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# Driving the Drug War: Difficulties with Proper Detection of THC and Measurement of Marijuana Intoxication for the Purposes of DUI Prosecution

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## ABSTRACT

The usage of marijuana has become more accepted in the United States over time. Thirty states have medical marijuana programs and nine states have legalized marijuana for recreational use. Politicians and public interest groups have widely debated the de-criminalization of marijuana use on the federal level. However, as with legalizing any mind-altering substance, there are issues that need to be considered. One of these issues is the arrest and prosecution of people driving under the influence of marijuana. There are several problems with efficient testing for tetrahydrocannabinol (THC), the primary psychoactive cannabinoid in marijuana. THC is fat soluble and can be stored in the fatty tissues of the body and released back into the blood in the days or weeks after consumption. In addition, THC levels in the blood and bodily excretions do not correlate directly to the level of intoxication or impairment. Due to these characteristics and others, there is currently no consistent and accurate way to test for marijuana intoxication. This paper will examine several of the tests that are currently used to test for marijuana intoxication: Blood, urine, and standardized field sobriety tests. This paper will also examine an emerging technology, called the "Marijuana Breathalyzer," which is claimed to detect the trace amounts of THC in breath. Finally, this paper will conclude that, to convict a person of DUI, the cumulative scientific evidence must be indicative of actual impairment.



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## INTRODUCTION & BACKGROUND

A forensic test that attempts to quantify marijuana intoxication for the purpose of DUI prosecution must be scientifically accurate. This is because a person who is arrested for driving under the influence of drugs or alcohol [hereinafter "DUI"] potentially faces devastating life implications. Some of the penalties for DUI are imposed before an individual has had the opportunity to address or refute the charge in a court of law. Administrative penalties, imposed by a state's Department of Motor Vehicles or its equivalent, are often based on an individual's failure of a roadside field sobriety test or refusal to take a sobriety test.[1] Though these administrative penalties vary by state, one of the most common of them is the temporary suspension of the individual's driver's license.[2] While many states may grant limited driving privileges for certain purposes, such as driving to and from work,[3] the suspension of a driver's license may still seriously affect an individual's employment and personal life. This penalty is

[1] *See, e.g. Driver Services: Driver Control*, ARKANSAS DEPARTMENT OF FINANCE AND ADMINISTRATION, https://www.dfa.arkansas.gov/driver-services/driver-control/ (last visited Oct. 3, 2018) (automatic six-month suspension, after administrative hearing upon request, for first-offense driving while intoxicated or refusal to take BAC test); *Driving Under the Influence (FFDL 35)*, CALIFORNIA DEPARTMENT OF MOTOR VEHICLES, https://www.dmv.ca.gov/portal/dmv/?1dmy&urile=wcm:path:/dmv_content_en/dmv/pubs/brochures/fast_facts/ffdl35 (last visited Oct. 3, 2018) (for first-time offenders, automatic four month suspension of driver's license for failure of chemical alcohol test and automatic one-year suspension for refusal to take a chemical test); *Connecticut's Drunk Driving Law: Operating Under the Influence*, CONNECTICUT DEPARTMENT OF MOTOR VEHICLES, https://www.ct.gov/dmv/cwp/view.asp?a=813&q=249562 (last visited Oct. 3, 2018) (automatic 45-day suspension of driver's license for failure of chemical alcohol test or refusal to submit to a breath, urine, or blood test); Ohio Department of Public Safety, *Alcohol and Drug-Related License Suspension*, OHIO BUREAU OF MOTOR VEHICLES, https://www.bmv.ohio.gov/susp-ad-als.aspx (last visited Oct. 3, 2018) (automatic 90-day to five-year suspension for failing a sobriety test and automatic one-five year suspension for refusal to take sobriety tests); Oregon Department of Transportation, *DUI Convictions: Suspensions, Hardship Permits, and Reinstatements*, DRIVER AND MOTOR VEHICLE SERVICES, https://www.oregon.gov/ODOT/Forms/DMV/6826.pdf (last visited Oct. 3, 2018) (automatic 90-day suspension of driver's license for failure of a breath or blood test and automatic one-year suspension for refusal to take a breath or blood test).

[2] *See supra* note 1 and accompanying text; *see also Alcohol-Impaired Driving*, GOVERNOR'S HIGHWAY SAFETY ASSOCIATION, https://www.ghsa.org/state-laws/issues/alcohol%20impaired%20driving (last visited Oct. 3, 2018) ("44 states, D.C., the Northern Mariana Islands and the Virgin Islands have administrative license suspension (ALS) on the first offense. ALS allows law enforcement to confiscate a driver's license for a period if he fails a chemical test.").

[3] *See Alcohol-Impaired Driving*, *supra* note 2.



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supplementary to any penalties that may be imposed by a court of law, which may include fines, long-term or permanent revocation of driver's license, or jail time.

These harsh penalties for drunken driving are a relatively new invention, stemming from a stringent anti-drunk-driving campaign by Mothers Against Drunk Driving [hereinafter "MADD"], an activist organization formed in 1980. MADD's campaign fought for the implementation of tougher drunk-driving laws.[4] Their campaign reframed the narrative of drunken driving in American culture, focusing on the potential tragedy surrounding drunk driving.[5] The campaign was successful, with states passing over 700 new drunk driving laws between 1980 and 1985.[6] Since the 1980s, alcohol-related traffic fatalities have been greatly reduced from 21,113 in 1982 to 10,497 in 2016.[7] In 2015, MADD updated its mission, stating that it would also "help fight against drugged driving."[8] In making this change, MADD wrote: "While research and evidence remains unclear into the impacts of drugged driving, we do know that the same tools and strategies that stop drunk driving will stop drugged driving, too."[9]

As MADD's statement suggests, detection and prosecution of drugged driving currently presents a serious political issue in the United States. This issue is exacerbated by the fact that many political and lobbying groups are pressing for the federal legalization of the psychoactive drug marijuana, both for medicinal and for recreational use. As of late 2018, thirty-one states and the District of Columbia have all legalized the use of marijuana for medicinal purposes. Thirteen

[4] Barron H. Lerner, *Drunk Driving, Distracted Driving, Moralism, and Public Health*, 365 NEW ENGL. J. MED. 879 (2011).
[5] Inge B. Schmidt, *Perpetual Trauma and Its Organizations: Mothers Against Drunk Driving and Drunk Driving Revisited*, 7 MEMORY STUDIES 239, 241 (2013).
[6] Lerner, *supra* note 4, at 880.
[7] National Highway Traffic Safety Administration, *Traffic Safety Facts 2016*, U.S. DEPARTMENT OF TRANSPORTATION (2018), https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812554.
[8] *Drugged Driving*, MADD, https://www.madd.org/the-solution/drugged-driving-prevention/ (last visited Oct. 9, 2018).
[9] *Id.*



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states have decriminalized marijuana,[10] and nine have legalized it for recreational use.[11] Given the potential for widespread use of marijuana in the United States in the future, a genuine question exists as to what regulations need to be placed on its use by drivers. Some argue that marijuana does not impair driving and does not need stringent regulation. Others believe that marijuana DUI laws should be as strict as current alcohol DUI laws. To fully understand the scope of this debate, and why it is important, one must understand what marijuana is, what its psychoactive effects are, and whether it causes impairment to the extent that those who take it should not be driving vehicles.

Marijuana is a mix of the dried leaves, stems, flowers, and seeds from the *Cannabis sativa* plant.[12] Marijuana is a psychoactive drug that is often consumed for its recreational or medicinal effects. The main psychoactive compound in the cannabis plant is $\Delta^9$-tetrahydrocannibinol [hereinafter "THC"],[13] a cannabinoid.[14] When THC is smoked or consumed, it produces several psychoactive effects. The experience depends on several factors, including individual physiology, dosage, and environment.[15] THC generally produces a "high," where users can feel lightheaded, euphoric, calm, and relaxed.[16] Other symptoms include lack of attention, focus, and vigilance,[17] poor retention of short-term memory,[18] impaired performance

[10] German Lopez, *The Spread of Marijuana Legalization, Explained,* VOX (last edited Aug. 20, 2018), https://www.vox.com/cards/marijuana-legalization/what-is-marijuana-decriminalization.
[11] Jeremy Burke & Skye Gould, *States Where Marijuana is Legal,* BUSINESS INSIDER (Oct. 17, 2018), https://www.businessinsider.com/legal-marijuana-states-2018-1.
[12] RICHARD R. COMPTON, MARIJUANA-IMPAIRED DRIVING: A REPORT TO CONGRESS 4 (2017), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812440-marijuana-impaired-driving-report-to-congress.pdf.
[13] *Id.*
[14] Leslie Iversen, *Cannabis and the Brain,* 126 BRAIN 1252, 1253 (2003).
[15] *Id.* at 1261.
[16] *Id.*
[17] *Id.* at 1257, 1259, 1261.
[18] *Id.* at 1257.



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on tests of balance and fine motor control,[19] drowsiness,[20] subjective enhancements of visual and auditory perception,[21] perception of time passing more quickly,[22] and increased appetite.[23] The subjective "high" and impairment peaks approximately 90 minutes after smoking,[24] though the levels may vary based on several independent factors.

While some claim that they "drive better while high," marijuana intoxication is moderately linked to poorer driving performance. A meta-analysis based on nine studies, including 49,411 participants in total, showed that there is twice the risk of motor vehicle collision for operators who are under the influence of marijuana.[25] Marijuana-intoxicated drivers can be aware of their impairments and are capable of attempting to compensate for perceived impairments.[26] For example, the car-following task, a task which requires that drivers maintain constant headway while following another car, is based on controlled information processing, making it easier for marijuana-intoxicated drivers to compensate for perceived deficits in their car-following while driving.[27] However, some impairments, such as those that relate to autonomic brain functions or rapid decision-making, cannot be compensated for. Marijuana most seriously impairs a driver's reaction times, ability to concentrate, ability to respond appropriately to urgent situations, and ability to track the position of other vehicles on the road.[28] Marijuana-

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[19] *Id.*
[20] *Id.* at 1261.
[21] *Id.* at 1258.
[22] *Id.*
[23] *Id.* at 1259–60.
[24] COMPTON, *supra* note 12, at 7–8.
[25] Percy Bondallaz et. al., *Cannabis and Its Effect on Driving Skills*, 268 Forensic Sci. Int. 92, 93 (2016) (citing Mark Asbridge, Jill Hayden & Jennifer Cartwright, *Acute Cannabis Consumption and Motor Vehicle Collision Risk: Systematic Review of Observational Studies and Meta-Analysis*, 344 BMJ 536 (2012)).
[26] *Id* at 95.
[27] *Id.* at 95, 100.
[28] *See id.* ("Reaction time measurement, divided attention tasks (DAT), critical tracking tasks (CTT), or the response to an urgent task appeared as mostly affected." (internal citations omitted)). The ability to track multiple moving objects is "thought to be integral to visual–motor coordination . . . and in the basic research, many have argued that



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impaired drivers also have inappropriate responses to emergencies, overblown reactions to sudden sounds, and take more time than sober drivers to respond to road signals and brake lights.[29] While studies often disagree on the actual degree of impairment that marijuana causes, especially considering the diminished effects of marijuana on heavy users,[30] there is demonstrated impairment to critical driving tasks and increased risk of accident, warranting that marijuana use by drivers be controlled.

## BODY

### A. The Current Standards for Marijuana DUI Prosecution

The standards for proving marijuana DUI in the United States vary based on applicable state laws. Some states, such as California, require that the state prove actual intoxication to impose criminal liability. The California Vehicle Code, § 23152(f), states that it is "unlawful for a person who is under the influence of any drug to drive a vehicle." Proof that the defendant had drugs in his or her system is not enough to prove DUI—the State must also prove that he or she was "under the influence."[31]As noted by the California Supreme Court, to be found guilty under § 23152, "the ... drug(s) must have so far affected the nervous system, the brain, or muscles [of the individual] as to impair to an appreciable degree *the ability to operate a vehicle*."[32] To meet

multiple-object tracking is critical to driving an automobile . . . ." Martin Lochner & Lana Trick, *Multi-Object Tracking While Driving: The Multiple-Vehicle Tracking Task*, 76 ATTENTION, PERCEPTION, & PSYCHOPHYSICS 2326, 2326 (2014).

[29] R. Andrew Sewell, M.D., et. al., *The Effect of Cannabis Compared with Alcohol on Driving*, 18 Am. J. Addict. 185, 187 (2009)

[30] *See, e.g,* Bondallaz et. al., *supra* note 25, at 95 ("Interestingly, other studies using [divided attention tasks] observed no significant differences after acute THC intoxication in a cohort of heavy chronic cannabis smokers, or even an improvement of daily cannabis users performances, suggesting an hypothetical adaptation to long-term cannabis exposure." (internal citations omitted)).

[31] This contrasts with § 23152(b), which establishes a *per se* standard, stating that it is unlawful for any driver to have a concentration of more than .08 alcohol in their blood, regardless of actual impairment.

[32] *People v. Canty*, 32 Cal.4th 1266, 1277 (Ca. 2004) (quoting *People v. Enriquez,* 42 Cal.App.4th 661, 665 (Ca. Ct. App. 1996)) (italics in original).



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this standard, California Police Departments train some police officers to become drug recognition experts and have the officers perform a twelve-step examination to assess an individual's level of actual impairment.[33] The officers perform standardized field sobriety tests, evaluate other physical signs, and occasionally instruct technicians to draw blood or collect urine for forensic analysis.[34]

Several states have established "per se" tests for marijuana DUI. Some give numerical limits, while others use "zero tolerance" tests. In Colorado, Illinois, and Montana, for example, a driver is *per se* intoxicated if he has more than 5ng/ml of THC in his blood.[35] Illinois law also states that a driver is *per se* intoxicated if he has have more than 10ng/ml of THC in his saliva or urine.[36] Fifteen states, such as Arizona, Delaware, Georgia, Indiana, and Pennsylvania, use zero tolerance standards.[37] Any amount of THC or its metabolites found in the blood and/or urine is considered a *per se* violation of the states' respective DUI statutes.[38] The states that use *per se* standards for DUI convictions rely heavily on forensic analysis. The states that require actual impairment may rely less so on forensic evidence to secure convictions, but forensic evidence may still be used to persuade the factfinder.

Reasoned decision-making in DUI cases must include an analysis of the accuracy and usefulness of the forensic tests. While the admissibility and use of tests depends on the state, there are three tests that are consistently used to prove intoxication both in and out of court: blood tests, urine tests, and standardized field sobriety tests (SFSTs). Breath tests have recently

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[33] James Queally & Sarah Parvini, *For Police, Catching Stoned Drivers Isn't So Easy*, L.A. TIMES (Mar. 22, 2018), http://www.latimes.com/local/lanow/la-me-ln-marijuana-dui-20180322-story.html
[34] *Id.*
[35] COL. REV. STAT. § 42-4-1301; 625 ILCS 5/11-501(a)(7), 11-501.2(a)(6); MO. CODE ANN. § 61-8-411.
[36] 625 ILCS 5/11-501(a)(6).
[37] COMPTON, *supra* note 12, at 15.
[38] AZ REV. STAT. § 28-1381(A)(3); 21 DEL. C. § 4177(6); 40 GA. C. § 40-6-391(6); 9 IN. C. ANN. § 9-30-5-1(c); PA. C.S. § 3802(d). *See also* COMPTON, *supra* note 12, at 15.



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gained popularity, perhaps due to their ease of use and their current widespread application to test for alcohol intoxication. This paper will examine the strengths, weaknesses, and practical applications of each of these four tests.[39] To facilitate understanding of the underlying reasons for these strengths and weaknesses, this paper will also provide a brief overview of the chemical structure of THC and its effects on the human body.

### B. Chemical Attributes of THC and THC's Effects on the Human Body

THC and other cannabinoids, such as the naturally produced endocannabinoid anandamide, exert their psychoactive effects primarily by binding to and activating the cannabinoid type 1 receptor [hereinafter "$CB_1$"], a neuromodulatory receptor in the brain and nervous system that is particularly abundant in the hippocampus, cortex, cerebellum, and basal ganglia.[40] $CB_1$ receptors generally modulate the release of neurotransmitters from axon terminals.[41] When THC attaches to and activates the $CB_1$ receptors, it inhibits the receptors' release of neurotransmitters.[42] The neurotransmitters whose release is inhibited by THC include "L-glutamate, GABA, noradrenaline, dopamine, 5-HT and acetylcholine."[43] Though THC has some form of inhibitory effect on dopamine, its use has been found to increase dopamine

[39] THC and its metabolites are also detectable in hair and stool. Hair is not commonly used to detect THC, likely because it is difficult to objectively quantify the consumption of marijuana with hair samples. *See* Michelle Taylor et. al., *Comparison of Cannabinoids in Hair with Self-Reported Cannabis Consumption in Heavy, Light and Non-Cannabis Users*, 36 DRUG ALCOHOL REV. 220, 225 (2017). Stool samples are not commonly used to test adults for THC, though the reason is unclear. Hospitals will occasionally test the meconium of newborn infants to determine if the infant was exposed to marijuana in-utero. *See, e.g.,* A. Chittamma et. al., *Detection of* In Utero *Marijuana Exposure by GC–MS, Ultra-Sensitive ELISA and LC–TOF–MS Using Umbilical Cord Tissue*, 37 J. ANALYTICAL TOXICOLOGY 391, 391 (2013) ("Immunoassays for detecting cannabis abuse determine $D^9$-THC and its metabolites in biological specimens such as . . . . meconium."). This paper will not explore the validity of these tests due to their lack of common use and popularity.

[40] Rachel I. Wilson & Roger A. Nicoll, *Endocannabinoid Signaling in the Brain*, 296 SCIENCE 678, 678 (2002).

[41] Iversen, *supra* note 14, at 1255.

[42] *Id.*

[43] *Id.*



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release.[44] As dopamine plays a key role in pleasure, reward, and behavioral reinforcement,[45] its increased release may be one of the main causes of THC's psychoactive effects.[46]

After THC is consumed, 90% of it binds to the plasma and 10% binds to the red blood cells.[47] Between 95-99% of the THC in the plasma binds to plasma proteins, the majority of which are lipoproteins.[48] THC is capable of rapidly penetrating vascular tissues such as the liver, lungs, and spleen, causing the THC in blood plasma to decrease relatively quickly after consumption.[49] The liver metabolizes THC with microsomal hydroxylation,[50] converting THC into the psychoactive 11-hydroxy-$\Delta^9$-tetrahydrocannabinol [hereinafter "11-OH-THC"].[51] Eventually, as the blood continues to circulate through the hepatic tissues, 11-OH-THC is further

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[44] *See, e.g.*, Erik Oleson & Joseph F. Cheer, *The Brain on Cannabinoids: The Role of Dopamine Release in Reward Seeking*, *2* COLD SPRING HARBOR PERSPECT. MED. 1, 1–3, 10 (2012) (finding that cannabinoids increase dopamine release, though the signaling reasons are unknown). *But see* Mohamed Sherif et. al., *Human Laboratory Studies on Cannabinoids and Psychosis*, 76 BIO. PSYCH. 526 (2016) ("[T]he HLS data remain mixed on whether cannabinoid-dopaminergic interactions are involved in the acute effects of THC . . . .").

[45] R.A. Bressan & J.A. Crippa, *The Role of Dopamine in Reward and Pleasure Behaviour – Review of Data from Preclinical Research*, 111 ACTA PSYCHIATR SCAND 14, 17 (2005) "[S]everal studies using animal models of reward and measuring the in vivo release of dopamine with microdialysis reveal that natural rewarding stimuli such as food, drink, sex and other pleasurable stimuli increase dopamine release in the nucleus accumbens.").

[46] *See, e.g.*, Oleson & Cheer, *supra* note 44, at 1 ("All known drugs of abuse, including $\Delta^9$-tetrahydrocannabinol, the primary psychoactive component of *Cannabis sativa*, increase dopamine concentrations in terminal regions of the mesolimbic dopamine system . . . . Increases in nucleus accumbens dopamine are theorized to mediate the primary positive reinforcing and rewarding properties of all known drugs of abuse.").

[47] Frank Musshoff & Burkhard Madea, *Review of Biologic Matrices (Urine, Blood, Hair) as Indicators of Recent or Ongoing Cannabis Use*, 28 THER. DRUG MONIT. 155, 156 (2006).

[48] *Id.*

[49] *Id.*

[50] Hydroxylation is the introduction of oxygen into an organic compound. RICHARD RENNIE, A DICTIONARY OF CHEMISTRY, *Hydroxylation* (7th ed. 2016). Oxygen degrades the organic compounds that it is introduced to. This hydroxylation is an important part of the liver's processing of certain toxins, since it makes toxic substances that are lipophilic more hydrophilic, and therefore more readily removed from the body by the kidneys. *See, e.g.*, Xinsheng Gu & Jose E. Manatou, *Molecular Mechanisms Underlying Chemical Liver Injury*, 14 EXPERT REV MOL MED 14 (2012). The liver performs hydroxylation using microsomes, vesicles containing enzymes that spur hydroxylation reactions. A DICTIONARY OF ZOOLOGY, *Microsome* (4th ed. 2014). Cytochrome P450 (CYP), contained in liver microsomes, is the main enzyme involved in the metabolization of THC. Kazuhito Watanabe et. al., *Cytochrome P450 Enzymes Involved in the Metabolism of Tetrahydrocannabinols and Cannabinol by Human Hepatic Microsomes*, 80 LIFE SCIENCES 1415, 1415 (2007). CYP P450 inserts one atom of oxygen into THC, converting THC, $C_{21}H_{30}O_2$, to 11-hydroxy-$\Delta^9$-tetrahydrocannabinol, $_{21}H_{30}O_3$.

[51] Musshoff & Madea, *supra* note 47, at 155–56.



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oxidized into the inactive 11-nor-tetrahydrocannabinol-9-carbolyxic acid [hereinafter "THC-COOH"].[52] This phase-II metabolism involves the addition of glucuronic acid, which improves the water solubility of the lipophilic THC and 11-OH-THC.[53] THC-COOH's improved water solubility assists the renal system with elimination,[54] though renal clearance of THC-COOH is still low due to the extensive protein binding of cannabinoids.[55] Because THC is lipophilic, it tends to accumulate in some less vascularized tissues, as well as in the body fat.[56] The THC in the vascular tissues and fat is released into the blood over time and metabolized in the same fashion, causing THC to have a lengthy half-life within the human body.[57]

### C. Tests Used for Detecting THC in the Body

Because of the unique characteristics of THC and the body's methods of metabolizing it, blood, urine, standardized field sobriety tests, and breath all have their own individual strengths and weaknesses in accurately analyzing whether someone has smoked marijuana and, if so, how much.

#### *i. Blood Tests*

Blood tests for THC have a selective advantage compared to urine tests, as blood plasma can contain both THC and THC's metabolites. THC peaks in the plasma approximately eight minutes after consumption, 11-OH-THC peaks at fifteen minutes after consumption, and THC-

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[52] *Id.*
[53] *See* Marilyn A. Huestis, *Humanoid Cannabinoid Pharmacokinetics*, 4 CHEM. BIODIVERS. 1770 § 2.3 (2009) ("Phase-II metabolism of THC-COOH involves addition of glucuronic acid . . . .Addition of the glucuronide group improves water solubility, facilitating excretion . . . .").
[54] *Id.*
[55] *Id.*
[56] *See* Huestis, *supra* note 53, at § 2.2 ("With prolonged drug exposure, THC concentrates in human fat, being retained for extended periods of time . . . ."); Musshoff & Madea, *supra* note 47, at 155 ("[THC] is rapidly assimilated after exposure, and because of its lipophilic nature is distributed to adipose tissue, liver, lung, and spleen. It is then slowly released back into the blood and metabolized, causing a relatively long terminal half-life.").
[57] *See id.* and accompanying text.



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COOH peaks at approximately 81 minutes after consumption.[58] By observing the levels of THC, 11-OH-THC, and THC-COOH in plasma from multiple samples taken at various times, one can potentially pinpoint the time of consumption and the amount of consumption.[59] In addition, blood tests for intoxicating substances already have a firm foothold in the United States legal system. All 50 states have a set .08% blood alcohol concentration [hereinafter "BAC"] as the legal limit for DUI, cementing BAC as the standard for determining intoxication. This legal standard also correlates with scientific standards, as a person's blood alcohol concentration directly correlates to his level of impairment.[60] As discussed *supra* Part A, several states have taken the example of the BAC legal limit and created *per se* limits of THC and/or its metabolites in the blood, perhaps due to the success and relative ease of using the BAC legal limit.

There are several problems with drawing a direct correlation between BAC and blood THC concentration [hereinafter "BTHCC"]. The first issue is a practical concern: Blood tests are invasive, expensive, and time-consuming, and require consent or a warrant to be administered.[61] In addition, BTHCC has a shorter window of significant detectability, which may pass during

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[58] Priyamvada Sharma, Pratima Murthy & M.M. Srinivas Bharath, *Chemistry, Metabolism, and Toxicology of Cannabis: Clinical Implications*, 7 IRAN J. PSYCH. 149, 157–58 (2012).

[59] Marilyn Huestis, Allan Barnes & Michael Smith, *Estimating the Time of Last Cannabis Use from Plasma $\Delta^9$-Tetrahydrocannabinol and 11-nor-9-Carboxy-$\Delta^9$-Tetrahydrocannabinol Concentrations*, 51 CLINICAL CHEM. 2289, 2290 (2005) (dosing thirty-eight test subjects with THC, testing their blood "2, 5, 10, 15, 20, 25, 30, 50, 70, 90, 110, and 235 min" after dosage, using predictive models to predict the time of last cannabis use using THC and THC-COOH levels, and determining that for the first cigarette, "combined models gave time estimates that were 99.1% accurate with no underestimates.").

[60] Nic Droste et. al., *Comparing Levels of Blood Alcohol Concentration and Indicators of Impairment in Nightlife Patrons*, 37 DRUG & ALCOHOL REV. S348, S351 (2018) ("[T]he sum of observable intoxication symptoms and levels of self- and interviewer-rated intoxication was positively associated with BAC.")

[61] The Supreme Court recently found that due to the intrusiveness of blood test on the privacy interest, warrantless blood tests that were taken without the presence of meaningful consent are unconstitutional under the Fourth Amendment. The Court also found that the State cannot impose criminal penalties for refusing a warrantless blood test. *Birchfield v. North Dakota*, 136 S.Ct. 2160, 2184, 2186 (2016).



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arrest, transportation, and processing,[62] unlike that of alcohol, which is metabolized at a constant rate and stays in a person's system longer the more he has drunk. The BAC can also be determined through a quick, portable breathalyzer test. Currently, there is not a quick, portable, and well-tested method to detect THC levels roadside.[63]

The second problem is that, while BAC's peak in a person's blood is directly correlated with his level of impairment,[64] the level of BTHCC is not. A person's peak impairment and a person's peak BTHCC are not directly linked.[65] Peak cognitive impairment can occur almost 90 minutes after smoking, after the consecutive peaks of THC and all of its metabolites in the blood plasma have been reached.[66] Given the fact that stopping a suspect, assessing his state, arresting him, processing him, and booking him can easily take more than 90 minutes, police are likely to be collecting blood samples that have long since passed the BTHCC peak. The implication is that, in practice, police could collect blood samples from persons who are extremely intoxicated from smoking marijuana, yet has very low levels of THC or its metabolites in their blood. This places a great burden on the police and the prosecutor, as a blood test showing a low level of THC can hinder their ability to make their case to the judge or the jury, even if they have other evidence of actual impairment.[67] In contrast, if the police manage to apprehend and process a person quickly, they can obtain a blood test that establishes a high level of THC or THC metabolites, even if the person tested was not objectively intoxicated while he was driving.[68] This creates a situation in which those who are less likely to be impaired could be convicted for

[62] The ideal window for detection of peak THC and its byproducts is, as discussed above, approximately 8–81 minutes. Sharma, *supra* note 58.
[63] *See infra* Part A.iv for a discussion of a new technology, the "Marijuana Breathalyzer," which attempts to serve this function for police.
[64] COMPTON, *supra* note 12, at 6.
[65] *Id.* at 7.
[66] *Id.* at 7–8.
[67] *Id.* at 29.
[68] *Id.* at 7 ("Peak THC level can occur when low impairment is measured . . . .").



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DUI more frequently than they should, and those who are more likely to be impaired could be convicted less frequently than they should.

Third, THC's fat solubility leads it to be absorbed into the body's fat cells and steadily released into the blood over time. The levels of THC that exist in the fat can build up with consistent use, with consistent marijuana users having significant amounts of THC stored in their fat.[69] THC tends to be redistributed into the blood passively and in small amounts, but can be redistributed into the plasma in larger quantities in conditions that promote lipolysis, such as starvation, stress,[70] or exercise.[71] In human fat biopsies, THC has been been observed up to 28 days after the final exposure to marijuana.[72] In a study of consistent marijuana users, both THC and THC-COOH were detectable in the blood plasma for up to thirty-three days after exposure.[73] While THC and THC-COOH levels were inconsistent from day to day, perhaps due to variability in individual lipolysis over the month-long study, two of the twenty-two subjects had .3 μg/L (or .3 ng/ml) of THC in their blood after 30 days, and one had .7 μg/L (.3 ng/ml) of THC-COOH in his blood after 33 days.[74] Of the blood samples from consistent users, 44% were THC-positive

[69] *Id.*

[70] One study administered daily injections of THC to rats and either administered ACTH, a hormone released in response to stress or deprived them of food. The researchers varied the amount of ACTH administered and when, the amount of time the THC was administered for, and the "washout period," among the various groups of rats in the study. Generally, the rats that were administered ACTH and the rats that were food deprived both had significantly increased blood THC concentrations compared to the control rats. Gunasekaran et. al., Reintoxication: *The Release*

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*of Fat-Stored D -tetrahydrocannabinol (THC) Into Blood is Enhanced By Food Deprivation or ACTH Exposure*, 158 British J. Pharmacology 1330, 1330–35 (2009).

[71] A study of regular cannabis users showed that moderate exercise increases THC blood concentration in regular marijuana users. Fasting for 12h did not increase THC blood concentration, though the researchers theorized that more extended fasts may increase lipolysis and cause higher concentration. Alexander Wong et. al., *Exercise Increases Plasma THC Concentrations in Regular Cannabis Users*, 133 DRUG AND ALCOHOL DEPENDENCE 763, 766–67 (2013).

[72] Eva Johansson et. al., *Determination of $\Delta^1$-tetrahydrocannabinol in Human Fat Biopsies From Marihuana Users by Gas Chromatography–Mass Spectrometry*, 3 BIOMED. CHROMATOGRAPHY 35, 38 (1989).

[73] Mateus M. Bergamaschi et. al., *Impact of Prolonged Cannabinoid Excretion in Chronic Daily Cannabis Smokers' Blood on Per Se Drugged Driving Laws*, 59 CLIN. CHEM. 519, 523 (2013).

[74] *Id.* at 522–23.



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through day 16,[75] and 85% of the samples were positive for THC-COOH through day 22.[76] Though the numbers observed were generally too low to meet the 5ng/ml thresholds established in some states, they would be sufficient to prove *per se* DUI in zero-tolerance states, and could be used as evidence of DUI in states that have not yet established specific numerical standards for marijuana intoxication. While researchers have stated that some subjects showed "persistence of THC impairment" throughout the study, the researchers' definition of "impairment" was based on *per se* limits that had been observed in earlier studies, not on observations of the subjects' actual impairment.[77]

These limitations do not necessarily mean that blood tests cannot ever be used as evidence for DUIs. As discussed earlier,[78] due to the body's methods of metabolizing THC, the presence of certain concentrations of THC, 11-OH-THC, and THC-COOH may be able to indicate approximately the time and amount of consumption. However, due to the limitations, it is difficult, if not impossible, to equate BTHCC with actual intoxication. For this reason, blood tests for THC or its metabolites should only be used as a supplement to other scientific tests and other evidence, not as sufficient evidence of impairment in and of themselves. This necessarily means that *per se* and zero tolerance statutes should not use blood tests to charge or prosecute DUIs, due to the potential for serious errors in their application.

### *ii. Urine Tests*

[75] *Id.* at 521, 523.
[76] *Id.* at 523.
[77] *Id.* at 524. *See id.* at 521, 524 ("Cannabinoid blood detection rates were calculated at the limits of . . . . lower range of a per se THC limit for defining performance impairment above which drivers are at increased risk for motor vehicle accidents . . . . However, additional research is warranted on . . . and the relationship between concentrations in blood and brain (the site of action of impairment).").
[78] See *supra* note 59 and accompanying text.



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Urine testing is the most common scientific method for detecting marijuana usage, both in the public and in the private worlds, as the test is noninvasive and the sample is generally easy to collect.[79] There are two potential ways of testing urine for drugs: screening tests, using immunoassay technology; and confirmatory tests, using gas chromatography/mass spectrometry.[80] Immunoassays use antibodies to detect drug metabolites, such as THC-COOH, that are present in the urine, though they are limited by the fact that some substances in the urine can have similar characteristics, possibly leading to false positives or negatives.[81] Confirmatory tests use gas chromatography/mass spectrometry to identify the specific chemical structures that are present in urine and to quantify the actual amounts of the metabolite in the sample.[82] The Department of Health and Human Services has a "cutoff concentration," requiring that a sample contain 50 ng/ml of THC-COOH in the immunoassay and 15 ng/ml in the confirmatory test to be considered positive for marijuana metabolites.[83] This is for the purpose of employee drug testing,[84] and does not apply to federal or state governments. In zero tolerance states that allow urine testing, for example, any amount of THC-COOH in the urine could hypothetically result in a DUI conviction.

One of the most controversial issues raised by testing for THC-COOH is its long detection window. Though studies have varied in their conclusions as to how long THC-COOH is excreted through the urine after consumption, it is commonly believed that THC-COOH can be excreted for a month or more. A fact sheet prepared for drug-court practitioners referred to

[79] Karen E. Moeller et. al., *Clinical Interpretations of Urine Drug Tests: What Clinicians Need to Know About Drug Screens*, 92 MAYO CLIN. PROC. 774, 775 (2017).
[80] *Id.*
[81] *Id.*
[82] *Id.*
[83] *Id.* at 775–76.
[84] *Id.* at 776.



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this window as the "30-plus day elimination assumption," which they described as a "widespread and longstanding" assumption held by judges, attorneys, and the public alike.[85] The fact sheet was critical of the 30-plus day elimination assumption, stating that "[s]tudy subjects with exceptionally long cannabinoid detection times (30-plus days) were just that—exceptional."[86] The fact sheet identified potential weaknesses in the studies that identified a 30-plus day detection window, including the use of chronic and heavy marijuana users as test subjects,[87] the use of outdated technologies that do not reflect the current capabilities of immunoassays,[88] a lack of monitoring subjects during testing, which may have allowed them to use marijuana while the study was being conducted,[89] and the use of cannabinoid cutoff concentrations that are lower than what a criminal justice program would use.[90] The fact sheet concluded that a 50 ng/ml cutoff level would be appropriate for chronic users, as it would be unlikely for 50 ng/ml of cannabinoids to appear in the urine longer than 10 days after smoking, and a 20 ng/ml cutoff for occasional or single-use users, as it would be unlikely for 20 ng/ml to appear in the urine longer than 7 days after smoking.[91] As for any potential "exceptional" cases, such as a person's extended and ongoing marijuana use over a period of years, the burden would fall on that person to prove such use and to demonstrate that such use led to an inaccurate portrayal of

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[85] Paul Cary, *The Marijuana Detection Window: Determining the Length of Time Cannabinoids Will Remain Detectable in Urine Following Smoking*, NATIONAL DRUG COURT INSTITUTE, at 1 (April 2006), *available at* https://www.ndci.org/sites/default/files/ndci/THC_Detection_Window_0.pdf.
[86] *Id.* at 7.
[87] *See id.* at 5, Table 5 (outlining "self-reported as chronic users" as a "[f]actor[] [p]otentially [a]ffecting the [r]elevance of [s]tudy [f]indings **"** for four academic studies).
[88] *See id.* at 6 ("[T]he results of cannabinoid elimination investigations performed in the 1980's may no longer be applicable to estimating the detection window for marijuana in urine using today's testing methodologies.").
[89] *See id.* ("The most serious of these obfuscating factors is the inability to assure marijuana abstinence of the subjects during the studies.").
[90] *See id.* ("Other study design issues that may limit their usefulness include the use of detection methods with cannabinoid cutoff concentrations far below those traditionally utilized in criminal justice programs . . . .").
[91] *Id.* at 9. Note that, though the fact sheet recommends these numbers, these are not requirements set by the legislature. The cutoffs can be much lower, or much higher, in court.



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intoxication.[92] To evaluate the argument that the fact sheet makes for the standards of marijuana urine testing, it is important to first consider the criticisms that it directs to the studies that came before it.

First, the fact sheet notes as a potential limitation that "[s]tudies of chronic marijuana users reporting prolonged cannabinoid excretion profiles have provided the basis for the common [30-day] assumption . . . ."[93] Though the majority of studies concerning testing for THC, including urine testing studies, appear to use chronic users or at least occasional users as test subjects,[94] that choice may not be inappropriate in evaluating the efficacy of testing for DUI purposes. In 2017, the Center for Behavioral Health Statistics and Quality surveyed 272,103 persons in the United States aged 12 or older.[95] Table 1 below shows the results of the survey.

| **Survey of Persons in the United States Aged 12 or Older** | |
|---|---|
| Used Marijuana in Entire Lifetime | 122,943 |
| Used Marijuana in the Past Year | 40,935 |
| Used Marijuana Daily or Almost Daily in the Past Year | 8,123 |
| Used Marijuana in the Past Month | 25,997 |
| Used Marijuana Daily or Almost Daily in the Past Month | 10,829 |

Table 1, showing data compiled on the demographic information of cannabis users. Dark grey identifies the subset of users who could be categorized as "chronic" users and light grey identifies the users who appear to be developing a pattern of chronic use.[96]

[92] *Id.*
[93] *Id.* at 6.
[94] This may be due to the fact that it is an ethical violation to expose heathy non-cannabis users to a potentially dangerous and addictive drug.
[95] *Results from the 2017 National Survey on Drug Use and Health: Detailed Tables,* at Table 12.2A, CENTER FOR BEHAVIORAL HEALTH STATISTICS AND QUALITY, https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/NSDUHDetailedTabs2017/NSDUHDetailedTabs2017.htm (last visited Oct. 18, 2018).
[96] *Id.* at Tables 1.16A, 1.69A, 6.1A & 7.1A.



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Of the 66,932 total marijuana users who had smoked marijuana within the last year or the last month, approximately 12% could be defined as "chronic" users, and approximately 16% could be defined as progressing towards becoming chronic users. Though the CBHSQ's survey is not directly scalable to the entire United States population, these statistics show that chronic users make up a statistically significant percentage of all marijuana users. Because of THC-COOH's long elimination period, chronic users are more likely to test positive for THC-COOH than light users, and therefore are likely to make up a more-then-representative percentage of those who test positive for THC-COOH when taking a urine test.

Second, the fact sheet notes two limitations that are related to the structure of the studies themselves: Lack of proper monitoring of users to control for ongoing marijuana use, and the use of outdated testing technologies.[97] Studies that were carried out after 2006, when the fact sheet was written, and that followed appropriate monitoring protocols, eliminate these stated limitations. In addition, the fact sheet notes that studies should use high cutoffs for THC levels to reflect the fact that drug courts will prosecute those with higher THC levels.[98] Therefore, an appropriate study will use a less sensitive cutoff for the test to be "positive."

A study by Robert S. Goodwin et. al. in 2008 performed urine tests on sixty healthy cannabis users between the ages of 18–45.[99] The mean number of years the subjects had smoked marijuana was 11.2 ± 6.4, and the subjects smoked a mean of 9.4 with a standard deviation of [hereinafter "±"] 9.7 joints/week.[100] The subject were divided into three groups: 0–50 ng/mg[101]

[97] Cary, *supra* note 85, at 6.
[98] *Id.*
[99] Robert S. Goodwin et. al., *Urinary Elimination of 11-Nor-9-carboxy- 9-tetrahydrocannnabinol in Cannabis Users During Continuously Monitored Abstinence*, 32 J. ANAL. TOX. 562, 563 (2008).
[100] *Id.* at 563.
[101] *Id.* at 566 (nineteen subjects).



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51–150 ng/mg,[102] and >150 ng/mg[103] initial creatinine-corrected THC-COOH concentration.[104] All participants had positive urine cannabinoid tests of >50 ng/ml upon intake.[105] The subjects resided in a closed research facility with 24h monitoring during a maximum thirty-day abstinence period.[106] Urine tests were taken randomly over the subjects' days of residence, with a 50ng/ml cutoff to test positive. The researchers noted that during the elimination period, samples of urine could test positive, negative, then positive again.[107]

The results showed that, as the initial TCH-COOH concentration increased, the mean days it took to test positive increased. However, there was still a significant amount of variation within and among the groups. In the 0-50ng/mg group, the mean day of the first negative specimen was 0.6 ± .08 days, and the mean day of the last positive specimen was 4.6 ± 5.6 days.[108] The range of days for the last positive specimen was between 0–21 days.[109] In the 51–100ng/mg group, the mean day of the first negative specimen was 3.2 ± 2.8 days, and the mean day of the last positive specimen was 9.7 ± 6.4 days.[110] The range of days for the last positive specimen was between 1.8–25.3 days.[111] In the >150ng/mg group, the mean day for the first negative specimen was 4.7 ± 4.8 days, and the mean day of the last positive specimen was 15.4 ± 9.8 days.[112] The range of days for the last positive specimen was between 3.6 and 29.6.[113] 0–50 ng/mg had detection rates between ~5-60% within the first 7 days of the first negative test.[114]

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[102] *Id.* (twenty-one subjects).
[103] *Id.* at 567 (twenty subjects).
[104] *Id.* at 566.
[105] *Id.* at 563.
[106] *Id.*
[107] *Id.* at 562.
[108] *Id.* at 565, T.2.
[109] *Id.*
[110] *Id.* at 566, T.2.
[111] *Id.*
[112] *Id.*
[113] *Id.*
[114] *Id.* at 568, Fig. 2.



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51–100 ng/mg had detection rates between ~0%-75% within ~22–23 days of the first negative test.[115] >150 ng/mg had detection rates between 60%-100% for 28 days after the first negative test.[116] The researchers found a significant correlation between BMI and extended periods of time until last positive test.[117]

The study shows that the number of days that THC-COOH can be detected in the urine depends generally upon the initial concentration of THC-COOH in the body. The initial concentration appears to depend upon the average number of joints smoked per week,[118] as well as how many days the subject smoked in the two weeks before testing. Table 2 below shows the relevant demographic information for members of each category.[119]

| **0 to 50 ng/mg Concentration** | | | | | |
|---|---|---|---|---|---|
| Subject | Joints/Week | Days Used in Last 14 Days | Years Used | Initial Concentration of THCOOH | Time of Last Positive Specimen |

[115] *Id.*
[116] *Id.* at 567.
[117] *See id.* at 568 ("BMI was significantly correlated with the day of the last positive specimen (i.e., the greater the BMI, the longer the interval until the last positive specimen was produced)."
[118] "Joints" vary in concentration of THC, depending on the type and quantity of cannabis used. For the purposes of this paper, it is assumed that the variation was normalized by the number of persons in the study and by the limited geographic area that the study encompassed.
[119] These numbers were not calculated by the researchers in the original study. These numbers were calculated by this paper's author by comparing Table 1's demographic characteristics of test subjects to Table 2's information about which subjects were in which categories. The numbers were tallied, excluding information from participants who did not include the relevant information, and the approximate mean was calculated from those numbers. Such calculations work as only rough approximations of the kinds of demographic information that may be linked to initial THC-COOH concentrations, as such specific data is currently lacking. *See, e.g.*, *id* at *564–66*, T.1 & T.2.



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| | | | | | |
|---|---|---|---|---|---|
| A | 2 | 4 | 8 | 47.3 | 4.3 |
| B | 10 | 10 | 25 | 30.1 | 1.5 |
| C | 12 | 14 | 9 | 34.6 | 3.8 |
| E | 3 | 7 | 24 | 9.8 | 2.2 |
| H | 11 | 11 | 8 | 46.8 | 1.2 |
| L | N/A | 1 | 11 | 27.8 | 0 |
| AA | 0 | 0 | 28 | 11.6 | 0.7 |
| BB | 4 | 5 | 25 | 1.8 | N/A |
| DD | 9 | 14 | 17 | 0 | N/A |
| EE | N/A | N/A | N/A | 40.4 | 3.3 |
| GG | 8 | 14 | 20 | 15.7 | 2.4 |
| LL | 12 | 14 | 5 | 24.8 | 21.8 |
| MM | 3 | 0 | 15 | 32.1 | N/A |
| OO | 2 | 9 | 10 | 29.5 | 5.6 |
| RR | 1 | 10 | 10 | 34.4 | 3.8 |
| TT | 1 | 1 | 6 | 15.5 | N/A |
| ZZ | 6 | 14 | 9 | 43.4 | 8.6 |
| DDD | N/A | N/A | N/A | 5.1 | N/A |
| FFF | 15 | 14 | 8 | 0 | N/A |
| | 6.2 ± 4.8 | 8.4 ± 4.5 | 14 ± 7.6 | 23.7 ± 15.94 | 4.6 ± 5.7 |

| **51 to 150 ng/mg Concentration** | | | | | |
|---|---|---|---|---|---|
| Subject | Joints/Week | Days Used in Last 14 Days | Years Used | Initial Concentration of THCOOH | Time of Last Positive Specimen |
| D | 8 | 14 | 12 | 133.5 | 4.3 |
| F | 6 | 14 | 10 | 101 | 3.1 |
| G | 1 | 9 | 11 | 70.2 | 1.8 |
| J | 4 | 3 | 17 | 74.6 | 11.6 |
| K | 16 | 14 | N/A | 120.8 | 8.3 |
| N | 24 | 14 | 8 | 90.6 | 3.3 |
| R | 6 | 14 | 6 | 142.2 | 10.1 |
| S | 3 | 14 | 10 | 96 | 3.7 |
| V | 6 | 6 | 7 | 62.6 | 8.9 |
| W | 12 | 12 | 13 | 78.9 | 2.6 |
| Y | 6 | 14 | 4 | 83.7 | 16 |
| CC | 3 | 5 | 17 | 114.9 | 3.8 |
| FF | 6 | 7 | 22 | 61.9 | 25.3 |
| HH | N/A | N/A | 7 | 101.4 | 11 |
| JJ | 3 | 8 | 9 | 96.1 | 11 |
| NN | 3 | 10 | 15 | 120.7 | 12.1 |
| QQ | 4 | 14 | 4 | 110 | 10.7 |
| WW | 15 | 14 | 8 | 110.2 | 20.9 |
| XX | 5 | 10 | 12 | 92.3 | 17 |
| CCC | 6 | 14 | 5 | 71 | 5 |
| HHH | 7 | 14 | 22 | 109.2 | 13.3 |



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| | | | | | |
|---|---|---|---|---|---|
| | 7.2 ± 5.6 | 11.2 ± 3.7 | 11 ± 5.4 | 97.2 ± 22.6 | 7. ± 6.4 |
| **> 150 ng/mg Concentration** | | | | | |
| Subject | Joints/Week | Days Used in Last 14 Days | Years Used | Initial Concentration of THCOOH | Time of Last Positive Specimen |
| I | 10 | 14 | 17 | 364.6 | 12.7 |
| M | 18 | 13 | 7 | 155.1 | 6 |
| O | 4 | 13 | 24 | 171.7 | 3.6 |
| P | N/A | 14 | N/A | 279.1 | 8.2 |
| Q | 6 | 8 | 4 | 158.4 | 3.6 |
| T | 6 | 14 | 9 | 681.9 | 29.8 |
| U | 4 | 10 | 10 | 190.5 | 29.3 |
| X | 12 | 14 | 13 | 171.8 | 14.7 |
| Z | 60 | 14 | 16 | 248.5 | 6.3 |
| II | 13 | 13 | 9 | 425.2 | 11 |
| KK | 11 | 14 | 5 | 315.3 | 11 |
| PP | 8 | 6 | 2 | 155.7 | 6.7 |
| SS | 6 | 10 | 6 | 181.3 | 8.8 |
| UU | 1 | 6 | 8 | 333.5 | 18.9 |
| VV | 30 | 14 | 12 | 176.8 | 27.3 |
| YY | 9 | 14 | 7 | 668.1 | 29.2 |
| AAA | 24 | 14 | 8 | 323.3 | 28.5 |
| BBB | 12 | 14 | 3 | 286.9 | 29.8 |
| EEE | 9 | 8 | 5 | 341.4 | 12 |
| GGG | 30 | 14 | 4 | 1165.9 | 11 |
| | 14.4 ± 13.8 | 12.1 ± 2.9 | 8.9 ± 5.5 | 339.8 ± 247.3 | 15.42 ± 9.8 |

Table 2, showing data compiled on the demographic information of marijuana users whose urine was tested for levels of THC.[120]

In the 0–50ng group, the subjects smoked a mean of 6.2 ± 4.8 joints per week, smoked a mean of 8.4 ± 4.5 of the 14 preceding days, and had been smoking for a mean of 14 ± 7.6 years.[121] The numbers ranged from 0–12 joints/week, smoking 0–14 of the preceding days, and 5–28 years of smoking history.[122] In contrast, in the >150 ng group, the subjects smoked a mean of 14.4 ± 13.8 joints per week, smoked a mean of 12.1 ± 2.9 of the 14 preceding days, and had

[120] *Id.*
[121] *Id.* at 564–66, T.1 & T.2; *see also* Table 1.
[122] *Id.* at 564–66, T.1 & T.2.



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been smoking for a mean of 8.9 ± 5.5 years.[123] The numbers ranged from 1–60 joints/week, smoking 6–14 of the preceding days, with 7–24 years of smoking history.[124] The exact way that these variables interact is unclear. Some appear to be more significant than others, though information about these interactions is currently lacking. Development of a mathematical model may be helpful in determining the demographics behind initial THC-COOH concentration in the future.

Comparisons between similar and dissimilar subjects in the same groups can show how demographic factors can conflict with one another and cause differing results. Table 2 below shows the variability in results between subjects. Joints/week, days used in the 14 days before the study, and the initial concentration of THCOOH all appear to be important variables, as the numbers trended upwards as the time of last positive specimen trended upwards.[125] However, as shown below, these variables did not serve as consistent or reliable predictors of the time of last positive specimen.

| **0-50 ng/mg Concentration** | | | | | |
|---|---|---|---|---|---|
| Subject | Joints/Week | Days Used in Last 14 Days | Years Used | Initial Concentration of THCOOH | Time of Last Positive Specimen |
| B | 10 | 10 | 25 | 30.1 | 1.5 |
| LL | 12 | 14 | 5 | 24.8 | 21.8 |
| **51-100 ng/mg Concentration** | | | | | |
| Subject | Joints/Week | Days Used in Last 14 Days | Years Used | Initial Concentration of THCOOH | Time of Last Positive Specimen |

[123] *See supra* note 121 and accompanying text.
[124] *Id.* at 564–66, T.1 & T.2.
[125] *See* Table 1, showing that the mean joints/week, days used in last 14 days, and initial concentration of THCOOH trended upwards along with the mean time of last positive specimen.



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| | | | | | |
|---|---|---|---|---|---|
| F | 6 | 14 | 10 | 101 | 3.1 |
| FF | 6 | 7 | 22 | 61.9 | 25.3 |
| **> 150 ng/mg Concentration** | | | | | |
| Subject | Joints/Week | Days Used in Last 14 Days | Years Used | Initial Concentration of THCOOH | Time of Last Positive Specimen |
| T | 6 | 14 | 9 | 681.9 | 29.8 |
| GGG | 30 | 14 | 4 | 1165.9 | 11 |

Table 3, showing the variable results of users with similar demographic information in the same groups.[126]

Though the exact findings of this study may warrant future explanation and testing, it shows that the thirty-day detection window is still a possibility for heavy cannabis users. While the fact sheet states that it is "unlikely" for more than 50 ng/ml of THC-COOH to appear in a heavy THC users' urine more than 10 days after consumption,[127] the 2008 study reported that detection rates for very heavy users ranged from 60-100% over 28 days.[128] There were detections of 50 ng/ml of THC-COOH in the urine at 20.9 days, 21 days, and 25.3 days for two chronic, but not heavy, users.[129] While the fact sheet may well be correct in stating that the 30-day detection window is "extraordinary," this study shows that a positive test within this window is far from uncommon. One must question if an estimate of 50 ng/ml for heavy users is a "reasonable estimate" if it risks implicating a person for DUI who has been abstaining from marijuana use for over three weeks.

### *iii. Standardized Field Sobriety Tests*

[126] *Id.* at 564–6, T.1 & T.2.
[127] Cary, *supra* note 85, at 9.
[128] Goodwin, *supra* note 101, at 567.
[129] *Id.* at 566.



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Standardized Field Sobriety Tests [hereinafter "SFSTs"] are widely used by police to detect a person's impairment. Of all the tests that are currently used by police to test for marijuana intoxication, SFSTs are the only tests that attempt to measure a person's actual level of impairment and intoxication. They do so by causing the subject to engage in certain behaviors, in order to observe and assess his or her motor skills, balance, attention, and other cognitive functions. There are three main SFSTs: Horizontal Gaze Nystagmus [hereinafter "HGN"], "Walk and Turn Away," and the "One Leg Stand."[130] Generally, if the subject shows impairment during two out of three of these SFSTs, he is classified as impaired on the overall SFST.[131]

HGN is an involuntary jerking movement of the eye.[132] This jerking movement of the eye is a result of the nervous system's temporary loss of control of the ocular muscles.[133] Because of the way the eye is connected to the orbit, if the ocular muscles are not being actively controlled by the nervous system, the eyes return to their primary gaze, which is staring straight ahead.[134] The neural integrator controls these opposing ocular muscles, allowing the eye to focus the retina on stationary targets, track slowly-moving objects through use of the "smooth pursuit system," or perform saccades, which are rapid, "explosive burst[s]" of eye movement that are used to change the object of fixation or track objects that are moving too quickly to be tracked by the smooth pursuit system.[135] Certain anomalies in the nervous system, such as the deficits created by

[130] Luke A. Downey et. al., *The Standardized Field Sobriety Tests (SFST) and Measures of Cognitive Functioning*, 86 ACCIDENT ANALYSIS & PREVENTION 90, 91 (2016)
[131] *Id.* at 92.
[132] *Id.* at 91.
[133] *See* Steven J. Rubenzer & Scott Stevenson, *Horizontal Gaze Nystagmus: A Review of Vision Science and Application Issues*, 55 J. FORENSIC SCI. 394, 395 (2010) ("Once the eyes find a stationary target, they must be maintained in the correct position. This requires the correct balance of muscle tone among the three pairs of opposing ocular muscles in each eye . . . Without continual input from the neural integrator (part of the oculomotor control center), the eyes cannot be held away from primary gaze (straight ahead).").
[134] *Id.* at 395.
[135] *Id.* at 394–95.



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alcohol, can cause the neural integrator to briefly lose control of the ocular muscles, making the eyes drift away from the target and back towards the primary gaze.[136] Once this error is caught, the neural integrator will initiate a saccade to focus the retina back on the target.[137] The drift of the eyes off of the target, and the subsequent refocusing through the saccade, is gaze nystagmus.[138]

When a person is sober, HGN occurs when his eyes are gazing to the side at high peripheral angles, stressing the ocular muscles.[139] When a person is intoxicated, due to the intoxicating agents' effects on the nervous systems, the HGN will be more exaggerated, occurring at less extreme angles and during more regular eye movements.[140] To perform the test, the police officer will hold an object, move it slowly in front of the subject's face, and tell the subject to follow its movement with his eyes. A sober, healthy, and focused person can follow the object with smooth eye movements.[141] In an intoxicated person, the eyes may be incapable of following the object smoothly, may jerk at maximum deviation, and may jerk within 45° of center.[142]

Some have questioned the accuracy of the HGN test. Nystagmus can also be caused by a variety of conditions that are not related to intoxication, such as poor lighting, distractions such as wind or traffic, various types of medical conditions, anxiety, circadian rhythms, and fatigue.[143]

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[136] *Id.* at 395.
[137] *Id.*
[138] *Id.*
[139] Wendy Bosker et. al., *A Placebo-Controlled Study to Assess Standardized Field Sobriety Tests Performance During Alcohol and Cannabis Intoxication in Heavy Cannabis Users and Accuracy of Point of Collection Testing Devices for Detecting THC in Oral Fluid*, 223 PYSCHOPHARMACOLOGY 439, 442 (2012).
[140] *See id.* ("However, when a person is impaired by alcohol, nystagmus is exaggerated and may occur at lesser angles.").
[141] *Id.*
[142] *Id.*
[143] Steven Rubenzer, *The Standardized Field Sobriety Tests: A Review of Scientific and Legal Issues*, 32 LAW HUM. BEHAVIOR 293, 299; Steven Rubenzer & Scott Stevenson, *supra* note 135, at 396.



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In a study testing correlations between performance on SFSTs and performance on other cognitive tests, there was a strong positive relationship between "lack of smooth pursuit," lower vigilance, and impaired choice reaction time, perhaps because impairments in the smooth pursuit system and the neural integrator are symptomatic of overall impairment in fine motor control.[144] However, no other significant associations were found between the HGN and impaired cognitive performance, and the test found that there was a significant amount of variation in identification of intoxicated individuals using HGN.[145] One paper outright suggested that the HGN test is "flawed" and "based on fraud," suggesting that "the Horizontal Gaze Nystagmus (HGN), the cornerstone of the test battery was fundamentally flawed and that the HGN test was improperly conducted by more than 95% of the police officers who used it to examine drivers . . . ."[146] Despite these issues, the HGN remains a popular way for police and other authorities to evaluate intoxication.

"Walk and Turn Away," sometimes referred to as the "Walk the Line" test, is a divided attention task, used to test motor skills, balance, and focus. The officer instructs the subject to take nine steps, heel to toe, along a straight line.[147] The subject must then turn on one foot and return by taking nine heel-to-toe steps in the same direction. The test looks for eight specific indicators of impairment: "participant cannot keep balance while listening to the instructions, participant begins before the instructions are finished, participant stops while walking to regain balance, participant does not touch heel-to-toe, participant steps off the line, participant uses

[144] Downey et. al., *supra* note 132, at 90.
[145] *Id.* at 96 ("That no other significant associations were noted for the HGN and cognitive performance may be due to inherent variations in the scoring process. Indeed, assessments of this variable have shown that a large degree of variation exists with regard to positive identification of affected individuals.").
[146] JL Booker, *The Horizontal Gaze Nystagmus Test: Fraudulent Science in the American Courts*, 44 SCIENCE & JUSTICE 133 (2004).
[147] Bosker et. al., *supra* note 141, at 442.



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arms to balance, participant makes an improper turn, or takes an incorrect number of steps."[148] The "Walk and Turn Away" test has high false positive rates, with two studies reporting an overall 37% false positive rate, one study reporting an overall 72% false positive rate, and one study reporting a 50% false positive rate for subjects at .00% BAC.[149] "Walk and Turn Away" has been found to be substantially correlated with BAC, with a mean 55% correlation with impairment.[150] The reason why the test may have so many false positives because of a lack of consideration for people who are older, overweight, physically inactive, or otherwise physically impaired.[151]

The "One Leg Stand" tests for cognitive and motor impairment. The officer directs the subject to stand on one leg, with the other raised ~15 cm off the ground, and count aloud from 1000.[152] The test lasts for approximately 30 seconds. The officer looks for swaying while balancing, the subjects' use of their arms to retain their balance, hopping to maintain balance, and putting the raised foot down to regain balance. The officer also measures how long it takes the subject to count to 1,030.[153] The test has a lower correlation with BAC than the "Walk and Turn Away Test," with a 45% correlation, but has demonstrated lower false positive rates than the "Walk and Turn Away" test, with an average 16% false positive rate when determining a BAC of .10%.[154]

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[148] *Id.*
[149] Rubenzer, *supra* note 145, at 303.
[150] *Id.*
[151] *See id.* ("[I]t appears that its cut-off score is set too low, particularly for older, heavier, and physically inactive or impaired subjects.").
[152] Bosker et. al., *supra* note 141, at 442.
[153] *Id.*
[154] Rubenzer, *supra* note 145, at 303.



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Though SFSTs have been used to test for intoxication and BAC since their development and implementation in 1981,[155] their potential use to detect marijuana intoxication has not been extensively studied. A 2005 study, attempting to resolve the question as to whether performance on SFSTs can be used to assess impairment due to THC consumption, dosed forty cannabis users with placebos, low-dose, and high-dose THC and assessed their impairment through the three standard SFSTs and a driving simulator.[156] One of the tests performed was the HGN and a closely related test, the vertical gaze nystagmus test.[157] The researchers told the subjects to focus on an object located 12–15 inches in front of their faces and moved the object horizontally and vertically. The investigator looked for "lack of smooth pursuit . . . distinct nystagmus at maximum deviation .. . . nystagmus onset before 45˚ . . .and nystagmus at the vertical position (VGN) . . . ."[158] The researchers also added an additional criterion to the HGN/VGN, "head movements or jerks . . . ."[159] The researchers also used the "walk and turn away" and "one leg stand" tests.[160] SFSTs were administered 5 minutes after smoking (SFST Time 1), 55 minutes after smoking (SFST Time 2), and 105 minutes after smoking (SFST Time 3).[161] Driving tests were administered 30 minutes after smoking (Driving Time 1) and 80 minutes after smoking (Driving Time 2).[162]

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[155] *See, e.g.*, James Fazzlaro, *The Use of Field Sobriety Tests in Drunk Driving Enforcement*, CT OFFICE OF LEGISLATIVE RESEARCH (Nov. 9, 2000), https://www.cga.ct.gov/2000/rpt/2000-R-0873.htm ("A subsequent 1981 study developed a standardized set of administration and scoring principles intended to promote consistency in the use of these tests. These three tests are now known as the Standardized Field Sobriety Test Battery and form the basis of a NHTSA training program for police officers.").

[156] K. Papafotiou et al., *The Relationship Between Performance on the Standardised Field Sobriety Tests, Driving Performance and the Level of Delta9-Tetrahydrocannabinol (THC) in Blood*, 155 FORENSIC SCI. INT. 172, 173–174 (2005).

[157] The vertical gaze nystagmus test has the same principles as the horizontal gaze nystagmus test, except the gaze is directed up and down, not side to side. *Id.*

[158] *Id.* at 173.

[159] *Id.*

[160] *Id.* at 173–74.

[161] *Id.* at 175.

[162] *Id.*



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Subjects who took driving tests at Driving Time 1 were not considered to be significantly impaired, though they did straddle solid and barrier lines at frequencies which approached statistical significance.[163] As driving was only significantly impaired at Driving Time 2, the researchers only analyzed SFST Times 2 and 3 to determine if the subjects' performance on the tests was correlated with driving impairment.[164] The subjects were further divided up into four categories: High-dose THC participants who were impaired on Driving Test 2, high-dose THC participants who were not impaired on Driving Test 2, low-dose THC participants who were impaired on Driving Test 2, and low-dose THC participants who were not impaired on Driving Test 2. The results, as shown in Table 4 below, indicated that the SFSTs could detect THC intoxication with 84-100% accuracy at both testing times, but also resulted in extremely high degrees of false positives.[165]

| SFST Time 2, 55 Minutes After Smoking | |
|---|---|
| Driving-Impaired, High-Dose THC | 92% correctly identified as impaired |
| Non-Driving-Impaired, High-Dose THC | 84.6% incorrectly identified as impaired |
| Driving-Impaired, Low-Dose THC | 88.5% correctly identified as impaired |
| Non-Driving-Impaired, Low-Dose THC | 61.5% incorrectly identified as impaired |
| SFST Time 3, 105 Minutes After Smoking | |
| Driving-Impaired, High-Dose THC | 84% correctly identified as impaired |
| Non-Driving-Impaired, High-Dose THC | 38.5% incorrectly identified as impaired |
| Driving-Impaired, Low-Dose THC | 100% correctly identified as impaired |

[163] *Id.* at 175–76.
[164] *Id.* at 176.
[165] *Id.* at 175–76.



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|---|---|
| Non-Driving-Impaired, Low-Dose THC | 100% incorrectly identified as impaired |

Table 4, showing data compiled on the efficacy of using SFSTs to determine intoxication.[166]

Based on this data, the study concluded that the SFSTs were capable of correctly identifying marijuana-related driving impairment.[167] The Walk and Turn test was considered to be the best predictor of driving ability for low-dose cannabis, and the One Leg Stand was considered to be the best predictor of driving ability for high-dose cannabis,[168] suggesting that SFSTs that assess impairments in balance and attention are therefore the best predictors of marijuana-related driving impairment. However, the researchers noted that the frequent classification of non-impaired participants as impaired may be an indication that the SFSTs are more capable of detecting THC consumption than actual impairment.[169] Though ultimately positive on the use of SFSTs to test for marijuana-related driving impairment, the researchers warned that "that in real-world scenarios, the amount of false positives could be quite high if the SFSTs alone are used to determine whether an individual is driving under the influence of drugs."[170]

Other studies have been less positive about using SFSTs to test for marijuana intoxication. A 2012 study, conducted on heavy cannabis users, showed that the overall score on the SFSTs did not successfully discriminate between baseline and impairment.[171] Of all the tests,

[166] *Id.*
[167] *See id.* ("When driving performance was impaired, a greater number of SFST signs were observed than when driving performance was not impaired.").
[168] *Id.*
[169] *Id.*
[170] *Id.* at 177.
[171] Wendy M. Bosker et al., *Medicinal $\Delta^9$-Tetrahydrocannabinol (dronabinol) Impairs On-the-Road Driving Performance of Occasional and Heavy Cannabis Users but is Not Detected in Standard Field Sobriety Test*, 223 PSYCHOPHARMACOLOGY 439, 444 (2012) ("[T]he overall score on SFST did not discriminate between THC and baseline.").



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the One Leg Stand test was the most successful, with the baseline displaying 21% impairment and the subjects who had taken marijuana displaying 50%.[172] For the HGN, there was 0% baseline impairment and 15% impairment for the subjects who had taken marijuana.[173] The Walk and Turn test was found to be the worst indicator in this study. When the Walk and Turn Test was administered, 58% were found to be impaired and 35% of the marijuana-intoxicated subjects were found to be impaired, meaning that sober subjects were actually more likely to be considered intoxicated.[174] The researchers in the 2012 study finally concluded that the SFSTs were only mildly accurate in detecting marijuana intoxication, perhaps because the heavy users had developed tolerance to THC's behavioral effects.[175] One thing to consider when looking at these supposedly adverse findings is that the 2005 study was not comparing against a baseline, but comparing impairment on SFSTs to impairment on driving tests.[176] As the Walk and Turn test assesses individual ability to perform a divided attention task, and as driving is a divided attention task, a reduced ability to perform on one is likely to be linked to reduced ability to perform on the other. Though opposed in conclusion, both the 2005 and the 2012 studies expose the serious weakness of potential false positives on SFSTs.

In a two-year study of SFST field application, researchers took cannabinoid-positive whole blood samples that were collected from drivers and evaluated whether THC concentration in the blood was correlated with poor performance on SFSTs.[177] Of the 363 positive whole blood samples, 116 (55.3%) received an evaluation from a Drug Recognition Expert [hereinafter

[172] *Id.* at 443.
[173] *Id.*
[174] *Id.*
[175] *Id.* at 445.
[176] Papafotiou et al., *supra* note 158, at 173.
[177] Kari Declues, Shelli Perez, & Ariana Figueroa, *A 2-Year Study of D 9-tetrahydrocannabinol Concentrations in Drivers: Examining Driving and Field Sobriety Test Performance*, 61 J. FORENSIC SCI. 1664, 1665 (2016).



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"DRE"] officer.[178] The range of THC ng/ml in the blood samples was between 2–60, with a mean of 9 and a median of 6.[179] As time is an important factor in considering blood samples, the researchers noted that for evaluations, the average time between driving and FST start was 69 minutes, the time between FST to blood draw was 123 minutes, and the total time between contact and blood draw was 193 minutes. For non-DRE evaluations, the average time between driving and FST was 33 minutes, FST to blood draw was 121 minutes, and the total time between contact and blood draw was 152 minutes.[180]

Of the 309 THC-positive subjects, 78.6% evaluated for HGN exhibited zero of the cues that the HGN evaluates, which was an expected result, as studies have showed that THC does not typically cause HGN.[181] For the Walk and Turn Test, "[t]here was no correlation of number of cues present with the concentration of THC found in the blood." A range of 75-100% of the Walk and Turn Test subjects displayed 2 or more cues, regardless of the amount of THC in their blood.[182] Given the results found in the previous studies, this may not be an indicator of the test's accuracy, as the researchers suggest,[183] but an indicator that it is relatively easy to fail the Walk and Turn Test. In the One Leg Stand Test, 64.9% of the subjects displayed two or more cues, with no correlation between number of cues seen and THC range in the blood.[184] The researchers concluded that "not every individual suspected of being under the influence of cannabis with THC in their blood performed poorly on every FST. This is further evidence that the FSTs,

[178] *Id.* at 1666.
[179] *Id.*
[180] *Id.*
[181] *Id.* at 1667. The particular reason why HGN does not work well to evaluate THC intoxication is unclear.
[182] *Id.*
[183] *Id.* at 1669 ("The WAT seemed to be the most sensitive in evaluating impairment by THC (for both DRE and non-DRE) as demonstrated by the higher percentage (when compared to the OLS) of subjects exhibiting two or more cues at all THC concentrations.").
[184] *Id.* at 1667.



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symptomatology, along with the presence of THC in the blood, should be used in totality to make the opinion of impairment for the purposes of driving."[185]

There were a significant number of limitations with this field study. First, as discussed *supra* Part C.i, blood THC level does not necessarily correlate directly to an individual's level of impairment. Therefore, using blood THC level to attempt to evaluate the efficacy of SFSTs in judging impairment may not be accurate. Second, this study evaluated impairment as measured by SFSTs, which does not correlate directly to impairment for the purposes of driving. Third, as this was a field study, the conditions were so varied and were under such little control of the researchers, that any number of variables could have interfered with and compromised the quality of the results. However, the researchers' conclusion need not be rejected because of these limitations. If SFSTs are linked in some way to measuring impairment, police officers could conceivably link evidence of poor driving ability, symptomatology, and blood or urine tests together to prove impairment.

*iv. Marijuana Breathalyzer*

In a push to develop a technology that is as easy, simple, and accurate as the Breathalyzer for testing BAC, a private company, Hound Labs, has released the "Marijuana Breathalyzer."[186] This technology is currently undergoing testing by police departments.[187] Information about how these devices work, and exactly what they detect, has not been released to the public at large. On their website and in press releases, Hound Labs has provided clues about how its new technology works. Hound Labs states on its website that it has developed "ultra-sensitive technology for

[185] *Id.* at 1669.
[186] *Hound Marijuana & Alcohol Breathalyzer*, HOUND LABS (last visited Oct. 25th, 2018), https://houndlabs.com.
[187] Eric Westervelt, *The Pot Breathalyzer is Here. Maybe*, NPR (Aug. 4, 2018), https://www.npr.org/2018/08/04/634992695/the-pot-breathalyzer-is-here-maybe.



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non-invasive breath measurement", claiming that "[u]sers with THC in their breath are within the impairment window" and that THC's "presence indicates recent use and thus likely impairment."[188] Hound Labs also notes that the Hound Marijuana Breathalyzer is calibrated so that it will trigger a positive test above the baseline of 5 pg/liter of breath.[189] Given that "ultra-sensitivity" tends to be inconsistent with accuracy when concerning THC testing, as discussed *supra,* and that THC's presence does not always indicate either recent use or impairment, there may be some serious issues with these conclusions. However, as the Marijuana Breathalyzer is a relatively new technology, and breath analysis works differently then blood or urine analysis,[190] the weaknesses of other tests may not apply to it. Understanding of how breath alcohol sensors currently work to analyze the presence of alcohol, and an analysis of prior studies using breath to measure THC levels, may provide insight into whether or not the Marijuana Breathalyzer is an effective method for measuring marijuana intoxication.

There are several kinds of sensors that measure alcohol in the breath. There are a variety of different kinds of chemical sensors, using methods such as colorimetry, fluorescence, and luminescence. There are also biosensors that use enzymes and certain microbial strains. However, these testing methods are generally expensive, as they require the time and expertise of lab technicians and/or chemists. Many of them also require the use of advanced equipment, which is often heavy and/or delicate, and therefore not particularly portable. Finally, these

[188] *Hound Marijuana & Alcohol Breathalyzer*, HOUND LABS (last visited Oct. 25th, 2018), https://houndlabs.com..
[189] *Hound Labs, Inc. and Triple Ring Technologies*, Hound Labs (last visited Oct. 26th, 2017), https://houndlabs.com/engineering/.
[190] This is because blood and urine tests for THC and metabolites that have already gone through some form of processing in the body, while breath tests detect marijuana particles that have coated the tissues inside the trachea during smoking.



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methods tend to take time. For these reasons, these kinds of techniques are generally reserved for confirmatory tests rather than initial roadside tests.

The fuel cell-based breath alcohol sensor is the most common, cheap, and portable type of breathalyzer. The fuel cell-based breath alcohol sensor (hereinafter "Fuel Cell Breathalyzer") works by detecting ethanol in the breath electrochemically.[191] The Fuel Cell Breathalyzer has two compartments with platinum-painted electrodes, a cathode and an anode, which are separated by a proton-exchange membrane.[192] The Fuel Cell Breathalyzer also contains an external circuit. When ethanol-infused breath is introduced into the anode compartment, it undergoes a process known as heterogeneous electrocatalytic oxidation, in which the ethanol travels over the platinum, the solid catalyst, and binds to the atoms on the platinum's surface.[193] This process converts the ethanol, $C_2H_5OH$,[194] to 12 $H^+$ + 12 $e^-$ + 2 $CO_2$.[195] This reaction also produces some chemical byproducts, most commonly acetic acid.[196] The protons and electrons generated by the anode then are transported to the cathode, protons through the proton-exchange membrane, the free electrons through the external circuit.[197] The protons and electrons then undergo a reaction with oxygen, forming water. These ethanol oxidation reactions produce an electrical charge. The charge is used to measure the amount of ethanol in the sample, which is then correlated to BAC.[198] Because of the structure and workings of the Fuel Cell Breathalyzer,

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[191] *E.g.*, Kenneth I. Ozoemena et. al., *Fuel Cell-Based Breath-Alcohol Sensors: Innovation-Hungry Old Electrochemistry*, 10 INNOVATIVE METHODS ON ELECTROCHEMISTRY 82, 83 (2018).
[192] *Id.*
[193] R.S. Swathi & K.L. Sebastian, *Molecular Mechanism of Heterogeneous Catalysis*, 6 RESONANCE 548, 549–50 (2008).
[194] Two carbon, five hydrogen, one oxygen.
[195] Twelve protons, twelve electrons, two carbon dioxide. S.P.S. Badawal et. al., *Direct Ethanol Fuel Cells for Transport and Stationary Applications – A Comprehensive Review*, 145 APPLIED ENERGY 80 (2015).
[196] Ozoemena et. al., *supra* note 193, at 83.
[197] *Id.*
[198] *Id.*



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ethanol is vital to its inner workings. Therefore, the cheap, handheld Fuel Cell Breathalyzer is not an option for detecting THC, and is unlikely to be the technology utilized by Hound Labs.

Larger, more expensive infrared spectrophotometers may also be used to test for alcohol in the breath. Infrared spectroscopy is a technique of chemical analysis.[199] In the infrared region of the electromagnetic spectrum, molecular vibrations occur, and certain functional groups have particular absorption frequencies.[200] Infrared spectrophotometers pass beams of infrared light covering a certain frequency range through an organic sample.[201] That spectrum is then obtained as a chart which shows the absorption peaks of the sample.[202] Infrared spectroscopy can be used as an evidential test at police stations, as it is capable of precisely measuring the amount of ethanol that is present in exhaled breath,[203] as well as in blood, if necessary.[204] Because infrared spectrophotometers are quite expensive,[205] as well as large, and the Fuel Cell Breathalyzers are capable of sufficiently measuring BAC roadside, police officers are not equipped with their own spectrophotometers.

Other methods, such as colorimetry and flurometry, are also capable of detecting THC. Technicians currently test for cannabinoids with colorimetry[206] by mixing the sample with

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[199] *Infrared Spectroscopy,* A DICTIONARY OF CHEMISTRY, OXFORD UNIVERSITY PRESS (7th ed. 2016).
[200] *Id.*
[201] *Id.*
[202] *Id.*
[203] *See, e.g.,* Alan Wayne Jones & Lars Andersson, *Determination of Ethanol in Breath for Legal Purposes Using a Five-Filter Infrared Analyzer: Studies on Response to Volatile Interfering Substances,* 2 J. BREATH. RES. 2 026006, *2-3 (2008)
[204] *See* Kakali Sharma, Shiba Sharma & Sujit Lahari, *Estimation of Blood Alcohol Concentration by Horizontal Attenuated Total Reflectance—Fourier Transform Infrared Spectroscopy* 44 ALCOHOL 351, 357 (2010) ("It measures total ethanol directly in the whole blood or serum sample . . . . In case of emergency, this method will be extremely useful as the measurement requires only a couple of minutes to determine BAC.").
[205] Prices vary substantially based on the specific capabilities of the machines. However, they can easily cost thousands, if not tens of thousands of dollars each.
[206] Colorimetry is used to determine the concentration of certain kinds of colored compounds in a solution. CATHERINE HOUSECROFT & EDWIN CONSTABLE, CHEMISTRY: AN INTRODUCTION TO ORGANIC, INORGANIC, AND PHYSICAL CHEMISTRY 349–353 (2006). Colorimetry can be used to test for the presence of certain chemicals or



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certain chemicals, most commonly with the Duquenois-Levine test.[207] The Duquenois-Levine test combines the sample with the Duquenois reagent, hydrochloric acid,[208] and chloroform.[209] If THC is present, the solution will turn purple.[210] This is destructive to the sample, requires human intervention and observation, and usually requires a larger sample than breath provides. Due to its low discriminating power, it is generally used to test samples of the drugs themselves, not bodily fluids.[211] One study used a digital fluorometer, which measures the wavelengths of fluorescence in a sample, to detect THC, with some success.[212] It proposed that the fluorometer test could work roadside. However, the fluorometer tested saliva, not breath, and required 30 minutes of incubation to produce a result.[213]

A short demonstration of the Marijuana Breathalyzer's testing process was given by Hound Labs' CEO, Mike Lynn.[214] He picked up a small plastic cartridge, stating that it was disposable and that there was a "whole bunch of science" in it. He then slid the cartridge into the handheld device and blew into the device for 30 seconds. The device began assessing for THC within the 30 seconds, and had a result by the time the 30 seconds was over.[215] He then slid the handheld device into a base station, which keeps the sample at a constant temperature, and noted that the Marijuana Breathalyzer requires a constant temperature for consistent results.[216] As

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enzymes that become colored upon exposure to reagents. *See, e.g.*, Morgan Philp & Shanlin Fu, *A Review of Chemical "Spot" Tests: A Presumptive Illicit Drug Identification Technique*, 10 DRUG TEST ANAL. 95, 96.

[207] *See id.* at 98 (noting that the Duquenois-Levine test is used for cannabis).

[208] The solution is "2.5 ml acetaldehyde and 2 g vanillin to 100 ml ethanol . . . ." *Id.* at 97.

[209] *Id.*

[210] *Id.* at 98.

[211] *Id.* at 95.

[212] Brian Plouffe & Shashi Murthy, *Fluoresence-Based Lateral Flow Assays for Rapid Oral Fluid Roadside Detection of Cannabis Use*, 38 ELECTROPHORESIS 501, 505 (2016) ("[I]t was shown that a simple fluorescent-based assay, using polymeric nanoparticle, could viably detect recent THC use in OFs.").

[213] *Id.* at 501, 503.

[214] Eric Westervelt, *The Pot Breathalyzer is Here. Maybe*, NPR (Aug. 4, 2018), https://www.npr.org/2018/08/04/634992695/the-pot-breathalyzer-is-here-maybe.

[215] *Id.*

[216] *Id.*



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biological field samples need to be retested at the police station to be considered confirmatory evidence, this device is likely intended to preserve the sample for that purpose. The demonstration rules out some possibilities as to the nature of the device, but not others. The colorimeter is unlikely, as the reagent, hydrochloric acid, and chloroform need to be added at different times for colorimetry to work properly. The device may be a fluorometer, as one study did provide a proof-of-concept mechanism that can detect THC, but the amount of time that the Marijuana Breathalyzer takes is very short, and thus is inconsistent with the 30-minute incubation period that the previous study found was required to analyze a sample with the fluorometer. The amount of time that the Marijuana Breathalyzer takes to scan and provide a result, and the apparent lack of need for a reagent or solution, is consistent with an infrared spectrophotometer. However, there does not appear to be an infrared spectrophotometer currently on the market that is as compact as the Marijuana Breathalyzer.

Regardless of what the Marijuana Breathalyzer is, and how it works, there are definite issues with using breath to detect THC. One issue of using breath to test for THC is the fact that, unlike alcohol, THC and its byproducts are not excreted from the lungs in large quantites.[217] Because this area is rather poorly studied and tested compared to alcohol breath tests and THC blood and urine tests, researchers have been unable to pinpoint exactly what is being detected when administering a breath test. A 2016 pilot study set out to measure the THC that was exhaled over time and compare it to physiological changes over time.[218] The researchers

[217] Blood and urine have the general 5-10 ng/ml THC concentration requirement. In contrast, a study attempting to detect THC on breath pads found a median of 95 pg/breath pad. Sarah K. Himes et. al., *Cannabinoids in Exhaled Breath following Controlled Administration of Smoked Cannabis*, 59 CLINICAL CHEM. 1780, 1786 (2013). 95 pg is .095 ng.

[218] Line Coucke et al., *Δ⁹-Tetrahydrocannabinol Concentrations in Exhaled Breath and Physiological Effects Following Cannabis Intake – A Pilot Study Using Illicit Cannabis*, 49 CLINICAL BIOCHEM. 1072, 1072 (2016).



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theorized that the source of THC in the breath is from THC being inhaled and partially deposited in the fluid lining the airway.[219] This theory, if proven in practice, would mean that those who test positive for THC on a breath test could have recently smoked marijuana, or perhaps been in the presence of someone else who was smoking marijuana. The researchers had thirteen subjects, all of whom had a history of cannabis use, abstain from using THC before the experiment.[220] The subjects first breathed into a mouthpiece attached to a bag lined with a polymer filter to trap microparticles, establishing a baseline. The subjects then smoked self-procured joints and returned to breathe into the mouthpiece again. The specimens were analyzed using the liquid chromatography-tandem mass spectrometry method.[221] The chronic users already had a significant level of THC in their breath when taking the baseline test.[222] Many of the infrequent users also had detectable THC concentrations in their breath for the baseline test, though there was a statistically significant difference between their baseline concentrations and the baseline concentrations of the chronic users.[223]

The time frame for detecting THC in the breath above baseline after smoking was estimated to be approximately three hours.[224] This contrasted with two previous studies, which found windows of .5-2 hours[225] and 12m–12 hrs[226] after smoking. The THC concentrations in the 2016 were consistently very high, at a range of 136 to 20,948 pg/filter, and a mean of 4192

[219] *Id.*
[220] *Id.* at 1074.
[221] *Id.* at 1073–74.
[222] *Id.* at 1075.
[223] *Id.*
[224] *Id.*
[225] Himes et al., *supra* note 219, at 1787. This study also found that the detection window was longer for chronic users as opposed to infrequent users. *Id.*
[226] Olof Beck et. al., *Detection of ⊿9-Tetrahydrocannabinol in Exhaled Breath Collected from Cannabis Users*, 35 J. ANALYTICAL TOXICOLOGY 541, 543 (2011).



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pg/filter.[227] This was again in contrast to previous studies, one finding concentrations between 18.0 and 77.3 pg/min (~180pg–770.3 pg/filter),[228] and another finding concentrations between ~50-1170 pg/pad.[229] The 2016 researchers theorized that, due to an inability to fully control the subjects, the subjects may have smoked or handled cannabis before the test, skewing the results higher than usual.[230] Alternatively, the subjects may have breathed in THC through secondhand smoke in the testing room and also may have had mouth residue of THC in their mouths that affected the samples.[231] In addition, the researchers theorized that the THC concentrations may have been higher than expected because the potency of the THC in the joints, provided by the subjects themselves, was not tested, presenting a major control problem.[232]

Though the specific technology of the Marijuana Breathalyzer is unclear, previous scientific testing has shown limitations in breath testing for THC. Secondhand smoke, residual THC in chronic smokers, mouth residue, and wide potential time ranges for detection all present problems. The biggest issue with the breath tests appears to be that they can detect trace amounts of THC, but no scientific testing has shown that those trace amounts are connected to impairment. The CEO of Hound Labs, Mike Lynn, himself stated that searching for the THC in the breath is "kind of like putting together more than a dozen Olympic size swimming pools and saying, 'Hey, go find those 10 specific drops of water and in those 10 pools put together.'"[233] It

[227] Coucke et. al., *supra* note 220, at 1075.
[228] Beck et. al., *supra* note 228, at 543.
[229] The second higher pad for this study was 409 pg/pad. The researchers theorized that the reasons for the outlier 1170 pg/pad "could include device malfunction resulting in oral fluid or smoke contamination." Himes et. al., *supra* note 223, at 1786.
[230] *See id.* ("Given that the self-reported abstention of smoking before the experiment this might indicate a longer detection time than a few hours, the presence of THC in the air of the room or contamination of THC from the subjects handling cannabis prior to the experiment despite measures to prevent that.").
[231] *Id.* at 1075–76.
[232] *Id.* at 1075.
[233] Eric Westervelt, *The Pot Breathalyzer is Here. Maybe*, NPR (Aug. 4, 2018), https://www.npr.org/2018/08/04/634992695/the-pot-breathalyzer-is-here-maybe.



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is always possible for technological innovation to leap forward, and perhaps Hound Labs has succeeded in creating an accurate technology that has gone briefly untested and undiscovered. Absent further research, however, it is best to exercise caution in considering the results of these kinds of tests.

### D. Evaluating the Appropriate Standards for Admission of Expert Testimony in Marijuana DUI Prosecution

#### *i. Overview*

If the results of a scientific tests, such as the results of a blood or urine test for THC, are offered into evidence, the analyst who performed the tests and prepared the report must testify as an expert witness to confirm the report's veracity.[234] The appropriate admissibility standard for expert testimony and, therefore, expert evidence, depends upon the jurisdiction. Federal courts follow the standard set by Rule 702 of the Federal Rules of Evidence [hereinafter "FRE"] and the Supreme Court case of *Daubert v. Merrell Dow Pharmaceuticals*.[235] Under these authorities, in the event of an objection, the judge, acting as a gatekeeper, must assess the admissibility of the expert evidence based on whether there is a scientifically valid methodology underlying the expert's testimony.[236] The *Daubert* court provided a non-exhaustive list of "factors" that may be used to determine if the evidence is the product of sound scientific methodology.[237] In *Kumho Tire Co. v. Carmichael*, the Court held that this standard applies to all expert testimony, including testimony from experts in non-scientific fields.[238] Since the FRE do not apply to the

[234] *Melendez-Diaz v. Massachusetts*, 557 U.S. 305, 309–11 (2009). The expert witness is not required to testify if he is unavailable or if the parties have stipulated to the report's contents. *Id.*
[235] 509 U.S. 579 (1993).
[236] *Id.* at 592–93.
[237] (1) Whether the theory or technique used can be, and has been, tested; (2) whether the theory or technique has been subject to peer review and publication; (3) whether the rate of error is known and, if so, whether the rate of error is acceptable; (4) whether there are standards controlling the technique's operation; (5) whether there is general acceptance of the technique in the scientific community. *Id.* at 593–95.
[238] 526 U.S. 137, 138 (1999).



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states, individual states have the option to adopt this standard or to use their own. Many state legislatures have adopted the language in the FRE's Rule 702 and the *Daubert* standard along with it. Some states have different phrasing in their Rules of Evidence. In addition, some courts still use the standard set in *Frye v. United States*, where evidence derived through a scientific technique is only admissible when the technique is generally accepted has been shown to be a reliable one in the relevant scientific community.[239]

There are different types of expert witnesses who may testify in marijuana DUI cases. If the evidence includes a report or affidavit on blood or urine taken from the defendant, the technician who performed the testing may testify about the equipment he used and the scientific procedures he followed.[240] The technician will offer his opinions about the working condition of the equipment and the validity of the scientific procedures followed by the laboratory. A toxicologist, either forensic or medical,[241] may appear to educate the jury about how the defendant's behavior, physical symptoms, performance on sobriety tests, and test results correlate with impairment. The toxicologist may also be the person who performed the original tests, obviating the need for a technician to testify. A certified drug recognition expert (DRE) may testify about the defendant's behavior, physical symptoms, and performance on the SFSTs, and render an opinion about whether the defendant was incapacitated based on his observations. These expert witnesses are subject to judicial scrutiny to determine whether their testimony and report are admissible.

The scientific evidence that is used for prosecution should be subject to constant reevaluation. The *Daubert* and *Frye* standards are structured such that the passing of time,

[239] 293 F. 1013, 1014 (D.C. Cir. 1923).
[240] *Bullcoming v. New Mexico*, 564 U.S. 647, 666–68 (2011).
[241] Forensic toxicologists are scientists and mainly work in laboratories. Medical toxicologists are medical doctors that sub-specialize in the treatment of medical issues involving poisons, drugs, or other chemicals.



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technological and other scientific progress, and the shifting of consensus in the scientific community can make previously admissible techniques inadmissible. No test can be, or should be, insulated from scrutiny, no matter its popularity or its history of extensive use. With the potential widespread legalization of marijuana in the United States visible on the horizon, now more than ever it is important to consider the usage of expert reports and expert testimony in marijuana DUI cases. As the Marijuana Breathalyzer is a new technology, and little is known about its operation, evaluating its admissibility under *Daubert* is not possible. An inability to evaluate its scientific methodology suggests that it should not and cannot be used to prosecute marijuana DUI cases at this time.

*ii. Cases Evaluating Admissibility of Blood and Urine Testing*

Only a handful of cases discuss the accuracy of blood and/or urine analysis in proving marijuana intoxication. Judges typically prefer to have evidence presented to the jury, allowing jurors to weigh its reliability and the credibility of the witness, rather than preclude its admission entirely,[242] and blood and urine tests are both common and popular. Of the handful of cases directly addressing the issue, only a small percentage of those involve a substantive analysis of admissibility. In *State v. Sercey,*[243] the state appealed a Florida trial court order granting the defendant's motions to exclude expert testimony from the state's toxicologists.[244] Part of the trial judge's decision to exclude the testimony was based on the finding that"there is no generally accepted per se limit for impairment of THC and [TCH-COOH] in blood" and "establishing a link between impairment and specific amounts of THC in blood is complicated by the fact that

[242] *See, e.g.*, *Daubert*, 509 U.S. at 596 ("Vigorous cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof are the traditional and appropriate means of attacking shaky but admissible evidence.").
[243] 825 So.2d 959 (Fla.App. 1 Dist., 2002).
[244] *Id.* at 973–74.



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chronic users of marijuana would likely have a baseline level of THC in their blood at all times."[245] During the *Frye* hearing, the state argued that the absence of a generally accepted *per se* limit for impairment from THC in the blood does not preclude the admission of blood tests, as, under Florida common law, the state may prove impairment from alcohol even if the defendant's BAC is below the statutory limit.[246] The appellate court agreed, holding that the state may use evidence of THC in the blood in conjunction with other evidence of impairment and that evidence of the presence of THC in the defendant's blood is therefore admissible, "even if it cannot be quantitatively related to impairment . . . ."[247]

Similarly to *Sercey*, in *Logan v. Cooper Tire & Rubber Co.*,[248] the court held that the state's expert was permitted to rely on urinalysis to form an opinion on impairment through marijuana use, even though the expert conceded "that a urinalysis alone [could not] support his opinion of marijuana-based impairment,"[249] because the expert used the urinalysis *and* the defendant's "cumulative evidence of drug abuse" to form his opinion.[250] The implication of that holding is that, in the absence of other evidence of drug abuse and intoxication, experts may not rely solely on urinalysis results to testify to impairment. The court also noted that *Daubert* does not hold experts to the "exacting standard" of determining the precise time of consumption or the exact degree of impairment.[251] In the court's opinion, because the expert "applied accepted

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[245] *Id.* (internal quotation marks omitted). Much of the trial judge's decision and the appellate court's opinion involved the reliability of the testing procedures used by the toxicologist that tested the defendant's blood. *Id.* at 974. The discussion and the evaluation of the validity of these procedures is outside of the scope of this paper.
[246] *See id.* at 975–76 ("[T]he levels of THC and [TCH-COOH] in Sercey's blood are highly relevant to the proof of her impairment, notwithstanding that a statutory per se limit for impairment of THC and [TCH-COOH] has not been established . . . the prosecution may prove impairment even when the defendant's BAC is less than the .08 statutory level . . . ") (internal quotation marks omitted)).
[247] *Id.* at 983.
[248] 2011 WL 3267869 (E.D.Ky.,2011).
[249] *Id.* at *4.
[250] *Id.*
[251] *Id.* at *5.



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toxicological standards in interpreting the urine results in this case, his opinion is reliable and relevant for the jury's consideration."[252]

In *Wingfield v. State ex rel. Dept. of Transp. and Development,*[253] the court stated that "tests available to determine levels of marijuana in one's system and its effects on driving are far from settled areas of science."[254] However, the court determined that the proponent of the evidence is not obligated under *Daubert* to submit evidence that has an "absolute degree of certainty."[255] It concluded that it is enough that "the proponent of the evidence show that the expert's conclusion has been arrived at in a scientifically sound and methodologically reliable fashion."[256] Though the plaintiff argued that it is improper to infer impairment from urinalysis alone, the court noted that the experts relied on other evidence to form an opinion on the defendant's impairment.[257] Namely, the state's experts used eyewitness testimony to classify the driver as an "occasional user" and used predictive models to determine the "detection time" of THC/THC-COOH in the urine for occasional users.[258] The court held that the trial court judge erred by excluding the expert testimony, concluding that the trial judge made an improper determination on the credibility of the expert, not the admissibility of the evidence.[259]

In *State v. Jayne,* the Oregon Court of Appeals affirmed the trial's courts exclusion of the results of urinalysis.[260] A laboratory report from the state's forensics lab showed that the defendant had marijuana metabolites, as well as the metabolites of other drugs, in her urine.[261]

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[252] *Id.*
[253] 835 So.2d 785 (La.App. 1 Cir., 2002).
[254] *Id.* at 797.
[255] *Id.*
[256] *Id.* (internal citations omitted).
[257] *Id.*
[258] *Id.* at 797–98.
[259] *Id.*
[260] 24 P.3d 920, 922, 173 Or.App. 533, 536 (Or.App., 2001)
[261] *Id.*



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Under Oregon precedent, there must be a "reasonably high correlation" between the results of the test and the defendant's impairment for the test to be admitted.[262] The urinalysis evidence could only demonstrate that the defendant "had used drugs some time before the accident."[263] The court held, therefore, that "the urinalysis evidence simply [could not] properly be viewed as having a direct correlation to the impairment of the subject at the time of the accident."[264] The court referred to *Daubert* approvingly as part of their analysis, concluding that because of the power and potentially misleading nature of expert testimony, courts should carefully counterbalance its probative value and its potential prejudicial effect.[265] Because the jury could be prejudiced by the test results and infer that the defendant was impaired at the time of the accident or that she was a generally reckless person, the court held that the prejudice that the test results could cause outweighed its probative value.[266] In a similar case, *Indemnity Insurance v. Petit*,[267] the court ruled that the evidence of the defendant's marijuana use was inadmissible because the blood and urine tests done were only able to show that the defendant had used marijuana at some point in the past.[268] The court concluded that, without corroborating evidence of impairment at the time of the defendant's accident, the test results could not be admitted and the expert could not reliably make a conclusion about the defendant's state of intoxication.[269]

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[262] *Id.* at 544 (noting that in a different case, the Oregon court "concluded that the evidence should not be excluded because the proponent of the evidence had adequately demonstrated, through the studies it introduced into evidence, *a reasonably high correlation between the results* of the DRE protocol *and impairment of the subject.*") (internal citations and quotation marks omitted)).

[263] *Id.*

[264] *Id.*

**265** *Id.* at 543 (citing *State v. O'Key*, 321 Or. 285, 305 (1995), which approvingly cited *Daubert* for the proposition that "because of the risk that expert testimony can be both powerful and quite misleading because of the difficulty in evaluating it, the trial court should exercise *more* control over expert witnesses than over lay witnesses in counterbalancing possible prejudice with probative force.").

[266] *Id.* at 544.

[267] 2006 WL 8432396 (D. Wyo., 2006).

[268] *Id.* at *4.

[269] *Id.*



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When reviewing these cases, a common thread becomes clear: The results of blood and urine tests, standing alone, are insufficient to prove impairment. The tests themselves are typically not at issue, if the technician or toxicologist followed proper procedures in performing them. But because of the tests' general inability to prove intoxication, their probative value is limited in cases where actual impairment is at issue. In the same vein, an expert cannot provide a reliable and helpful opinion as to intoxication with only the results of blood or urine tests, as the tests, standing alone, are not capable of proving impairment.

In the states of Florida, Kentucky, Louisiana, Oregon, and Wyoming, the states where the above cases were decided, the state is required to prove that the defendant was under the influence in DUI cases.[270] In contrast, as discussed in *supra* Part A, some states have *per se* standards for THC in the blood or urine in their DUI statutes. Because of this, when prosecuting a marijuana DUI case, the government need only prove beyond a reasonable doubt that the defendant was driving with the requisite amount of THC in his blood or urine. In these cases, the government may present the lab report and bring forth the technician or toxicologist to testify as to the state of the equipment and the validity of his procedures. In these jurisdictions, challenging the admissibility of the blood or urine tests is difficult. The problems with blood and urine testing, discussed *supra* Parts C.i and C.ii, are not with finding THC or its metabolites in the blood or urine; they are with correlating the level of THC in the blood or urine to impairment.

[270] Fla. Stat. § 316.193 (stating that a person is guilty of driving under the influence if he is under the influence of alcohol, drugs, or other controlled substances and is "affected to the extent that [his] normal faculties are impaired . . . ."); KY. REV. STAT. ANN. § 189A.010 (stating that a person shall not operate a motor vehicle "[w]hile under the influence of any other substance or combination of substances which impairs one's driving ability . . . ."); La. R.S. 14:98 (stating that it is a crime to be operating a vehicle when "[t]he operator is under the influence of any controlled dangerous substance listed in Schedule I . . . ."); ORS 813.010 ("A person commits the offense of driving while under the influence of intoxicants if the person drives a vehicle while the person. . . [i]s under the influence of intoxicating liquor, cannabis, a controlled substance or an inhalant . . . ."); Wyo. Stat. Ann. § 31-5-233 ("No person shall drive or have actual physical control of any vehicle within this state if the person . . . To a degree which renders him incapable of safely driving . . . Is under the influence of a controlled substance . . . .").



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The accuracy of the tests used to find the amount of THC in blood or urine is not in serious dispute. Even if the entire scientific community reached a perfect consensus in finding that blood and urine tests are not capable of detecting impairment from marijuana, the *per se* states could continue to use the tests to secure convictions, since impairment is not actually at issue. In most cases, the defendant's only path for excluding the evidence would be alleging that the technician's procedure was improperly performed or otherwise scientifically invalid.

### *iii. Cases Evaluating Admissibility of Standardized Field Sobriety Tests*

The admissibility of the results of SFSTs, unlike blood and urine tests, has been extensively challenged under *Daubert* and *Frye*. This may be because SFSTs have less indicia of reliability than blood and urine tests. As discussed *supra* Part C.iii, the SFSTs have been shown to be unreliable in detecting intoxication from marijuana, even in laboratory conditions,[271] where distractions and other contributing factors can be limited or eliminated by the researchers. The SFSTs are usually conducted roadside,[272] which introduces many factors that cast doubt on the results. For example, the time of day and weather conditions can limit visibility, the environment can be inherently distracting, or the examinee could have a physical or mental condition that the examiner does not have the proper training to recognize or evaluate.[273] In addition, unlike blood and urine tests, SFSTs do not have a long history of usage by law enforcement. The widespread use of SFSTs by law enforcement is a relatively recent development, with the "SFST Battery"

[271] *See supra* Part C.iii.

[272] These tests are conducted roadside often enough that they are better-known as "roadside sobriety tests." SFSTs are often used by police and the prosecution to establish probable cause for arrest, necessitating their roadside use. *See, e.*g., Jonathan D. Cowan & Susannah G. Jaffee, *Proof and Disproof of Alcohol—Induced Driving Impairment Through Evidence of Observable Intoxication and Coordination Testing*, 9 AM. JUR. PROOF OF FACTS 3d 459, § 1 (1990)

[273] *See supra* Part C.iii.



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(HGN, Walk-and-Turn, and the One Leg Stand) having been developed and promulgated by the National Highway Traffic Safety Administration in 1981.[274]

The Walk-and-Turn and One Leg Stand tests have often been classified as parts of the arresting officer's general observations of the defendant's conduct and appearance,[275] making the results of such tests lay testimony, not expert testimony, and therefore not subject to evaluation under *Frye* or *Daubert.*[276] The admissibility of HGN, on the other hand, has been more

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[274] National Highway Traffic Safety Administration, *Standardized Field Sobriety Test (SFST) Validated at BACS Below 0.10 Percent*, U.S. DEPT. OF TRANSP. (Mar. 1999), https://one.nhtsa.gov/portal/site/NHTSA/menuitem.554fad9f184c9fb0cc7ee21056b67789/?vgnextoid=1e2fcd8c4e7bff00VgnVCM1000002c567798RCRD&vgnextchannel=d8274dc9e66d5210VgnVCM100000656b7798RCRD&vgnextfmt=default.

[275] *See, e.g.*, *Williams v. State*, 710 So. 2d 24, 28 (Fla. Dist. Ct. App. 1998) ("Because the tests, signs and symptoms of the protocol are within the common understanding of the average layman, the general portion of the protocol is not "scientific" within the meaning of *Frye*. The fact that some of the examinations in the protocol are borrowed from the medical profession, does not elevate the protocol to scientific status."); *State v. Meador*, 674 So. 2d 826, 831 (Fla. Dist. Ct. App. 1996) ("A defendant's ability to perform these simple psychomotor tasks is within a juror's common experiences and understanding. There are objective components of the field sobriety exercises, which are commonly understood and easily determined . . . . evidence of the police officer's observations of the results of defendant's performing the walk-and-turn test, the one-legged stand . . . should be treated no differently than testimony of lay witnesses (officers, in this case) concerning their observations about the driver's conduct and appearance."); *State v. Smith*, 329 Ga. App. 646, 649, 765 S.E.2d 787, 789 (2014) "[S]obriety tests such as the walk and turn and the one leg stand, both of which demonstrate a suspect's dexterity and ability to follow directions, do not constitute scientific procedures." (internal citations omitted)).*State v. Ferrer*, 95 Haw. 409, 425, 23 P.3d 744, 760 (Ct. App. 2001) ("Because the evidence procured by administration of psychomotor FSTs is within the common experience of the ordinary citizen, the majority of courts that have addressed the issue generally consider psychomotor FSTs to be nonscientific evidence."); *People v. Vega*, 145 Ill. App. 3d 996, 1001, 496 N.E.2d 501, 505 (1986) ("The other tests, "walk the line," "one leg stand," and "finger to nose," are not so abstruse as to require a foundation other than the experience of the officer administering them."); *State v. Shadden*, 290 Kan. 803, 823, 235 P.3d 436, 450 (2010) (holding that the results from field sobriety tests are admissible as lay witness testimony, providing "circumstantial evidence of intoxication."); *Commonwealth v. Gerhardt*, 477 Mass. 775, 776, 81 N.E.3d 751, 754 (2017) ("[T]o the extent that they are relevant to establish a driver's balance, coordination, mental acuity, and other skills required to safely operate a motor vehicle, FSTs are admissible at trial as observations of the police officer conducting the assessment."); *State v. Beck*, 254 Or. App. 60, 66, 292 P.3d 653, 657 (2012) (concluding that individual components of a DRE's comprehensive test, such as the walk-the-line test and the one leg stand test, may be admissible as "nonscientific evidence of impairment."); *McRae v. State*, 152 S.W.3d 739, 746 (Tex. App. 2004) ("We conclude that the testimony by the arresting officer concerning the one-leg stand, which follows, is lay witness testimony . . . ."). *But see State v. Beltran-Chavez*, 286 Or. App. 590, 615–16, 400 P.3d 927, 942 (2017) (noting that the question is that "when an officer testifies that a defendant 'failed' the walk-and-turn or one-leg-stand test, the jury will think that science supports the propositions that []impairment can be objectively measured through the walk-and-turn and one-leg-stand tests and that the defendant's performance showed that he was objectively impaired. We conclude that, using their ordinary powers of deduction, jurors will think so. Accordingly, the state here had to establish that, in fact, [] impairment is reliably measured through the walk-and-turn and one-leg-stand tests before introducing the testimony that defendant "failed" the tests to prove that he was impaired.").

[276] If so, the officer is not permitted to testify to any scientific connection between the results of the test and intoxication.



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stringently questioned, as the relevance of HGN to the case depends on a scientific assertion that HGN is linked to alcohol or drug intoxication. Some jurisdictions have accepted HGN as entirely admissible. For example, the Court of Appeals of Georgia held that the HGN testing for alcohol intoxication has reached a level of "verifiable certainty" in the scientific community and that a trial court may take judicial notice of that verifiable certainty without receiving evidence.[277] Similarity, the Supreme Court of Illinois held that a properly-conducted HGN test may be presumptively admitted under *Frye* to prove impairment.[278] Other courts have been less generous, holding that HGN tests are admissible, but are not conclusive of impairment.[279] Only a couple of cases have found HGN to be scientifically unreliable and inadmissible.[280]

Occasionally, courts have found individual FSTs to be less than reliable, but such unreliability has been dismissed as ultimately inconsequential, as additional SFSTs and other evidence has been interpreted as "curing" any issues with the individual tests. The DRE Classification Program, which is used by all fifty states, trains DREs to use a comprehensive 12-

[277] *State v. Tousley*, 271 Ga. App. 874, 878, 611 S.E.2d 139, 144 (2005)

[278] *People v. McKown*, 236 Ill. 2d 278, 306, 924 N.E.2d 941, 957 (2010)

[279] *See People v. Joehnk*, 35 Cal.App.4th 1488, 1504, 1507–08 (Cal.App. 4 Dist.,1995) ("[T]here is no claim HGN testing alone can determine whether a suspect is under the influence of alcohol nor determine a blood alcohol level . . . that nystagmus testing is neither definitive nor able to determine intoxication alone, does not, of course, render it irrelevant . . . [the] qualified scientific community accepts the HGN testing procedures used in this case as a useful tool when combined with other tests and the observations in reaching an opinion whether a defendant was intoxicated."); *People v. Robinson*, 349 Ill. App. 3d 622, 636 (1st Dist. 2004) (holding that HGN tests may be admitted, but "are not conclusive and can only be considered along with other evidence of intoxication."); *City of Fargo v. McLaughlin*, 512 N.W.2d 700, 708 (N.D., 1994) ( [T]he HGN test results are admissible only as circumstantial evidence of intoxication, and the officer may not attempt to *quantify* a specific BAC based upon the HGN test."); *United States v. Horn*, 185 F. Supp. 2d 530, 560–61 (D. Md. 2002) ("The results of properly administered WAT, OLS and HGN SFSTs may be admitted into evidence in a DWI/DUI case only as circumstantial evidence of intoxication or impairment but not as direct evidence of specific BAC.").

[280] *City of Wichita v. Molitor*, 301 Kan. 251, 264, 341 P.3d 1275, 1276, 1283 (2015) (holding that HGN is scientifically unreliable and noting that it is inadmissible at trial); *Young v. City of Brookhaven*, 693 So. 2d 1355, 1360–61 (Miss. 1997) (applying *Frye* and concluding that the "HGN test is not generally accepted within the scientific community and cannot be used as scientific evidence to prove intoxication or as a mere showing of impairment.").



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step protocol to evaluate a person's level of intoxication.[281] The twelve-step DRE Protocol as a whole has been found generally admissible by several courts, despite the issues that the individual tests may have.[282] In *State v. Daly*, the Nebraska Supreme Court found that HGN is "insufficient to support a conviction for DUI," but concluded that its use in a standardized examination by a Drug Recognition Expert is admissible, as the issue is not an whether a singular observation by a DRE can be dispositive of the issue of intoxication, but "whether an opinion based upon all of the relevant observations is reliable enough to be admissible."[283] In *State v. Beck*, the Oregon Court of Appeals concluded that the admissibility of the DRE officer's

[281] The standardized examination by the DRE is known as the "DRE Protocol," which is currently used by all fifty states. *Drug Recognition Experts (DRE): History and Development*, THE INTERNATIONAL DRUG EVALUATION & CLASSIFICATION PROGRAM, https://www.theiacp.org/what-they-do (last visited Nov. 11, 2018). DREs are trained through a two-day preliminary DRE training program, a seven-day DRE school, and a certification training phase where they participate in conducting twelve or more drug evaluations under the supervision of a DRE instructor. *Drug Evaluation and Classification Training, "The Drug Recognition Expert School"*, NHSTA (Jan. 2011), https://www.wsp.wa.gov/breathtest/docs/dre/manuals/7day/2011/instructor_7day_jan2011.pdf. The DRE Protocol consists of twelve steps: (1) The DRE administers a breath alcohol test; (2) the DRE interviews the defendant to determine whether they gave any statements and to determine if any drugs or drug paraphernalia were found in the defendant's vehicle or on the defendant's person; (3) the DRE performs a preliminary examination by questioning the defendant about his medical history, checking his eyes and pupils, and checking his pulse; (4) the DRE performs several eye examinations, including the HGN; (5) the DRE performs a second round of sobriety tests, including the "Romberg Balance Test, walk and turn test, one leg stand, the finger to nose test, and the HGN test"; (6) the DRE takes vital signs; (7) the DRE examines the defendant in a darkroom; (8) the DRE performs a physical examination, checking for flaccid or rigid muscle tone; (9) the DRE checks the defendant's arms for signs of injections; (10) the DRE performs a post *Miranda* interrogation; (11) the DRE forms an opinion as to intoxication; (12) toxicological screenings, such as blood or urine, are taken. *See, e.g.*, Gregory T. Seiders, *Call In The Experts: The Drug Recognition Expert Protocol and Its Role in Effectively Prosecuting Drugged Drivers*, 26 WIDENER L.J. 229, 238 (2017).

[282] *State v. Campoy*, 214 Ariz. 132, 136 (Ariz.App. Div. 2, 2006) ("Testimony that a defendant exhibited four cues of impairment on a field sobriety test does not improperly assert or imply the defendant has been scientifically *proven* to have been impaired. Rather, such testimony constitutes relevant evidence of a defendant's impairment, which jurors may consider and balance against evidence of the tests' limitations."); *Bridgers v. Com.*, 2007 WL 1221846, at *2 (Ky. App. 2007) (holding that it is unnecessary for the state to prove that field sobriety testing is scientifically reliable under *Daubert* and *Kumho* and finding that officers can offer both lay and expert testimony as to the defendant's intoxication based on the results of the test); *State v. Sampson*, 167 Or.App. 489, 511 (Or.App.,2000) (holding that DRE evidence is sufficiently reliable to admit under *Daubert* so long as the "state is offering the protocol as evidence tending circumstantially to make more probable . . . . that defendant was under the influence of a controlled substance."); *State v. Chitwood*, 369 Wis.2d 132 (Wis.App. 2016) (evaluating the DRE protocol under *Daubert* and concluding that the potential rate of error is "acceptable," the theory can be tested, the theory has been subject to scrutiny, and the theory is reliable).

[283] *State v. Daly*, 278 Neb. at 917.



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complete examination "does not demonstrate the general admissibility of each component of the protocol . . . we approved the 12 step DRE [examination] as scientific evidence because its complete administration by a competent examiner qualified for admission as scientific evidence."[284] Some, however, still question the Protocol's scientific reliability, with one court commenting that there was no evidence before it that allowed it to conclude that the use of the protocol led to scientifically accurate results.[285]

This "curing," so to speak, is also present in cases where the DRE Protocol is not used. In *United States v. Daras,* the Fourth Circuit concluded that it did not need to evaluate the scientific reliability of HGN under *Daubert,* since the other field sobriety tests conducted, the results of the breathalyzer test, and the testimony of the arresting officer were "more than adequate" to support the defendant's conviction for DUI.[286] In *Joehnk,* the California Court of Appeals stated that HGN is "neither definitive nor able to determine intoxication alone," but concluded that HGN is a "useful tool when combined with other tests and observations in reaching an opinion . . . ."[287] In contrast, in a recent case, the Massachusetts Supreme Judicial Court concluded that a police officer may testify as to a defendant's performance on the standard SFSTs, but is not permitted to suggest that there is any *proven scientific connection* between the results of the test and the

[284] *State v. Beck*, 254 Or. App. 60, 66, 292 P.3d 653, 657 (2012)
[285] *City of West Bend v. Wilkens*, 693 N.W.2d 324, 328 (Wis.App.,2005) (doubting the accuracy of the protocol, stating that "[o]ther than the bare assertion that the recommended standardized tests are both scientifically reliable and valid, the record contains no indication that they are based on science. Any scientific explanation for *why* the standardized procedures yield any particular result is completely absent . . .", but concluding that the SFSTs were admissible evidence because Wisconsin allows the jury to weight the validity of scientific evidence and Wisconsin judges do not serve as gatekeepers). *See also U.S. v. Everett*, 972 F.Supp. 1313, 1320 (D.Nev. 1997) (doubting the veracity of the DRE protocol and finding that "DRE can testify to the probabilities [of intoxication], based upon his or her observations and clinical findings, but cannot testify, by way of scientific opinion, that the conclusion is an established fact by any reasonable scientific standard.").
[286] *United States v. Daras*, 164 F.3d 626 (4th Cir. 1998)
[287] *Joehnk*, 35 Cal. App. 4th at 1504, 1507–08.



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defendant's impairment.[288] The court held that "[a] police officer may not suggest, however, on direct examination that an individual's performance on an FST established that the individual was under the influence of marijuana" and that an officer may not state that the defendant "passed" or "failed" a test.[289] The court also noted its concern that the use the word "test" by an officer or DRE may create an improper "aura of scientific validity" around SFSTs, a result it sought to avoid.[290]

*iv. Propriety of a "Totality of the Circumstances" Admissibility Standard*

As the above cases demonstrate, there is confusion and inconsistency surrounding the admissibility of tests for marijuana intoxication, especially SFSTs. The line is blurred between expert and lay testimony, opinion versus observation, reliable and unreliable. These cases are also complicated by the appellate courts' standards of review. A trial court's ruling on admissibility must be reviewed only for abuse of discretion, not *de novo*,[291] and decisions on admissibility of evidence should only be vacated if the decision affected the defendant's substantial rights.[292] These standards lead to "curing," where appellate courts will conclude that

[288] *Commonwealth v. Gerhardt*, 477 Mass. 775, 784 (2017)
[289] *Id.*
[290] *Id.*
[291] Courts of appeals are required to apply the abuse-of-discretion standard when reviewing admissibility determinations. *Gen. Elec. Co. v. Joiner*, 522 U.S. 136, 141 (1997). Under this standard, court judges have broad latitude to make determinations of admissibility and appellate court judges must only vacate such determinations upon finding that they were "manifestly erroneous." *Id.* at 142.
[292] The harmless error doctrine dictates that an appellate court must only vacate a lower court's decision if it finds that decision had a legitimate negative effect on the case. "T]he Constitution entitles a criminal defendant to a fair trial, not a perfect one . . . . The harmless-error doctrine recognizes the principle that the central purpose of a criminal trial is to decide the factual question of the defendant's guilt or innocence, and promotes public respect for the criminal process by focusing on the underlying fairness of the trial rather than on the virtually inevitable presence of immaterial error." *Delaware v. Van Arsdall*, 475 U.S. 673, 681 (1986) (internal citations omitted). Jurisdictions vary in what they consider to be "harmless error." The Federal Rules of Criminal Procedure, which are mirrored by several jurisdictions, state that any error that or defect must be disregarded unless the error affected the defendant's "substantial rights." Fed. R. Crim. P. 52. The harmless error doctrine and the abuse-of-discretion standard have been criticized for reducing findings of error in admissibility hearings to mere "procedural footnote[s]" and for making findings of admissibility by trial courts essentially irreversible. Wes R. Porter, *Repeating, Yet Evading Review: Admitting Reliable Expert Testimony in Criminal Cases Still Depends Upon Who Is Asking*, 36 RUTGERS L. REC. 48, 66 (2009). *See also* Michael Risinger, *Navigating Expert Reliability: Are*



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a test like HGN is unreliable and would be inadmissible by itself, but do not vacate the trial court's judgment because other pieces of evidence were admitted that supported the conclusion that the defendant was intoxicated. This type of holding serves to make the appellate court's statement about HGN's inadmissibility dictum, which can be helpful, but can also lead to unacceptable confusion, since dictum is not binding on the appellate court or on any trial or appellate courts below it.

Another issue with the "curing" seen above is that it can perpetuate unfairness and insulate unscientific evidence from judicial scrutiny. This self-perpetuating nature is best demonstrated in a set of hypothetical cases. The defendant challenges the admissibility of a urine test. The urine test, taken by itself, would be inadmissible, but the DRE also did HGN, Walk-the-Line, and One Leg Stand tests and those, together with the urine test, sufficiently prove intoxication, so the error of the urine test's admission was harmless. The defendant challenges the admissibility of an HGN test. HGN, by itself, is inadmissible, but the DRE also did a urine test and the Walk-the-Line and One Leg Stand tests, and those, altogether, sufficiently prove intoxication, so the error of the HGN's admission was harmless. The defendant then challenges the admissibility of the DRE expert's opinion on intoxication, since it is not based on reliable science. The DRE expert's testimony is admissible because he used a protocol that included urine testing and HGN, two scientific tests that have been successfully used to help prove intoxication in the past.

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*Criminal Standards of Certainty Being Left on the Dock?*, 64 ALB. L. REV. 99, 121 (2000) ("The doctrine of harmless error insures few reversals even when a way has not been found around the formal restrictions on use."); Jeffrey Schuum, *Precious Little Guidance to the "Gatekeepers" Regarding Admissibility of Nonscientific Evidence*: An Analysis of Kumho Tire Co. v. Carmichael, 27 FLA. ST. U. L. REV. 865, 866 (2000) ("The applicable abuse-of-discretion standard, frequently bolstered by harmless error analysis, makes the trial court's reliability determination essentially irreversible."); Judge Donald E. Shelton, *Forensic Science Evidence and Judicial Bias in Criminal Cases*, JUDGES' J., SUMMER 2010, at 18, 20 ("[E]ven though there are serious questions about the scientific validity of many non-DNA forms of forensic science evidence, criminal court judges, at both the trial and appellate levels, continue to admit virtually all prosecution-proffered expert testimony.").



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While the troublesome nature of this circular system is undeniable, it is important to distinguish between preventable error and unescapable necessity. Criminal trials are always permeated with imperfections that are born of necessity. A defendant who is convicted of murder stands to lose his liberty or even his life, and these kinds of trials are taken extremely seriously. Despite how seriously the prosecution takes the trial, there will never be a perfectly fair murder prosecution, simply because it is impossible to see inside of the mind of another person. Evidence in a trial is always limited to the things that humans can physically perceive—blood in a car trunk, fingerprints on a knife, the words said or written by the defendant—evidence that is imperfect because, by its very nature, it can only *imply* that an event has occurred. Absent a confession, what can the prosecution rely on but implication? For proving intoxication in a DUI case, if the prosecution cannot rely upon tests of the defendant's bodily fluids and or upon the intoxicated behavior of the defendant, what can it rely on? In situations like these, the right middle ground must be found between perfect and simply improper.

The best standard to use for evaluating the admissibility of expert testimony in marijuana DUI cases would be a modified "totality of the circumstances" test, which would mirror the "curing" strategy that is utilized by the courts of appeals, but with a stricter standard for reliability and general admissibility. This test would be designed both to put an end to the circular system of admissibility of evidence and to dull the aura of scientific validity. The court would not make a binary "admissible" versus "not admissible" decision for each isolated piece of evidence. Instead, the court would evaluate admissibility of the evidence in a holistic manner, considering not only the *Daubert* factors, but also the potential prejudicial effect versus probative value of the scientific evidence.



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There would be two general assumptions in applying the totality of the circumstances test. First, the results of blood and urine tests, if standing on their own, would be *per se* inadmissible as proof of intoxication, since using blood or urine tests to test for legitimate intoxication is not generally accepted in the scientific community and the tests have an unacceptable rate of error when they are used to test for intoxication. The prosecution may make an argument that it is being admitted for a legitimate purpose other than proving intoxication. Even if such a legitimate purpose exists, the judge should also weigh potential prejudice versus potential probative value under Rule 403 of the FRE, because blood and urine tests have a solid reputation in the United States and may be surrounded in an aura of validity. Second, the results of the Walk-the-Line and One Leg Stand tests, the physical symptoms of marijuana intoxication, and other similar facts would usually be considered non-scientific. They would qualify as the observations of lay witnesses, which the jury is generally capable of evaluating with their own experiences and understandings of intoxication.

The totality of the circumstances test, using these presumptions, would evaluate each individual case, with the basic idea being that the more reliable evidence of intoxication there is, the more appropriate it is to admit the cumulative evidence of intoxication. To eliminate the circular and self-perpetuating nature of admissibility in these kinds of determinations, each piece of evidence would be considered both individually and in context. To put it simply, not all evidence is made alike. The fact that there is a *lot of* the unreliable evidence does not work to cure the fact that the individual pieces of evidence are unreliable.

As an illustrative example, an expert intends to testify to his opinion that a person was intoxicated, based on (1) blood tests showing a high level of THC in the blood; (2) bloodshot eyes and slurred speech; (3) swerving or otherwise failing to follow the road correctly; and (4)



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severe performative deficiencies in all the SFSTs. Blood tests, especially blood tests showing significant levels of active THC in the blood, are more valuable than urine tests. Evidence of intoxicated behavior, especially behavior showing that the defendant's intoxication affected his driving skills, is more valuable than just HGN. The individual pieces of evidence are more reliable and, when put all together, the science behind his opinion has been more extensively tested by the scientific community, is better-accepted in the community, and has a lower rate of error. His testimony may be found admissible and, because of that fact, the other evidence may be admitted as well.

Contrast the above example with that of an expert who intends to testify that a person was intoxicated, based simply on a blood test showing a high level of THC in the blood. Though the blood test for THC is generally more reliable than some other tests, the blood test alone cannot be enough to admit the expert's opinion, since a blood test by itself is not a well-accepted scientific method to evaluate a person's level of intoxication. The expert's opinion is inadmissible. While the blood test could conceivably be admitted after a *Daubert* analysis, since it cannot reliably prove intoxication and its prejudicial value would outweigh its probative value, it should be inadmissible.

In a final illustrative example, an expert intends to testify that a person was intoxicated, based on (1) a urine test showing THC-COOH in the urine; (2) a blood test showing a negligible amount of THC in the blood; (3) mild cognitive deficiencies in the HGN and One Leg Stand test; (4) rapid pulse and sweating during the traffic stop. The expert plans to use just as many facts and pieces of evidence as the expert in the first example to prove his point. However, in the scientific field, each of the tests is considered relatively unreliable in proving intoxication. In addition, rapid pulse and sweating can be symptoms of marijuana intoxication, but they may also



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be symptoms of stress, and they do not show intoxication that affected the defendant's driving skills. The evidence both individually and cumulatively is less tested, less accepted, and has a higher rate of error. The expert's opinion is inadmissible. The individual tests and the facts may or may not be found admissible—however, once again, the judge should consider prejudice versus probative value.

Some may argue that this kind of test would be evaluating weight and credibility, rather than admissibility, and thus should be evaluated by the jury, not the judge. However, this "totality of the circumstances" test is not intended to, nor does it, replace the role of the jury. Evaluating the tests and the facts both individually and in context with each other does not change the nature of the judge's evaluation. Like an autopsy or a psychological evaluation, the toxicologist's conclusion is based on an assembly of facts and tests. The admissibility of each individual fact and test does matter, but it also matters how the expert puts the pieces together. There are multiple ways to look at an assembly of facts and multiple ultimate conclusions that can be reached. The diversity of approaches complicates an evaluation under *Daubert*, since the scientific community paints a spectrum of "sound scientific methodology" which starts at "totally unacceptable" and ends at "totally acceptable." It is the judge's job as a gatekeeper to accurately paint that spectrum and place the expert opinion at issue in the place where it belongs. If the judge fails to do that and simply evaluates the admissibility of each individual test that the expert used or considered, then he has have failed to consider the whole picture. By doing so, he would allow an expert to testify to an opinion that may be acceptable on paper, but may also be totally unacceptable in the scientific community. Making the jury ultimately responsible for deciding how a toxicologist must evaluate and put together test results forces them into the shoes of the scientific community, which goes against the spirit of both *Daubert* and *Frye.*



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Others may argue that this test would place too much power in the hands of the judiciary. On the contrary, it would simply reassert a responsibility and privilege that the Supreme Court has already vested in judges. Another argument would be that the test is biased against the prosecution and would prevent them from carrying out their goal of protecting the public from intoxicated driving. While the test does place more weight on proof of actual intoxication, the pendulum swings in both directions. A test that is unfavorable for the prosecution, such as a blood test showing a low level of THC in the blood, would not prove to be a death knell for the prosecution's case if they have other pieces of evidence that are enough to support an expert's opinion that the defendant was intoxicated. Finally, there may be an argument that this standard would impose great administrative burdens, cost the government more money, and slow down already slow criminal trials. While this may be the case, no amount of administrative ease and efficiency justifies taking away a criminal defendant's freedom. Additionally, though it may take time, the scientific and criminal justice communities would be able to respond to the new standard and formulate better, more reliable ways to ascertain intoxication, perhaps meaning that eventually, judges would not have to perform a substantial amount of evaluations under the standard.

## CONCLUSION

Scientific studies have shown, over the years, that testing for marijuana intoxication is enormously complicated. Blood tests, urine tests, sobriety tests, and breath tests all have been shown to have points of potential error and, therefore, potential failure. Given that scientific testing is often seen as a silver bullet in court, even with evidence to the contrary, these potential failures run the risk of convicting sober people of DUIs, and letting intoxicated people go free. The simple, and easiest, solution would be to say that marijuana should not be legalized in the



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United States if the United States is incapable of testing to ensure that people do not smoke and drive. However, this solution may not be a solution at all, as people can and will smoke and drive, regardless of the legality of marijuana.

There is no easy, right answer to this problem. On occasions like these, where the scientific community, the legal community, and the political parties are so divided, lines must be drawn only where impropriety can be clearly measured. The facts show that THC can be detected in tests long after exposure and long after impairment has ceased. Because chronic smokers, including medical marijuana patients, may be disproportionately affected, *per se* tests, and especially zero tolerance tests, are an inaccurate and inequitable way of securing DUI convictions. Instead of being based on these *per se* limitations, DUI convictions should be based on actual proof of impairment, with the scientific evidence filtered through a "totality of the circumstances" test. For that purpose, the statements of the defendant, the physical signs of intoxication shown, evidence of impairment on SFSTs, and results on blood and urine tests should be evaluated individually as well as altogether. The potential weaknesses and inaccuracies in the blood and urine tests should be fully stated, and the defendant should have the opportunity to introduce factors to contest the validity of the scientific test, such as a history of marijuana usage, obesity, or recent weight loss. Only the combined weight of that evidence should be used to convict or acquit a defendant. If a person was not actually intoxicated, it is inappropriate to convict him of driving under the influence, regardless of the amount of THC in his body.

The rationale behind the zero tolerance THC test is simple—if you have marijuana in your system, and you drive, you should be arrested and convicted of driving under the influence. The *per se* tests are similar in rationale, but simply raise the level of unacceptability. MADD,



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and many others, focus on the fact that driving after consuming an intoxicating substance is a choice that a person makes, and choices have consequences. Getting behind the driver's seat after smoking marijuana, while being fully aware that it may impair your cognition and driving capabilities, is a moral failing, an action that many see as patently unforgivable. But the law, though it is intended to embody certain moral and societal standards, should not be focused on the inflammatory question of moral culpability. When making decisions, decision-makers must focus on the facts, and how they fit into our legal system. While we might morally condemn people who pick up their joints and their car keys, that condemnation alone does not justify the use of inaccurate tests to ensure convictions.

Forensic science's search for objective truth is compromised when the weaknesses in its application are exploited. Weaknesses and inaccuracies in the blood, urine, and sobriety tests allow people to be punished for perceived moral failings under the veil of forensic science's objectivity and accuracy. Even if the accused can afford expert witnesses and defense attorneys who can attack the accuracy of these forensic tests, the judge and jury may still believe that these tests represent total scientific truth. The tests do not have to be abandoned, but their weaknesses must be addressed and mitigated. By abandoning *per se* and zero tolerance tests, and requiring that judges evaluate the scientific legitimacy of the tests used, state legislatures can help ensure that people convicted of DUI were actually under the influence.



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