test demonstrated a sensitivity of 65%, a specificity of 77% and an accuracy of 66%, meaning that FIT identifies the majority of drug positive and drug negative cases. Consequently, **FIT in its current form is useable for screening purposes. However, further development is required to improve its performance**. … Finally, **there is no absolute definition of driving impairment nor is there an objective, validated method by which driving impairment (and FIT) can be assessed**." (Oliver et al., 2006. *Monitoring the Effectiveness of UK Field Impairment Tests*)

How Do LEOs Detect Suspected DUI Cannabis Drivers?

- DRE examination
    - Lack of convergence
    - elevated blood pressure
    - perception of time
    - pupil size
    - conjunctiva of the eye

- Toxicological exams
    - Blood test and/or urinalysis

Cannabinoid Pharmacokinetics

Blood Levels of THC & Metabolite THC-COOH
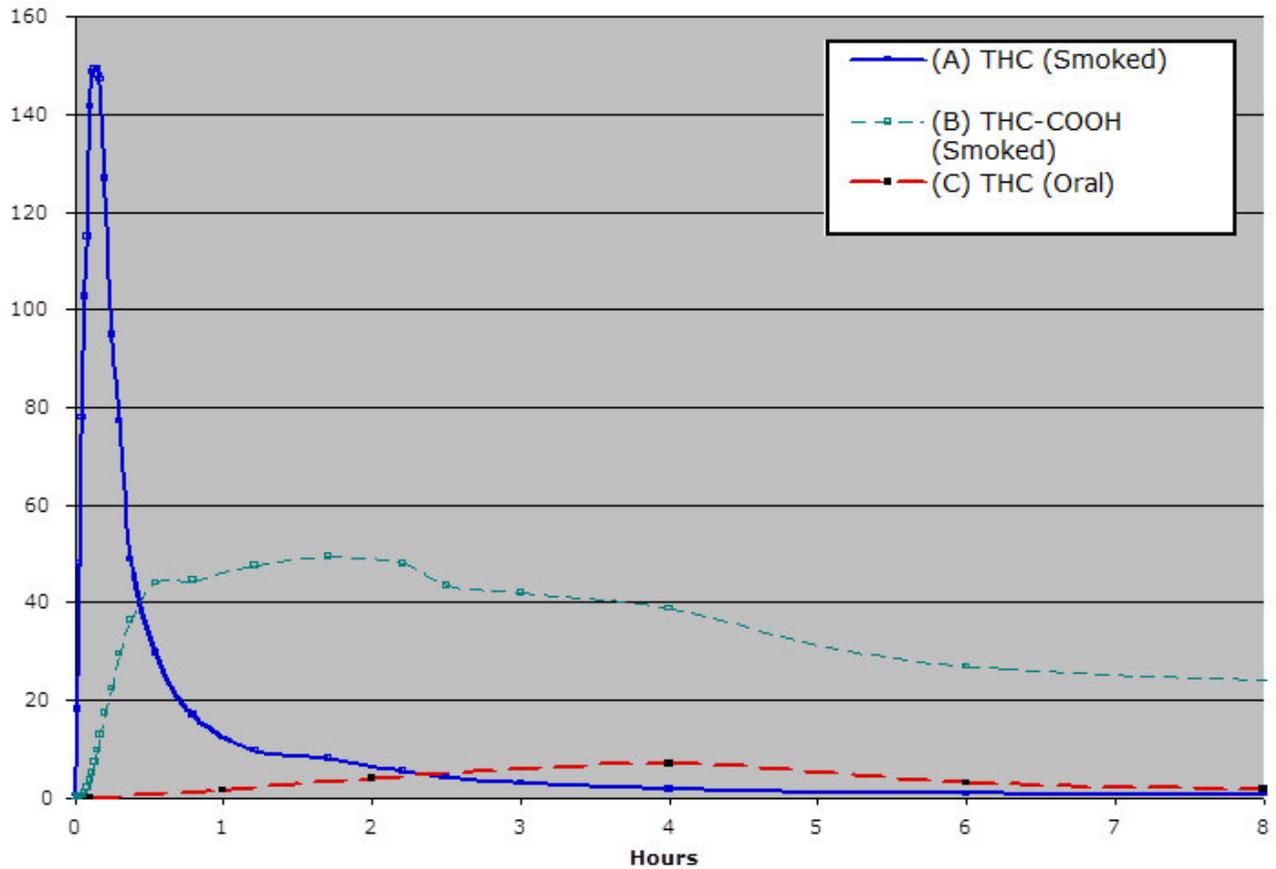
Cannabinoid Pharmacokinetics

- THC is the primary psychoactive component in cannabis
  - o Peak Blood/THC levels do not precisely correlate with peak of impaired cannabis performance

- THC is metabolized to 11-hydroxy-THC and carboxy THC
  - o 11-hydroxy-THC is psychoactive; has a relatively short half-life
  - o Carboxy THC is not psychoactive; has a relatively long half-life (especially in urine)
  - o **The presence of carboxy THC (especially in urine) is not associated with psychomotor impairment**
    - ▪ "*R]ecent cannabis use may increase crash risk, whereas, past use of cannabis as determined by the presence of THC–COOH in drivers does not." (Ramaekers et al., 2004. op. cit.)

What Are *Per Se* Standards?

- ***Per se* are levels of detection, not standards of behavioral impairment**

- Violators of *per se* laws are essentially guilty of internal possession, rather than their external behavior

  - o State does not have to prove actual impairment, only the presence of a certain substance in the body at a level above the statutory *per se* threshold

- Individuals can test below the *per se* cut-offs and still be charged with impaired driving

Experts Have Reached No Consensus RE: *Per Se* DUI Cannabis Standards

- "The most meaningful recent culpability studies indicate that drivers with THC concentrations in whole blood of less than 5 ng/mL have a crash risk no higher than that of drug-free users. The crash risk apparently begins to exceed that of sober drivers as THC concentrations **in whole blood reach 5–10 ng/mL** (corresponding to about 10–20 ng/mL in blood serum or plasma)." (Grotenhermen et al. 2005*. Developing science-based per se limits for driving under the influence of cannabis: Findings and recommendations by an expert panel*)

- "For drivers with blood THC concentrations of **5 ng/ml or higher** the odds ratio was greater and more statistically significant (OR 6.6, 95% CI 1.5–28.0). The estimated odds ratio is greater than that for drivers with a blood alcohol concentration (BAC) of 0.10–0.15% (OR 3.7, 95% CI 1.5–9.1)." (Drummer et al., 2004. *The involvement of drugs in drivers of motor vehicles killed in Australian road traffic crashes*)

Experts Have Reached No Consensus RE: *Per Se* DUI Cannabis Standards

- "Case-control studies are inconsistent, but suggest that while low concentrations of THC do not increase the rate of accidents, and may even decrease them, serum concentrations of **THC higher than 5 ng/mL** are associated with an increased risk of accidents." (Sewell et al., 2009. *The effect of cannabis compared with alcohol on driving*.)

- "A comparison of meta-analyses of experimental studies on the impairment of driving-relevant skills by alcohol or cannabis suggests that a THC concentration in the serum of 7–10 ng/ml [**3.5–5 ng/**ml in whole blood] is correlated with an impairment comparable to that caused by a blood alcohol concentration (BAC) of 0.05%. Thus, a suitable numerical limit for THC in serum may fall in that range." (Grotenhermen et al., 2007. *Developing limits for driving under cannabis*.)

Experts Have Reached No Consensus RE: *Per Se* DUI Cannabis Standards

- "Experimental and epidemiological study indicate that a legal limit for THC in the 7 to 10 ng/ml range (measured in blood serum or plasma, equivalent to **4 to 6 ng/ml in whole blood**) offers a reasonable separation of unimpaired from impaired drivers who may pose a higher risk of causing accidents." (Ramaekers. 2006. Commentary on Cannabis and Crash Risk: Concentration Effect Relation. In: *Transportation Research Circular E-C096: Drugs and Traffic*.)

- "The present data thus supports epidemiological data and shows that THC serum concentrations between **2 and 5 ng/ml** establish the lower and upper range of a per se limit for defining general performance impairment above which drivers are at risk. **It should be stressed, however, that the predictive validity of such a per se limit is confined to the driving population at large, and not necessarily applicable to each and every driver as an individual**." (Ramaekers et al., 2006. *Cognition and motor control as a function of Delta-9-THC concentration in serum and oral fluid: Limits of impairment*)

Experts Have Reached No Consensus RE: *Per Se* DUI Cannabis Standards

- "Experimental and epidemiological data also indicate that any scientific THC standards should be in the range of 2-10ng/ml in serum (i.e**. 1-5 ng/ml in whole blood**. Experimental data indicate that impairment emerges at serum THC concentrations >2 ng/ml , whereas epidemiological data indicates that crash risk emerges at serum concentrations between 4 and 10ng/ml **[2 to 5 ng/ml in whole blood**]. **It should be stressed however that the predictive validity of any per se limit is confined to the driving population at large, and not necessarily applicable to each and every driver as an individual."** (Ramaekers et al., *Dose related risk of motor vehicle crashes after cannabis use: an update*, in Vester et al., 2009. Drugs, Driving, and Traffic Safety)

Which States Have Enacted *Per Se* DUI Marijuana Standards?

- States with 'zero tolerance' per se DUI cannabis laws
  - Arizona** (state-licensed patients excluded), Delaware**, Georgia**, Illinois**, Indiana, Iowa, Michigan (state-licensed patients *not* excluded), Rhode Island (state-licensed patients excluded), South Dakota**, Utah**, Wisconsin (** indicates that THC *and* THC-COOH are referenced under the law; statutes may be found at: http://norml.org/index.cfm?Group_ID=6669)

- States with 'zero tolerance' *per se* DUI standards for illicit drugs *other than* cannabis
  - Minnesota, North Carolina, Virginia

- States with *per se* DUI marijuana statutes
  - Nevada (>2ng/ml THC/blood and/or >15ng THC-COOH/urine)
  - Ohio (>2ng/ml THC/blood and/or >15ng THC-COOH/urine)
  - Pennsylvania (>1ng/ml THC/blood)

- **In all instances, these statutory standards are arbitrary, non-scientific standards**

Nonetheless, Courts Have Upheld Enforcement Of *Per Se* DUI Marijuana/Drug Laws

- People v Derror (marijuana)
  - "Nor does *the statute+ require a defendant to be impaired while driving. Rather it punishes for the operation of a motor vehicle with any amount of a scheduled I controlled substance in the body. ... **That the statute might apply to some persons who are not actually 'under the influence' of [a controlled substance] does not render the statute unconstitutional**." *People v Derror, People v Kurts (**Michigan Supreme Court, June 21, 2006).*

- People v Martin (methamphetamine)
  - "In concluding that the statute was a reasonable exercise of the State's police power, we noted that **it creates an absolute bar to driving after ingesting a controlled substance, 'without regard to physical impairment**.' Indeed, while it is possible to determine scientifically the amount of alcohol that renders a driver impaired, it is not possible to do the same for drugs." *(**Illinois** Supreme Court, April 21, 2011)*

Practical Limitations Of Proposed *Per Se* DUI Cannabis Standards

- Lack of scientific consensus regarding what standards are appropriate
  - "In terms of attempting to link drug concentrations to behavioral impairment, blood is probably the specimen of choice. However, **forensic toxicologists generally have failed to agree on specific plasma concentrations that could be designated as evidence of impairment**." (NHTSA. 2003. op. cit.)
  - "It is clear that relating absolute levels of THC in blood to either subjective impairment effects or psychomotor effects on driving is complex. Ideally, there is a need to take several values over time, but this has rarely been done in assessments on driving skill." (Sexton et al., 2000. op. cit.)

- Wide variance among individual consumers
  - "Individual drivers can vary widely in their sensitivity for THC induced impairment as evinced by the weak correlations between THC in serum and magnitude of performance impairment." (Raemakers et al., 2009, op. cit)

Practical Limitations Of Proposed *Per Se* DUI Cannabis Standards

- Cannabis consumption impacts the psychomotor performance of naïve and experienced subjects differently
  - "THC did not affect performance of heavy cannabis users in the critical tracking task, the stop-signal task, and the Tower of London. These tasks have previously been shown to be very sensitive to the impairing potential of THC when administered to infrequent cannabis (users). **The lack of THC on these tasks basically confirms the previous notions that heavy cannabis users can develop tolerance to behaviorally impairing effects of THC**." (Ramaekers et al., 2010. *Tolerance and cross-tolerance to neurocognitive effects of THC and alcohol in heavy cannabis users*)

Practical Limitations Of Proposed *Per Se* DUI Cannabis Standards

- Presence of residual THC/blood levels in heavy users may confound proper interpretation

  o "On day 7, 6 full days after entering the unit, six participants still displayed detectable THC concentrations. ... The highest observed THC concentrations on admission (day 1) and day 7 were 7.0 and 3.0 ng/ml, respectively. ... Conclusions: **Substantial whole blood THC concentrations persist multiple days after drug discontinuation in heavy chronic cannabis users**. ... These findings also may impact on the implementation of per se limits in driving under the influence of drugs legislation." (Karschner et al., 2009. *Do Delta- 9-tetrahydrocannabinol concentrations indicate recent use in chronic cannabis users?*)

  o "A threshold of 2-3ng/ml THC as an indicator of recent drug use (i.e, smoking within the previous 6 hours) as recommended by Huestis et al appears to be valid only for occasional users. Heavy users might exhibit measurable cannabinoid concentrations in blood (median: 3.2ng/ml THC in blood serum), even if the last cannabis use was more than 24 hours ago. ... Therefore, **cannabinoid concentrations in heavy users' blood from a later elimination phase might not be distinguished from an acute use of an occasional user**." (Toennes et al., 2008. *Comparison of cannabinoid pharmacokinetic properties in occasional and heavy users smoking a marijuana or placebo joint*)
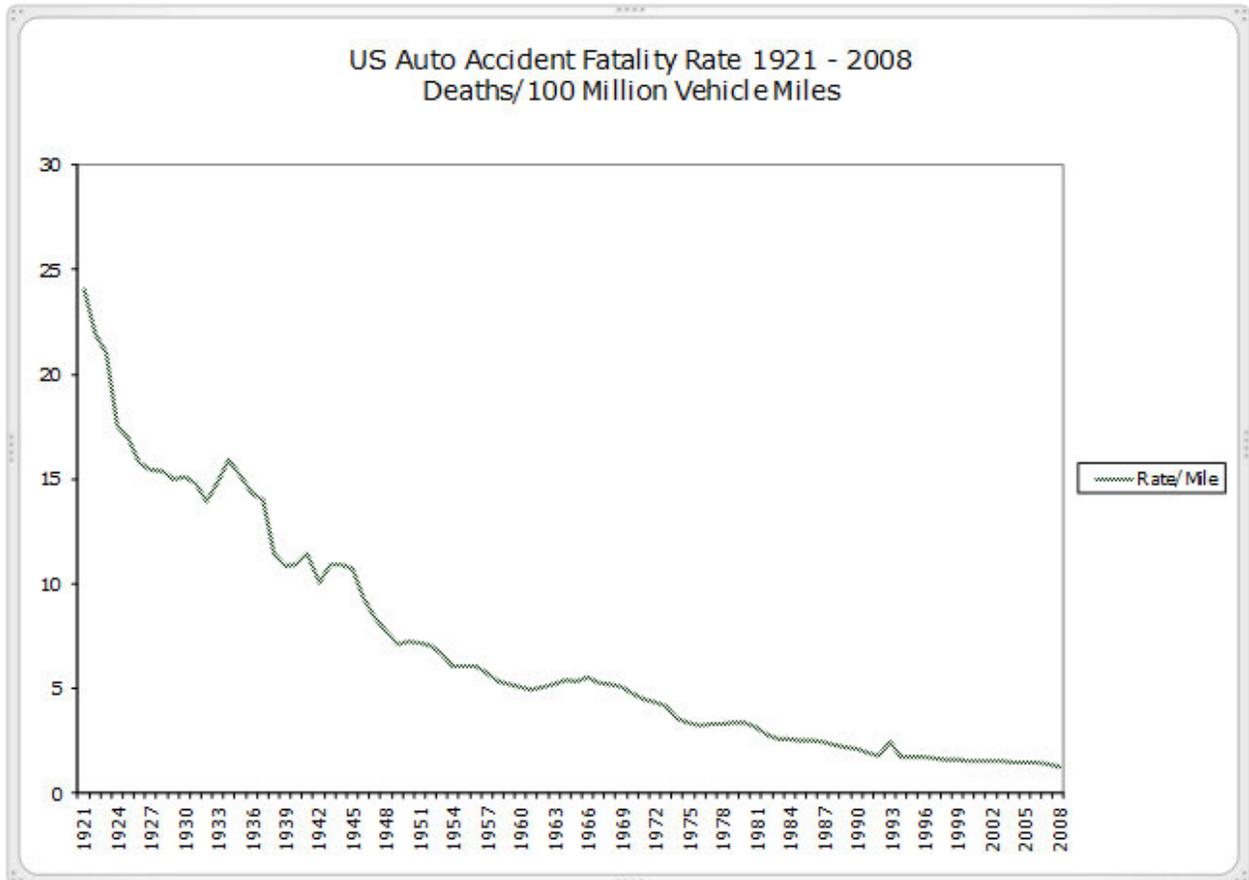
Practical Limitations Of Proposed *Per Se* DUI Cannabis Standards

- Estimated limits are based on retrospective, not prospective (e.g., Grand Rapids model) case-control studies
  - ○ "Our study is an epidemiological study including a control group of non-accident drivers selected randomly from the moving traffic flow. The key advantage of this study is that the control (non-accident) drivers were legally stopped, tested for drug use and compared with a representative group of seriously injured drivers. … In our study, **no association was found between exposure to cannabis and road accidents**." (Movig et al. 2004. *Psychoactive substance use and the risk of motor vehicle accidents*)

Practical Limitations Of Proposed *Per Se* DUI Cannabis Standards

- No practical way for LEOs to collect a blood sample in a time-sensitive manner
  - ○ "*I]n DUID cases, the delay between the accident and the final blood draw can be long and **back-extrapolation is not an option** due to the complex pharmacokinetic profile of THC." (Wille et al., 2010. *Conventional and alternative matrices for driving under the influence of cannabis*.)

- Enforcement of *per se* DUI cannabis laws do not deter incidences of DUI marijuana
  - ○ "**Zero-concentration limit[s] have done nothing to reduce DUID** or deter the typical offender because recidivism is high in this population of individuals. ... Indeed, many traffic delinquents ... are criminal elements in society with previous convictions for drunk and/or drugged driving as well as other offenses. The spectrum of drugs identified in blood samples from DUID suspects has not changed much since the zero-limit law was introduced." (Jones. 2005. *Driving Under the Influence of Drugs in Sweden with Zero Concentration Limits in Blood for Controlled Substances*)

Where's The Need?
Traffic Fatalities Are Falling While Cannabis Use Is Rising

US Auto Accident Fatality Rate 1921 - 2008
Deaths/100 Million Vehicle Miles

Where's the Need?
Fatal Accident Rates (Fatalities/100 mile) By State: 2008
Green=MedMj; Blue=Decrim

State	Rank	Rate	
Montana	1	2.12	
Louisiana	2	2.03	
South Carolir	3	1.86	
West Virginia	4	1.82	
Arkansas	5	1.81	
Mississippi	6	1.79	
Kentucky	7	1.74	
Wyoming	8	1.68	
Alabama	9	1.63	
Nevada	10	1.56	
Oklahoma	11	1.55	
Arizona	12	1.52	
Idaho	13	1.52	
Florida	14	1.5	
Tennessee	15	1.5	
Texas	16	1.48	
Missouri	17	1.41	
North Carolin	18	1.4	
New Mexico	19	1.39	
Georgia	20	1.37	
Pennsylvania	21	1.36	
Delaware	22	1.35	
South Dakota	23	1.35	
Iowa	24	1.34	
North Dakota	25	1.33	
Kansas	26	1.29	
Alaska	27	1.27	1.27
Oregon	28	1.24	1.24
Indiana	29	1.16	1.16
Colorado	30	1.15	1.15
Ohio	31	1.1	1.1
Nebraska	32	1.09	1.09
Maryland	33	1.07	1.07
Maine	34	1.06	1.06
New Hampshi	35	1.06	1.06
Utah	36	1.06	1.06
California	37	1.05	1.05
Wisconsin	38	1.05	1.05
Hawaii	39	1.04	1.04
Vermont	40	1	1
Virginia	41	1	1
Illinois	42	0.98	0.98
Michigan	43	0.96	0.96
Connecticut	44	0.95	0.95
Dist. Columb	45	0.94	0.94
Washington	46	0.94	0.94
New York	47	0.92	0.92
New Jersey	48	0.8	0.8
Rhode Island	49	0.79	0.79
Minnesota	50	0.78	0.78
Massachuset	51	0.67	0.67
USA		1.26	1.26

Practical Alternatives To Proposed *Per Se* DUI Cannabis Standards

- Better training/greater use of DREs

- Better development of cannabis-specific FSTs

- Greater public education

- Development of cannabis-specific POCT devices (e.g., oral swab testing)

- Possible enforcement of administrative, but not criminal, sanctions for violations of *per se* DUI cannabis

- **CONCLUSION: Proposed *per se* DUI cannabis proposals are a solution in search of a problem. They are laws of convenience, not efficacy.**

About Me

- Paul Armentano is the Deputy Director of NORML and the NORML Foundation. He has spoken at numerous national conferences and legal seminars, testified before state legislatures and federal agencies, and assisted dozens of criminal defense attorneys in cases pertaining to the use of medicinal cannabis, drug testing, and drugged driving. He has appeared as an expert witness in federal court on issues pertaining to the proper interpretation of drug testing examinations. He is a faculty member at Oaksterdam University in Oakland, where he lectures on the medicinal properties of cannabinoids, as well as on issues pertaining to workplace drug testing. In 2009, Mr. Armentano co-authored the book Marijuana is Safer: So Why Are We Driving People to Drink? (2009, Chelsea Green), which reached #14 on Amazon.com's best-sellers list and was selected by Publishers Weekly as one of "20 titles from independent presses that show big promise."

- paul@norml.org

Testimonials

- "My client and I were very appreciative of the assistance provided by Paul Armentano in a DUI case arising strictly out of the use of marijuana. Paul is extremely knowledgeable about the effects of marijuana and can obtain for counsel all of the important studies and research done in this developing area of the law. We were able to use the science provided by Paul to achieve a good result in our case" -- *Kristi Blazer, Esq. Missouri River Law Office, Craig, MT*

- "Mr. Armentano is a wealth of knowledge regarding the effects of cannabis on a person's motor skills. He is engaging, interesting and even-handed in his presentation on this topic. Mr. Amentano is able to back up his presentation with citations to important, relevant published articles concerning research in this area and recognizes both the possibilities and limitations that exist for the defense in these types of cases." -- *Craig M. Peters, Esq., Director of Training, Office of the Public Defender, San Francisco County, San Francisco, CA*

- "Thank you, Paul, for the breadth of information and reports you provided. I now … am much more prepared for my next marijuana DUI case. I would recommend Mr. Armentano for anyone seeking help in a marijuana DUI case."-- *Joy Hlavenka, Esq., Office of the Public Defender, San Bernadino County, San Bernardino, CA* "Thank you for your detailed, thoughtful analysis. DA offered … a fine only, no probation, nothing more. [Defendant] is beside himself with joy. … I cannot imagine doing a DUID pot case in the future without your input." --- *Leonard Frieling, Esq., Law Offices of Imhoff & Associates, Boulder, CO*

- "Thank you for your recent consultations … in regards to cannabinoids and driver impairment. Our client's charges have been dismissed. … I greatly appreciate the time you took to discuss this case and will most certainly keep you in mind for further use in cases of this type." -- *Raymond Sciarrino, Esq., Law Offices of Sciarrino & Sciarrino, Livingston County, NY*