Marijuana and DWI

Using Science to Cut Through the Smoke
Hello Mary Jane
Marijuana and Public Policy

- Between 25% and 60% of cartel profits come from Marijuana
  - RAND Corporation study vs. White House Office of National Drug Control Policy
- Warrantless stops, frisks and searches of people, cars and homes based on the smell of Marijuana have eviscerated the Fourth Amendment in poor and minority neighborhoods.
Summary

• 1 Pharmacokinetics of Marijuana
• 2 Measuring Marijuana in the Body
• 3 Measuring Impairment from Marijuana
• 4 Marijuana and Car Crash Risk
Cannabis in the Body
Route of Administration

- Smoking
- Vaporizing
- Ingestion of “edibles”
Meet the Marijuana Family

- The ‘Prodrug’: *Cannabis Sativa* and its cousin *Cannabis Indica*
- The ‘Parent Drug’: Δ-9-Tetrahydrocannabinol (THC) (The major psychoactive element of Marijuana)
- 11-OH-THC (Hydroxy-THC) (A psychoactive metabolite of THC)
- THC-COOH (Carboxy-THC) (An INACTIVE metabolite)
Marijuana in the Body (plasma levels)
Effects of THC
THC Effects

- “[The] spectrum of behavioral effects is unique, preventing classification of [cannabis] as a stimulant, sedative, tranquilizer, or hallucinogen.”
  - NHTSA, Drugs and Human Performance Fact Sheets
- Relaxation
- Euphoria
- Increased Appetite
- Delayed Reaction Times
THC - Recreational Dose Effects

- Relaxation
- Euphoria
- Relaxed inhibitions
- Sense of well-being
- Disorientation
- Altered time and space perception
- Lack of concentration, impaired learning and memory, alterations in thought formation and expression
- Drowsiness, sedation, mood changes such as panic reactions and paranoia
- More vivid sense of taste, sight, smell, and hearing.
Physiological THC Effects

- Dry Mouth
- Faster, Shallower Breathing
- Increased Pulse and Blood Pressure
- Red Eyes and Dilated Pupils
- Dizziness
- Decreased Sensitivity to Light
- Vasodilation (relaxation of blood vessels)
THC Metabolism - Smoked

• THC is metabolized quickly in the body.
• Smoking marijuana results in rapid absorption with peak THC plasma concentrations occurring prior to the end of smoking.
• Concentrations vary depending on the potency of marijuana and the manner in which the drug is smoked, however, peak plasma concentrations of 100-200 ng/mL are routinely encountered.
• Plasma THC concentrations generally fall below 5 ng/mL less than 3 hours after smoking.
• THC is highly lipid soluble, and plasma and urinary elimination half-lives are best estimated at 3-4 days, where the rate-limiting step is the slow redistribution to plasma of THC sequestered in the tissues.
  • NHTSA, Drugs and Human Performance Fact Sheets
Marijuana Metabolites - Hydroxy-THC

• 11-OH-THC or Hydroxy-THC is a psychoactive metabolite of THC, with effects similar to THC itself.

• “Peak 11-OH THC concentrations occur approximately 9-23 minutes after the start of smoking.”
  • NHTSA, Drugs and Human Performance Fact Sheets

• Hydroxy-THC is very short-lived, being rapidly metabolized into THC-COOH or Carboxy-THC (an INACTIVE metabolite).

• Like THC, Hydroxy-THC plasma levels often decline to less than 5 ng/ml at 3 hours after smoking.
  • NHTSA, Drugs and Human Performance Fact Sheet
Marijuana Metabolites - Carboxy-THC

- 11-nor-9-carboxy-THC (THC-COOH) is also known as “Carboxy-THC”.
- Carboxy-THC is NOT psychoactive, meaning it is NOT recognized to impair the “mental or physical faculties”.
- Carboxy-THC can persist in the blood for several hours, but its presence does not indicate impairment. Chronic users might show average plasma Carboxy-THC levels of 45 ng/ml at 12 hours after use.
- “It is currently impossible to predict specific effects based on THC-COOH concentrations.”
  - NHTSA, Drugs and Human Performance Fact Sheets (Revised April 2014)
Eating Marijuana

Blood Levels of THC & Metabolite

- (A) THC (Smoked)
- (B) THC-COOH (Smoked)
- (C) THC (Oral)

ng/ml in plasma vs Hours
THC Metabolism - Oral

- THC levels from oral consumption peak at 1-3 hours after dosing.
- Peak THC levels are lower than when smoking.
  - The intestines and liver metabolize significant amounts of swallowed THC before it reaches the bloodstream - ‘first pass’ metabolism.
- The peak tends to be flatter and wider than when smoking.
Marijuana Blood Results
Interpreting THC Blood or Plasma Results: What do they mean?

• “It is difficult to establish a relationship between a person’s THC blood or plasma concentration and performance impairing effects.”
• “Concentrations of parent drug and metabolite are very dependent on pattern of use as well as dose.”
  • NHTSA, Drugs and Human Performance Fact Sheets
• “It should be cautioned that cannabinoid blood concentrations from heavy users in a late elimination phase may be difficult to distinguish from concentrations measured in occasional users after acute cannabis use.”
  • Toennes Stefan W et al, Comparison of Cannabinoid Pharmacokinetic Properties in Occasional and Heavy Users Smoking a Marijuana or Placebo Joint, Journal of Analytical Toxicology, Vol 32, 9/2008 470-477
Whole Blood vs. Plasma Concentrations

- NOT the same thing!
- Plasma is blood with the blood cells removed - plasma is more concentrated and will show higher THC levels.
- Experiments suggest mean whole-blood/plasma ratios of 0.39 (0.28-0.48) for THC, 0.56 (0.43-0.73) for 11-OH-THC, and 0.37 (0.24-0.56) for THCCOOH.
- Make sure you know whether your result is from whole blood or plasma! Whole blood samples will show concentrations less than half that of plasma samples from the same blood draw.
- Most research is done with plasma, so be careful comparing those data with whole blood forensic samples in your cases.
Same Dose, Different People, Different Levels

• “Caution should be exercised in assuming that drug presence implies driver impairment. Drug tests do not necessarily indicate current impairment. Also, in some cases, drug presence can be detected for a period of days or weeks after ingestion”

No Retrograde Extrapolation with Marijuana: First-Order Kinetics (THC) vs. Zero-Order Kinetics (Ethanol)
Alcohol Elimination Curve

- Absorption Phase
- Elimination Phase
- Peak
- Alcohol Concentration
- Time
THC-COOH / THC Ratio for Time Estimate?

* Very General Rule of Thumb:
  * Ratio less than 1/1 = use within 30 minutes
  * Less than 2/1 = use within one hour
  * Less than 3/1 = use within two hours
  * Less than 4/1 = use within three hours
    * (Garriot et al. 1986)

* But remember, frequent users will have persistently high levels of THC-COOH even when they have not smoked for several hours. This will affect the ratio.
SFSTs and Marijuana

• “Drug impairment manifests itself much differently than alcohol impairment, and Standardized Field Sobriety Tests (SFST) have been proven to be insensitive in detecting impairment in chronic marijuana users.”
  
SFSTs Were Validated for Ethanol, Not Marijuana!
Consider a Rule 702 Challenge to SFSTs as Evidence of Marijuana Impairment!

- If the witness testifies that she used the SFSTs to assess impairment from Marijuana, use 702(a) to challenge whether:
  - (1) The testimony is based upon sufficient facts or data.
  - (2) The testimony is the product of reliable principles and methods.
  - (3) The witness has applied the principles and methods reliably to the facts of the case.

- Challenge probable cause to arrest based on SFSTs applied to a Marijuana case -
SFSTs and Marijuana cont.

“Taken together, the results indicated that the SFST were mildly sensitive to THC use in heavy users, probably because many of the participants have developed behavioral tolerance to THC-induced impairments. SFST were sensitive to low levels of alcohol in combination with THC as indicated by increments in the number of participants rated as impaired on HGN, OLS, and total SFST score.”


- This result was found even when the average serum THC level during the SFSTs was 13.4 ng/mL! (Equivalent of approximately 5.36 ng/mL THC in whole blood.)
What Findings do SFST / DRE Materials Associate with Marijuana Use?

- NOT HGN - DRE training says HGN is NOT present from THC alone.
- Dilated pupils (sometimes but not always)
- Lack of Convergence (can’t cross the eyes to focus on a close-in stimulus)
- Problems on One Leg Stand most often associated with THC impairment
- “Body Tremors” allegedly associated with THC
THC Effects on Driving

- Decreased car handling performance
- Increased reaction times
- Impaired time and distance estimation
- Inability to maintain headway
- Lateral travel
- Subjective sleepiness, motor incoordination, and impaired sustained vigilance
- BUT some drivers may actually be able to improve performance for brief periods by overcompensating for self-perceived impairment.
- The greater the demands placed on the driver, however, the more critical the likely impairment.
- Marijuana may particularly impair monotonous and prolonged driving. Decision times to evaluate situations and determine appropriate responses increase.
- “Mixing alcohol and marijuana may dramatically produce effects greater than either drug on its own.”
  - NHTSA, Drugs and Human Performance Fact Sheets
Marijuana and Crashes
Crash Risk and THC
Grotenhermen et al., *Addiction* 102:1910-17, 2007

**Figure 1** Correlation between delta-9-tetrahydrocannabinol (THC) concentration in whole blood and accident risk (odds ratio) calculated with the data of the study by Drummer et al. [12]
Crash Risk of Being Male and Young?
NHTSA Crash Risk Study Virginia Beach 2015

“The first large-scale case control study in the United States to assess the crash risks associated with both drug and alcohol use by drivers.”

- **Adjusted Odds Ratios Between Drug Class Use and Crash Risk (Adjusted for Demographic Variables: Age, Gender And Race/Ethnicity)**

<table>
<thead>
<tr>
<th>Drug of Interest</th>
<th>Adjusted Odds Ratio</th>
<th>95% CI*</th>
<th>P Value</th>
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</thead>
<tbody>
<tr>
<td>THC (Marijuana)</td>
<td>1.05</td>
<td>0.86 - 1.27</td>
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<td>Antidepressants</td>
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<td>Sedatives</td>
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<td>0.93 - 1.75</td>
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<td>Stimulants</td>
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<td>0.72 - 1.22</td>
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<td>Illegal Drugs</td>
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<td>0.88 - 1.23</td>
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<td>Legal Drugs</td>
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<td>0.84 - 1.27</td>
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<th>P Value</th>
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<td>THC (Marijuana)</td>
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<td>Narcotic Analgesics</td>
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<td>Sedatives</td>
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<td>Stimulants</td>
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<tr>
<td>Legal Drugs</td>
<td>1.02</td>
<td>0.83 - 1.26</td>
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## Contribution of Alcohol and Drugs to Crash Risk
NHTSA VA Beach Study 2015

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<tr>
<th>Drug and Alcohol Use</th>
<th>Adjusted Odds Ratio</th>
<th>95% CI*</th>
<th>P Value</th>
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<tr>
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<tr>
<td>No Alcohol / Positive Drug</td>
<td>1.02 0.88 - 1.17</td>
<td>0.83</td>
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<td>Positive Alcohol (&lt; 0.05) / No Drug</td>
<td>0.84 0.55 - 1.29</td>
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<td>Positive Alcohol (&lt; 0.05) / Positive Drug</td>
<td>1.03 0.55 - 1.94</td>
<td>0.93</td>
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<tr>
<td>Positive Alcohol (≥ 0.05) / No Drug</td>
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<td>&lt;0.0001</td>
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<tr>
<td>Positive Alcohol (≥ 0.05) / Positive Drug</td>
<td>5.34 2.75 - 10.37</td>
<td>&lt;0.0001</td>
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