

Written Testimony of Jesse Alderman, Esq.

Good morning Chairman Regan, Minority Chairman Brewster and members of the Senate Law and Justice Committee. My name is Jesse H. Alderman and I am co-chair and co-founder of the nationwide Cannabis Practice at Foley Hoag LLP. Foley Hoag has offices in Boston, New York, and Washington D.C., and we have been practicing cannabis law for several years. We counsel clients from the largest Multi-State Operators – who are large vertically integrated companies operating in multiple medical and adult use cannabis jurisdictions and often publicly traded on the Canadian Securities Exchange – to smaller single state operators and ancillary technology and services companies to serve the industry. We have an active start-up and *pro bono* practice where we represent small entrepreneurs, medical patients, and social equity license applicants and businesses. I have confronted complex issues of state cannabis regulatory compliance since the early stages of medical cannabis legalization on the U.S. East Coast. I also serve on the Law and Regulations Committee of the U.S. Cannabis Council. And, finally I am a Pennsylvania native and though I now live in New England, the land of Belichick and Brady, I remain a die-hard Eagles fan. Thank you for the opportunity to provide testimony.

**1. Medical to Adult Use Conversion**

Among the most critical provisions of any adult use cannabis legislation is a clear roadmap for bringing an adult-use cannabis program into the market parallel to the existing medical program. As such, any adult-use program should enhance and re-enforce the medical program, assuring that Pennsylvania’s medical cannabis patients continue to receive the high level of care and access that have been hallmarks of the program for the past four years.

At the same time, it is critical that this enabling legislation provide existing Medical Dispensary, Grower Processor and Chapter 20 permit holders with:

- Clear deadlines by which they must be allowed to convert to dual-medical adult use licensees;
- Clear procedures spelled out in statute – and not left to further development by regulations – under which they can receive adult-use permits and/or conversion approvals;
- Clear requirements to maintain access for medical patients and continue a research agenda (in the case of Chapter 20 permit);
  - In particular, the continued viability of the medical program is aided by the research agenda of Chapter 20 permit holders who publicize new therapeutic uses of cannabis and can provide data to support safe and effective implementation of an expanded adult use program in the Commonwealth as they continue their research missions.
- Imposition of conversion fees that can be used by the Commonwealth to:
  - Support social equity in the cannabis industry,

- Defray the initial costs of establishing the adult use regulatory body and structure,
- Provide aid, grants and assistance to offset any additional impacts imposed on municipalities, law enforcement, and other stakeholders, and
- Support medical cannabis research and patient initiatives.

As discussed below, recently Arizona and Illinois provide good examples for the Commonwealth to emulate in terms of the efficiency of their conversion processes. Other states have conversion fee schedules that bear consideration.

As a consequence, as shown below, the states with the most efficient statutory structure for an existing medical permit holder to convert to a dual adult use and medical permit holder have realized the most immediate and substantial gains in cannabis tax revenue without disruption to patient access.

**As shown below, in the first year of adult use cannabis sales, Arizona and Illinois (which had relatively efficient and deadline-driven conversion mechanisms set by enabling legislation) raised approximately \$195,000,000 and \$295,000,000 in estimated state tax revenue respectively compared to Massachusetts, which made all existing medical marijuana treatment centers apply anew for licenses.**

I also fully support the details in the proposed adult use legislation introduced to date in the Commonwealth (Senate Bill 473 and House Bill 2050) that seek to protect and enhance the patients experience such as requiring medical marijuana organizations to adopt procedures to ensure that medical marijuana identification cardholders and caregivers are given priority access to complete purchases and eliminating or relaxing any taxes imposed on the sale of medical cannabis.

I also support the provisions that seek to draw upon the experience and expertise of the existing medical operators in order to gradually allow an adult use market to grow without major disruption to municipalities and public safety. After all – these operators are already there. They are experienced and equipped in managing potential crowds, complying with the manifold public safety regulations and working with local communities and stakeholders. Again, gearing the initial licensing period towards expedited conversions and a simplified conversion application process, for example, is a model that I support.

a. *Medical to Adult Use Conversion Requirements*

State	Medical to Adult Use License Conversion Requirements
<b>Arizona</b>	<p>Given the large number of medical marijuana dispensaries in Arizona at the time adult-use was passed, the initial licensing period was geared towards “Early Applicant” conversions and quickly turning over a new industry. The standard for conversion was relatively minimal simply requiring that the medical marijuana dispensary is registered and in good standing with the Arizona Department of Health Services. The application itself merely required:</p> <ul style="list-style-type: none"> <li>● <a href="#">Financial Institution Statement.</a></li> </ul>

	<ul style="list-style-type: none"> <li>• Necessary to provide documentation that the applying entity, principal officer, and/or board member had at least \$500,000 in liquid capital at the time of application.</li> <li>• <a href="#">Documentation of Zoning Compliance.</a></li> <li>• <a href="#">Documentation of Property Ownership.</a></li> <li>• <a href="#">Principal Officer Attestation.</a></li> </ul> <p>Notably, no fees were specified in the regulations for conversion.</p> <p>While Proposition 207 – passed in November 2020 to legalize adult-use marijuana – required that Arizona “promote the ownership and operation of marijuana establishments and marijuana testing facilities by individuals from communities disproportionately impacted by enforcement of previous marijuana laws,” this same emphasis was not applied in equal measure to the initial licensing conversions for existing medical marijuana dispensaries.</p>
<b>Connecticut</b>	<p>Connecticut’s medical conversion rules are tied to the size of the facility, but may be reduced upon the medical operator’s participation in a social equity joint venture. For instance, the general fee for conversion is \$3 million for Producers (Cultivators/Manufacturers) and \$1 million for Dispensaries. However if the Producer/Dispensary participates in social equity joint ventures, the fee gets reduced to \$1.5 million and \$500,000 respectively. All conversion fees received by the State of Connecticut are put towards the Social Equity and Innovation Fund.</p> <p>The Social Equity and Innovation Fund is formed to collect all fees dedicated by statute, which are designed to be dedicated to expenditures that further the principles of equity, including for:</p> <ul style="list-style-type: none"> <li>• Access to capital for businesses.</li> <li>• Technical assistance for the start-up and operation of a business.</li> <li>• Funding for workforce education;</li> <li>• Funding for community investments.</li> </ul> <p>The conversion process is relatively straightforward, in that the Producer/Dispensary must:</p> <ul style="list-style-type: none"> <li>• Complete a form prescribed by the Department of Consumer Protection.</li> <li>• Provide a medical cannabis preservation plan.</li> <li>• Payment of conversion fee (\$3 million/\$1.5 million or \$1 million/\$500,000).</li> <li>• Submission of <a href="#">workforce development plan.</a></li> <li>• Contribution of \$500,000 to the Social Equity Council or participation within social equity partnership (different from social equity joint venture).</li> </ul>

	<ul style="list-style-type: none"> <li>○ Social Equity Partnership – Producer provides 5% of grow space associated with the expanded activity of the Producer to a social equity business, and the Producer must commit for a five (5) year term to provide to the social equity partner mentorship and all overhead costs that are “necessary to ensure success.”</li> </ul>
<p><b>Illinois</b></p>	<p>Medical cannabis dispensing organizations were permitted to convert to an early approval adult use dispensing organization. In particular, the fee charged by Illinois was as follows:</p> <ul style="list-style-type: none"> <li>● A non-refundable application fee in the amount of \$30,000.</li> <li>● A non-refundable fee equal to 3% of the dispensing organization’s total sales from June 1, 2018 to June 1, 2019 or \$100,000, whichever is less, which was to be deposited in the Cannabis Business Development Fund.</li> </ul> <p>Beyond that, the process for dispensaries was relatively simple, including:</p> <ul style="list-style-type: none"> <li>● Submission of <a href="#">application form</a>.</li> <li>● Completed <a href="#">proposed principal officer application</a> for each principal officer.</li> <li>● <a href="#">Notice of proper zoning form</a>.</li> <li>● Adult-use dispensary <a href="#">surety bond</a>.</li> <li>● Adult-use dispensary <a href="#">escrow agreement</a>.</li> </ul> <p>The process for cultivators (regulated by a different agency in Illinois) required as follows:</p> <ul style="list-style-type: none"> <li>● Payment of a non-refundable application fee of \$100,000. <ul style="list-style-type: none"> <li>● Proof of registration as a medical cannabis cultivation center that is in good standing.</li> </ul> </li> <li>● Submission of the application by the same person or entity that holds the medical cannabis cultivation center registration. <ul style="list-style-type: none"> <li>● Legal name of the cultivation center. <ul style="list-style-type: none"> <li>● Physical address of the cultivation center.</li> <li>● Name, address, and social security number and date of birth of each principal officer and board member of the cultivation center.</li> </ul> </li> <li>● Non-refundable Cannabis Business Development Fee equal to 5% of the cultivation center’s total sales between June 1, 2018 to June 1, 2019 or \$750,000, whichever is less, but not less than \$250,000, to be deposited in to the Cannabis Business Development Fund.</li> </ul> </li> </ul>

- A commitment to completing one of the Social Equity Inclusion Plans before the expiration of the Early Approval License:

- A contribution of 5% of the cultivation center’s total sales from June 1, 2018 to June 1, 2019, or \$100,000, whichever is less, to one of the following:

- The Cannabis Business Development Fund.
- A cannabis industry training or education program at an Illinois Community College.
- A program that provides job training services to persons recently incarcerated or that operates in a Disproportionately Impacted Area.

- Participate, for at least one year, as a host in a cannabis business incubator program approved by the Department of Commerce and Economic Opportunity, and in which an Early Approval License holder agrees to provide a loan of at least \$100,000 and mentorship to incubate a licensee that qualifies as a Social Equity Applicant. “Incubate” meaning providing direct financial assistance and training necessary to engage in licensed cannabis industry activity similar to that of the host licensee. The Early Approval License holder or the same entity holding any other licenses issued pursuant to the Act shall not take an ownership stake of greater than 10% in any business receiving incubation services. If an Early Approval License holder fails to find a business to incubate to comply with this subsection before its Early Approval License expires, it may opt to meet the requirements of this subsection by completing another item from this subchapter prior to the expiration of its Early Approval License.

For Illinois, initial conversion fees were paid into the Cannabis Business Development Fund, which is a special fund used exclusively for the following purposes:

- Providing low-interest rate loans to Qualified Social Equity Applicants to pay for ordinary and necessary expenses to start and operate a cannabis business establishment.
- Provide grants to Qualified Social Equity Applicants to pay for ordinary and necessary expenses to start and operate a cannabis business establishment.
- To compensate the Department of Commerce and Economic Opportunity for any costs related to the provision of low-interest loans and grants to Qualified Social Equity Applicants.
- To pay for outreach that may be provided or targeted to attract and support Social Equity Applicants and Qualified Social Equity Applicants.
- To conduct any study or research concerning the participation of minorities, women, veterans, or people with disabilities in the cannabis industry, including, without limitation, barriers to such individuals entering the industry as equity owners of cannabis business establishments.
- To assist with job training and technical assistance for residents in Disproportionately Impacted Areas.

<b>Massachusetts</b>	There is no conversion mechanism under Massachusetts law. Medical marijuana treatment centers are required to apply for a license to operate as marijuana establishment, as if they were an entirely new applicant. Existing medical marijuana treatment centers received “priority” review of their applications over “general” applicants. All applicants, including medical marijuana treatment centers, were required to execute Host Community Agreements with the municipalities in which they operated, which could include a “fee” of up to 3% of gross revenues.
<b>Michigan</b>	Similar to Massachusetts, there is no conversion mechanism under Michigan law. Under the Michigan Regulation and Taxation of Marihuana Act of 2018, existing medical operators were originally given a two-year “head start,” however that requirement was later removed to allow cannabis businesses to apply for standalone adult-use licenses.
<b>New Jersey</b>	<p>New Jersey charges medical alternative treatment centers (“ATCs”) up to a \$1 million fee, depending on how many parts of its supply chain it seeks to convert to adult-use. By way of brief background, ATCs are, on the whole, vertically integrated operations, permitted to cultivate, manufacture, and dispense all under one license. Additionally, certain ATCs were provided the right to obtain up to two (2) additional satellite dispensaries, meaning, under its vertically integrated license, it could hold three (3) dispensary locations (its original location plus the satellites).</p> <p>The fees charged to ATC are not statutory, but instead set by regulations. Additionally, and in light of the fact that municipal approval is required for each medical facility being proposed to convert, the fee structure recognized that parts of the vertical, but in certain circumstances not all, could convert. Thus, for instance, while an ATC with a full statutory footprint is charged \$1 million, that fee could be broken up and only applied to its respective aspects of the supply chain as follows:</p> <ul style="list-style-type: none"> <li>i. Medical cannabis cultivation expansion: \$400,000</li> <li>ii. Medical cannabis manufacturer expansion: \$300,000</li> <li>iii. Medical cannabis dispensary expansion: \$100,000</li> <li>iv. Vertically integrated ATC with three dispensaries: \$1,000,000</li> <li>v. Vertically integrated ATC with two dispensaries: \$900,000</li> <li>vi. Vertically integrated ATC with one dispensary: \$800,000.</li> </ul> <p>The above-referenced fees are deposited into the Cannabis Regulatory, Enforcement Assistance, and Marketplace Modernization Fund. The monies in this fund are appropriated annually as follows:</p> <ul style="list-style-type: none"> <li>• 70 percent of all tax revenues on retail sales appropriated for investments, including through grants, loans, reimbursements of expenses, and other financial assistance, in municipalities defined as an “impact zone,” as well as to provide direct financial assistance to qualifying persons residing therein as recommended by the commission.</li> <li>• Remainder of the fund to be appropriated by the Legislature as follows:</li> </ul>

- To oversee the development, regulation, and enforcement of activities associated with the personal use of cannabis, and assist with assuming responsibility from the Department of Health for further development and expansion, regulation, and enforcement of activities associated with the medical use of cannabis.
- To reimburse the expenses incurred by any count or municipality for the training costs associated with the attendance and participation of a police officer from its law enforcement unit in a program provided by an approved school that trains and certifies the police officer, including a police officer with a working dog as a Drug Recognition Expert.
- For further investments, including through grants, loans, reimbursements of expenses, and other financial assistance, in municipalities defined as an “impact zone,” as well as providing direct financial assistance to qualifying persons residing therein as recommended by the commission.

The mechanism for conversion – beyond the fee – is a certification process; a certification that the ATC has sufficient supply to meet the reasonably anticipated needs of its registered patients, and municipal approval. Thus, to convert, an ATC was required to submit the following:

1. A letter of intent notifying the Commission of the licenses sought by the ATC;
2. Municipal approval for each class of license sought by the ATC, including:
  - a. The ordinances adopted by the municipality authorizing the operation of each class of cannabis business license being sought by the ATC, or a statement explaining that there exists no municipal ordinances prohibiting the class of cannabis business license and, thus, all classes are allowed.
  - b. An attestation by the ATC that, as a condition of licensure, it shall comply with all restrictions on the location, manner, and times of operation of cannabis businesses established by the municipality.
  - c. Zoning approval, a resolution from the municipality’s governing body, or a letter from the highest-ranking municipal official, that authorizes the ATC to engage in the cultivation, manufacturing, retailing, wholesaling, distributing, or delivery of cannabis items as the ATC’s current premises.
3. A certification to the Commission that the ATC has sufficient quantities of medical cannabis and medical cannabis products available to meet the reasonably anticipated needs of registered qualifying patients.
4. A certification to the Commission that the ATC shall not make operational changes that reduce access to medical cannabis for current and newly registered qualifying patients in order to operate a cannabis establishment or delivery service. Such certification shall include a detailed plan for prioritizing and meeting the needs of registered qualifying patients.

	<p>5. A list of owners, principals, management services contracts, financial sources, and vendor-contractors associated with the proposed cultivation, manufacturing, retailing, wholesaling, distributing, or delivery of cannabis items, as applicable.</p> <p>6. Attestation signed by a bona fide labor organization stating that the ATC has entered into a labor peace agreement with such bona fide labor organization.</p> <p>7. Any other information that the Commission deems relevant in determining whether to accept the ATC's certifications.</p>
<b>New York</b>	The Marijuana Regulation and Taxation Act increases the number of dispensing facilities a Registered Organization may operate to eight, but requires the first two additional sites to be located in underserved or unserved areas as determined by the board. The MRTA grants the Cannabis Control Board the authority to assess a registered organization with a one time special licensing fee for adult-use licensure. The fee will be assessed at an amount to adequately fund social and economic equity incubator assistance programs. Registered organizations must also demonstrate the organization's maintenance of effort in manufacturing and/or dispensing and/or research of medical cannabis for certified patients and caregivers. The timing and manner of a registered organization's participation in the adult-use market will be determined by the Cannabis Control Board.

b. *State by State Comparison – Estimated Tax Revenue<sup>1</sup>*

State	2019	2020	2021
<b>Arizona</b> <i>(adult use sales began in January 2021)</i>	Not currently available	Not currently available	\$217,553,360 <sup>2</sup>
<b>Illinois<sup>3</sup></b> <i>(adult use sales began in 2020)</i>	Not currently available	\$52,698,873	\$315,645,689 (projected)
<b>Massachusetts</b> <i>(adult use sales began in 2018)</i>	\$22,058,544 <sup>4</sup>	\$51,684,592	\$104,428,106 (projected)

<sup>1</sup> Sources: <https://taxfoundation.org/states-projected-post-higher-marijuana-revenues-2021/> Note these figures do not include sales tax or local tax revenue.

<sup>2</sup> Source: <https://azdor.gov/reports-statistics-and-legal-research/marijuana-tax-collection>

<sup>3</sup> Illinois started collecting taxes in January 2020.

<sup>4</sup> <https://www.fool.com/research/marijuana-tax-revenue-by-state/>



<b>Michigan<sup>5</sup></b> <i>(adult use sales began in December 2019)</i>	Not currently available	\$31,364,000	\$75,000,000 (projected)
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## **2. Regulatory Agencies and Boards**

When standing up a regulated adult-use marijuana program, states grapple with building an administrative infrastructure around a complex web that includes growers, processors, distributors, retailers, doctors, patients, caregivers, consumers, and regulators.

In early days of medical marijuana program adoptions we tended to see cannabis programs nestled within Departments of Health or other state agencies. More recently, states that have legalized adult-use sales have opted to create standalone cannabis agencies and/or boards to regulate the legal cannabis industry – housing both medical and adult-use marijuana under an independent state regulatory agency that licenses and regulates all cannabis activity in the state – and in some cases hemp too. For example, in New York and New Jersey, the Office of Cannabis Management and Cannabis Regulatory Commission serve as the sole authorities for cannabis regulation in each state, a model which the Commonwealth’s SB 473 currently contemplates with the establishment of the Cannabis Regulatory Control Board. Establishing one central agency to regulate all cannabis activity in the states has several benefits such as:

- Creates a single point of contact for licensees, local governments and other stakeholders;
- Simplifies and centralizes licensing and regulatory oversight;
- Supports businesses to be successful and compliant with state law;
- Improves enforcement coordination to better protect public health, safety and lands and make it more costly to operate in the illicit cannabis market;
- Creates more consistency in application review;
- Enables multiple state constitutional officers or other appointing authorities to shape the regulatory body through appointment, and increase accountability.
  - For instance, in Massachusetts, the Cannabis Control Commission has five commissioners appointed by the State Treasurer, Governor, and Attorney General.

Additionally, some states have opted to regulate marijuana like alcohol, such as Washington where the cannabis program is housed under the Washington State Liquor and Cannabis Board. I do not support this approach for several reasons. While there are some comparisons in alcohol regulatory schemes such as monitoring the sale and distribution of alcohol, requiring a minimum age of 21 years of age to consume and purchase alcohol, proving

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<sup>5</sup> Michigan started collecting taxes in December 2019.

age during purchase, and requiring proper labeling, the scope of the regulatory responsibilities for cannabis are dramatically more complex given the federal illegality of marijuana. For example, because marijuana is still federally illegal, it cannot be sold or transferred across state lines. Preventing the diversion and/or transfer or sale of marijuana across state lines requires states with regulated marijuana programs to maintain seed-to-sale tracking systems that tracks retail marijuana from either seed or immature plants stage to the point marijuana and marijuana products are sold to a customer at a retail store, to ensure that no marijuana grown or processed by a retail marijuana establishment is sold or otherwise transferred except by a retail marijuana store. To my knowledge, no rule exists in Washington state's liquor rules or codes that creates a comparable tracking system for alcohol. An exclusive cannabis regulator has the time and narrower mission of focus to promulgate the necessary tracking, tracing, inspection, enforcement, and other infrastructure to prevent diversion and illicit sales.

Additionally, given that marijuana is still federally illegal and as such there is no federal program that performs standardized testing on marijuana products, state regulatory marijuana programs typically establish comprehensive testing processes to ensure minimum standards of quality for human consumption of marijuana and marijuana products. Such testing procedures are typically done by independent third party laboratories which are subject to strict regulatory protocols and requirements for licensure. By contrast, while alcohol is monitored for adulterants and potency, these are not activities that are typically monitored at the state level, but rather under the Federal Alcohol Administration Act.

Unlike alcohol, marijuana does not only function as a recreational substance. Given that it is also regulated as a medical substance, its regulatory regime should be treated as such in terms of dosage, guidelines, production, distribution and product configuration. Regulating marijuana independently from alcohol is another way to reinforce this important distinction, and to better ensure that patient care and access remains at the forefront of the implementation of state marijuana programs. Simply put, alcohol regulators do not have the necessary experience to support patient health, access, education and safety. An independent cannabis regulator can properly focus on protection and preservation of the medical cannabis marketplace.

Lastly, Pennsylvania is unique – and in my opinion, innovative and intelligent – to have created the Chapter 20 permit. This class of permittee has clinical and broader social research responsibility overseen currently by the Department of Health. A uniform, independent cannabis regulator could greatly benefit from this growing body research, effectively oversee it and contribute to its expansion and publication. Conversely, a liquor regulator seems ill adapted to support and oversee the beneficial research being performed by Chapter 20 permittees and Academic Clinical Research Centers.

The regulatory mandates created by these considerations are complex and require a more focused approach. Creating an independent cannabis regulatory agency that has the resources and authority to oversee and enforce Pennsylvania's cannabis programs is an effective way to better ensure public health and safety and prevent the diversion of cannabis.

*State Marijuana Regulatory Bodies*

State	Regulator
<b>Arizona</b>	Department of Health Services (DHS)
<b>California</b>	Department of Cannabis Control
<b>Connecticut</b>	Department of Consumer Protection
<b>Illinois</b>	The Illinois Department of Financial and Professional Regulation and Department of Agriculture
<b>Massachusetts</b>	Cannabis Control Commission
<b>Michigan</b>	Marijuana Regulatory Agency; housed in the Department of Licensing and Regulatory Affairs
<b>New Jersey</b>	Cannabis Regulatory Commission (formerly regulated by the Department of Health)
<b>New York</b>	Office of Cannabis Management (formerly regulated by the Department of Health); an independent agency housed within the division of alcoholic beverage control

### 3. State Marijuana Tax Rates<sup>6</sup>

Below is a summary of *state* tax rates. Without opining on any exact framework, a state cannabis excise – and any additional locally imposed taxes – must take a “Goldilocks” approach. Too low and the state will not realize the full and substantial fiscal benefit of legalizing adult use cannabis; too high and safe, regulated permit holders will lose out to the illicit market that can undercut pricing.

State	Taxes
Alaska	Excise tax of \$50/ounce for flowers Excise tax of \$15/ounce for stems and leaves Excise tax of \$25/ounce for immature flowers/buds (added 10/2018)

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<sup>6</sup> Sources: <https://www.taxadmin.org/assets/docs/Research/Rates/marijuana.pdf> and <https://www.urban.org/policy-centers/cross-center-initiatives/state-and-local-finance-initiative/state-and-local-backgrounders/marijuana-taxes#:~:text=The%20possession%20of%20marijuana%20is,York%2C%20Vermont%2C%20and%20Virginia.&text=Colorado%20and%20Washington%20have%20been%20collecting%20marijuana%20tax%20revenue%20since%202014.>

State	Taxes
Arizona	Percentage-of-price tax on retail transactions (16 percent). The state (5.6 percent) and local governments also levy their general sales tax on marijuana purchases.
California	Cultivation Tax of \$9.25/ounce for flowers [\$9.65 after 1/1/20] \$2.75/ounce for leaves [\$2.87 after 1/1/20] Fresh plant material \$1.29/ounce [\$1.35 after 1/1/20] Excise tax of 15% of Retail Sales State retail sales tax applies (7.25% plus local taxes)
Colorado	Excise Tax of 15% of Average Market Rate, sales to retail stores Retail Tax of 15% (10% before July 2017) - local government receive 10% of this tax. (2.9% retail sales tax before July 2017) Local Option Retail Tax up to 8%
Connecticut	Excise Tax of 0.625 cents per milligram of THC for cannabis flower 0.9 cents per milligram for other product types 2.75 cents per milligram for edibles 6.35% retail sales tax plus 3% municipal sales tax
Illinois	7% Tax on Sales to Dispensaries Retail Excise Taxes 10% on marijuana with THC level of 35% or less 20% on cannabis-infused products 25% for marijuana with THC level above 35% Local option tax up to 3% [7/1/2020]
Maine	Excise tax of \$335 per pound - flower Excise tax of \$94 per pound - trim Excise tax of \$1.50 per seedling Excise tax of \$0.35 per seed Retail sales tax of 10%
Massachusetts	10.75% Excise Tax on Retail sales (initially 3.75% on ballot) 6.25% Retail Sales Tax applies Local Option Excise Tax of up to 3% is permitted (initially 2% on ballot)
Michigan	10% Retail Excise Tax 6% State Sales Tax (effective February 6, 2020)
Montana	Marijuana and marijuana-infused products would be taxed at 20% of the retail price. Local option up to 3% Medical marijuana taxed at 4% of retail price
Nevada	Wholesale Excise Tax 15% [Fair Market Value determined by DOT], also applied to medical marijuana Retail Tax 10% Sales tax imposed 6.85% (plus local)
New Jersey	The legalization legislation passed in 2021 did not include an excise tax on marijuana purchases. However, the state's Cannabis Regulatory Commission is authorized to impose a weight-based excise tax at rates tied to the average retail price of marijuana. Marijuana purchases will be subject to the state general sales tax (6.625 percent). Localities will also have the option to impose an additional 2 percent sales tax on purchases. As of January 2022, Legal sales and tax collection have not yet begun.
New Mexico	Excise tax of 12% of Retail Sales [tax rate will increase annually beginning in 2025 to 18%] Retail sales tax applies
New York	A tax of 0.5 cent/milligram of THC in Flower A tax of 0.8 cent/milligram of THC in Concentrate

State	Taxes
	A tax of 0.3 cent/milligram of THC in Edibles A Retail Tax of 9% plus a statewide 4% local tax
Oregon	17% Retail Sales Tax a temporary 25% tax was imposed on Medical Dispensary sales January - December 2016. Local Option sales tax up to 3%
Washington	A 37 percent excise tax is levied on the retail transaction price. The state (6.5 percent) and local governments also levy their general sales tax on purchases.
Vermont	A percentage-of-price tax (14 percent) is levied on the retail transaction price. Marijuana purchases are also subject to the state's general sales tax (6 percent) and local sales taxes.
Virginia	Retail sales tax of 21% for all products sold through Marijuana stores a 3% local options sales tax may also apply
Washington	37% Tax on Retail Sales 6.5% Retail Sales Tax (plus local tax) [medical is exempt from sales taxes after June 2016]

#### **4. Mechanisms to Ensure Continued Success of Medical Program**

Pennsylvania's medical cannabis program provides critical access and support to its patients, and that should not change with the introduction of adult-use into the market. Statutory guard rails are recommended to ensure adult use cannabis does not displace the medical marketplace. As such, there are several measures that we recommend to ensure the continued success of the medical program.

1. Eliminate the 5% gross receipts excise on the sale of medical marijuana. This will decrease the price and incentivize consumers to register for medical cards.
2. Consider waiving medical marijuana registration fee for patients. New York implemented this change earlier this year and has a patient count now totaling 125,232.
3. Consider dropping qualifying conditions for the medical marijuana program to allow physicians and other medical practitioners to prescribe medical marijuana for any condition if they feel it can be treated by cannabis, rather than qualifying conditions set by statute or regulation. This is another change that was recently implemented in New York earlier this year and has been embraced by medical doctors able to evolve with the growing body of clinical research on the therapeutic benefits of cannabis.
4. Create processes to further streamline the patient registration process.
5. As provided for in Pennsylvania HB 2050, in the event of a shortage of cannabis or cannabis products, require medical marijuana organizations to prioritize serving medical marijuana identification cardholders and caregivers.
6. Require that existing medical groups maintain medical licenses as condition of streamlined adult use conversions. States like New Jersey that have recently legalized adult-use require existing medical licensees to certify to the Commission

that the ATC has sufficient quantities of medical cannabis and medical cannabis products available to meet the reasonably anticipated needs of registered qualifying patients, and that the ATC shall not make operational changes that reduce access to medical cannabis for current and newly registered qualifying patients in order to operate a cannabis establishment or delivery service.

7. Prior to adult use sales, allow expedited or priority expansion for existing Grower/Processors to allow them to begin increasing supply in order to ensure that there will be sufficient quantities to continue to supply the medical patient population in addition to the new adult-use consumers.
8. Remove potency restrictions or other restrictions such as limits on form factors (other than those forms that may be attractive to children) to deter patients from going to other nearby states without such restrictions to obtain the products they want.

Thank you again for the opportunity to participate in today's hearing. I am happy to answer any questions that you may have.



Introductory Testimony of Brandon Nemec, PharmaCann Penn LLC

Pennsylvania Senate Law and Justice Committee

February 28, 2022

To the Honorable Chairman and Committee Members:

Thank you Chairman and Committee Members, my name is Brandon Nemec, and I am a Government and Regulatory Affairs Associate Counsel with PharmaCann. We currently operate a medical marijuana Grower/Processor in the greater Scranton area, and have three medical dispensary permits with sites located throughout Southeast and Central Pennsylvania in Bucks, Delaware, Lancaster, Montgomery, North Umlerland, and Philadelphia Counties. We also operate in five states outside of Pennsylvania across the Midwest and Northeast, along the I-80 corridor.

Most recently, our company has transitioned into adult-use sales in Illinois, and is now gearing up for the adult-use regulatory rollout in New York. Additionally, just like here in Pennsylvania, adult-use policy conversations are picking up in border states such as Ohio and Maryland.

With 18 states now legal for adult-use consumption, no state has been perfect in its transition from medical to adult-use regulation. To be sure, there have been critical lessons learned in each state transition, with innovative and successful legislative and policy outcomes, along with pitfalls that have stalled the transition to adult-use regulation.

There are many policy considerations inherent in transitioning Pennsylvania to a highly regulated and safe adult-use marketplace, with the primary goal of moving those aged 21 and over currently consuming cannabis from the illicit cannabis trade, into the regulated marketplace as quickly and effectively as possible. Today I'd like to discuss a few primary considerations that can bolster Pennsylvania's transition if the legislature elects to move forward on adult-use legislation – (1) tax and revenue generation, (2) regulatory structure, and (3) workforce development for tens of thousands of new jobs.

#### TAXES AND REVENUES

With the consideration of adult-use legalization, Pennsylvania has an opportunity to generate new, meaningful, and sustained revenue towards spending priorities within the Commonwealth. A primary consideration in order to ensure the success of the cannabis program – and maximize tax revenue – tax rates should be sufficient to



generate meaningful revenue aligned with the collective reinvestment goals of the legislature, while avoiding high pricing that is not competitive with an illicit market. Pennsylvania's adult-use program should incentivize the transition of consumers from the illicit market to a regulated market to realize both optimal tax revenues and consumer protection, where cannabis users 21 and over can begin accessing safe, lab-tested products at a price competitive with the unregulated cannabis that is being produced or sourced illegally in Pennsylvania.

Pennsylvania can learn important lessons from developing adult-use cannabis markets and set a cumulative tax rate on adult-use marijuana that strikes the appropriate balance, ensuring that prices remain competitive enough for adult-use consumers to move into the regulated market and meet the Commonwealth's revenue priorities.

- To provide some examples of competitive tax rates
  - Michigan's combined effective tax rate is 16%, with a 10% cannabis excise tax and 6% regular state sales tax
    - In 2021, Michigan achieved over \$1.3 billion in adult-use sales, and generated ~250 million in tax revenue for its respective spending priorities
  - Massachusetts has a combined tax rate of 20%, a 10.75% cannabis excise tax, 3% municipal cannabis tax, and 6.25% regular state sales tax
    - Massachusetts is on pace to realize approximately \$150 million in state revenues in FY2021-22, with a population of only 6.8 million
    - State tax revenues for cannabis now comfortably clear that of alcohol sales
- To provide some examples of non-competitive tax rates: California and Illinois
  - In contrast, California opened its adult-use market with much higher effective tax rates hovering between 40-50%, depending on the local taxes added by municipal jurisdictions. The state combines cultivation, excise, retail and sales taxes at the state level, layered with local and county taxes. This tax structure simply priced out many adult-use consumers, and kept them in the state's entrenched illicit market.



# PHARMACANN

- California's marijuana sales and associated state tax revenues fell short of initial projections as a result of its cumulative tax rates on marijuana.
- In fact, it was the only state on record to experience a reduction in overall market sales in its first year following the legalization of adult-use cannabis:
  - ~\$2.5 billion in combined medical and adult-use sales in 2018, down from ~\$3 billion solely from the medical market in 2017<sup>1</sup>
- Regulators and policymakers alike now recognize the need to make taxes more competitive, and discussions are currently underway in California to roll back portions of the taxing structure
- For additional comparison, Illinois has an effective tax rate of around 30% for whole flower products, and as high as 45% on oil and vape products. Like California, although not as extreme, Illinois layers multiple cultivation, excise, and sales taxes, as well as local municipal and county taxes. Tax revenues are strong, but Illinois has some of the most expensive regulated adult-use cannabis products in the country, and is losing market share to illicit, untested cannabis sales.<sup>2</sup>
  - Illinois achieved over \$1.3 billion in 2021 adult-use sales, with strong revenues posted at \$387 million for the year
  - Adult-use sales are beginning to plateau into 2022, and one possible explanation is the relatively high tax rate keeping some adult-use consumers in the illicit market.

## CANNABIS RETAIL TAX

As a final note on taxes – the most seamless taxing structure for both operators and regulators alike is to assign a cannabis tax at the point of retail sale. If Pennsylvania plans to maintain its existing medical patient market, this will assure that the appropriate tax is assigned and differentiated between medical patients and adult-use

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<sup>1</sup> "[California Says Its Cannabis Revenues Have Fallen Short of Estimates, Despite Gains](#)," Bill Chappell, NPR, Aug. 23, 2019

<sup>2</sup> "Illinois Has Some of the Highest Tax Rates in the Country, Could Keep Black Market Thriving." Illinois Policy Institute, January 9, 2020; available at <https://www.illinoispolicy.org/illinois-cannabis-taxes-among-nations-highest-could-keep-black-market-thriving/>



consumers. In other words, the only place to determine whether an adult-use tax should be applied, is at the point of sale when the consumer either does or does not produce a patient registration card.

Placing cannabis excise taxes as the product moves through the wholesale market along the supply chain has the effect of compounding the tax as it makes its way through the supply chain, and ultimately inflating prices for patients and consumers alike. It also causes headaches for operators and revenue collectors to differentiate between medical and adult-use products, because at the time of production it is simply unknown whether the product will be sold to a medical patient or adult-use consumer. Applying the cannabis tax at the point of retail sale helps alleviate these issues.

### CENTRALIZED REGULATORY OVERSIGHT

On regulatory and administrative oversight – from our experience, it is beneficial when state law builds in a centralized regulator to oversee the entirety of the adult-use and medical cannabis programs together. This allows the state regulator to make policy decisions that review the two programs together holistically, rather than forcing two or more separate agencies to communicate across functions related to the administration and enforcement of the programs in separate silos. A centralized regulator can also write and update regulations for both programs that reduce unnecessary redundancies, and create efficiency and synergy between the two.

For example, Illinois currently has two separate lead regulatory agencies overseeing the program, its Illinois Department of Agriculture for cultivation and production, and Department of Professional and Financial Responsibility overseeing dispensary operations. The overlap can cause redundancies for simple issues such as assigning agent badges for employees that perform cross-functions, reporting metrics and seed-to-sale tracking information along the supply chain, and submitting a streamlined process for licensure and renewals.

Michigan has a centralized regulator in the Marijuana Regulatory Agency, Massachusetts in the Cannabis Control Commission, and New York is now drafting both medical and adult-use rules under a unified Cannabis Control Board. Notably, New York's CCB also now oversees the hemp industry. Minimizing regulatory overlap with a single regulatory agency can ensure policy decisions are made in consideration of the entire industry, and alleviate unnecessary and burdensome overlapping duties for the state.



## WORKFORCE DEVELOPMENT AND ACADEMIC PARTNERSHIPS

In its medical market, Pennsylvania has been a national leader in supporting academic and operator partnerships under its Clinical Registrant program, opening the potential for more clinical research into the state's medical cannabis industry. In the adult-use context, similar partnerships can garner not only improved study and knowledge of the medical impacts of cannabis, but serve as a formalized area of study for the business, trade, and agricultural aspects of the industry.

Current projections rightly anticipate that an adult-use transition in Pennsylvania will generate tens of thousands of good-paying, living-wage direct industry jobs to meet demand. Creating a formalized field of study to create a pipeline into the industry will ensure that these new positions are filled by trained professionals ready to meet the needs of the industry.

In Illinois, the state utilized a cannabis certificate program generated at Community Colleges to fill this need. Our company had already been working in an advisory capacity to build institutional knowledge in programs such as business operations, supply chain management, and legal and regulatory compliance. Recognizing that community colleges primarily serve economically, demographically, and geographically diverse students who demonstrate financial need – in its adult-use law, the state provided the opportunity for Community Colleges to open a plant-touching field of study into the agricultural aspects of the plant, facilitated by industry operators like PharmaCann to aid in the security and design of the grow facility.

Ten Illinois community colleges have received licenses to add the plant-touching curriculum at their institutions so far throughout the state, and our company and many others are opening this direct recruitment pipeline into job openings throughout our businesses. Our trained professionals now serve as adjunct professors and guest speakers regularly to facilitate hands-on, experiential learning. The workforce development component of the adult-use transition, and partnering with academics to create a low barrier of entry for low-income and diverse students from communities in need of good-paying manufacturing and retail jobs that can benefit from these new and exciting career paths, is one that Pennsylvania can harness as well.

These are just a few of many important considerations that Pennsylvania can learn from and consider as it continues policy discussions on an adult-use statutory framework.

Thank you again for the opportunity to participate in today's hearing.

## **Testimony of Trent Wolovek, Chief Commercial Director, Jushi, Inc.**

### **Opening Remarks:**

Good morning senators, and thank you for the opportunity to testify today. My name is Trenton Woloveck. I am the Chief Commercial Director of Jushi, the which operates a medical grower/processor and dispensaries through subsidiaries here in the Commonwealth. I started working in the Cannabis industry in 2009 in Colorado, and over the last 13 years have worked in several states with both medical and adult use programs. In a few cases, including right now in Virginia and recently in Illinois, I have worked through the transition from one to the other.

For the past several years myself and Jushi have proudly contributed to building the Commonwealth's medical marijuana program and making an alternative therapeutic option available to over 600,000 registered patients. We take great pride in both our talented local workforce of over 200 Pennsylvanians, and our dispensary and grower/processor facilities, where we have invested over \$100M to date. We are also proud that the communities where we do business have welcomed us, and members of those communities, we enjoy working with them on projects designed to support community needs.

The Pennsylvania medical marijuana program illustrates the ability of Jushi and other permit holders to safely, responsibly and accountably produce safety-tested cannabis products subject to stringent regulatory requirements, and to control public access to those products by only selling them to a legislatively predetermined segment of the population – registered patients. The Commonwealth's successful medical program demonstrates Pennsylvania has a foundation upon which to launch a regulated adult use program – it proves that a legal, regulated structure works, that permit holders can cultivate, process, package, transport and sell cannabis products to only a specific group of people without product diversion, leakage or theft-related losses. In short, Pennsylvania medical cannabis permit holders put quality- and safety-tested state-approved cannabis products bearing accurate labeling, sold only to purchasers whose eligibility has been verified in proper packaging and with proper counseling – all documented with redundancies and fully transparent to the state.

I've described critical safety and security considerations, along with points of control that are only available in a strictly regulated cannabis market. These are significant, but they are just some of the benefits of replacing an unregulated, untaxed illicit market that funds criminal enterprises and sells to anyone regardless of age with a regulated market that mandates safety and security considerations and points of control.

Making the shift from an illicit market to a regulated market also takes untaxed money away from criminal enterprises – 100% of which engage in other illegal activity from trafficking in

Fentanyl to human beings<sup>1</sup> – and brings it into the legitimate, taxed Pennsylvania economy where it can be put to use for things like desperately needed community development, law enforcement resources, and infrastructure projects.

On tax policy, the comprehensive view should look to establish a tax rate that, over time, both strangles the illicit market and incentivizes Pennsylvanians to purchases within the Commonwealth, which combined will result in a stable, mature controlled market. Revenue potential is of course an important part of any adult use program. In the short term, the critical revenue consideration Pennsylvania should focus on is the hundreds of millions of dollars it can generate by setting a total “sweet spot” tax rate based on adjacent jurisdictional rates and rates that will allow a legal market to capture illicit market share. Over time, that revenue number will grow to north of ten figures – every dollar not flowing out of Pennsylvania diverted away from criminal enterprises.

But in order to realize the benefits of government oversight and control of the cannabis market, to restrict access, set quality, quantity and safety standards, and generate new revenue streams that can be used to **improve the lives of citizens of the Commonwealth from Philly to Harrisburg to Erie**, Pennsylvania needs to take the affirmative step of adopting comprehensive Cannabis reform, including authorizing strictly regulated adult use sales.

In my role at Jushi, I am constantly monitoring conditions in other markets, especially those we operate in. A couple states, discussed at greater length in my extended remarks, illustrate how other jurisdictions have moved from a medical only cannabis program to a medical plus adult use cannabis program – Illinois, California, Colorado and Nevada in particular, each of which highlights policy decisions that shaped the programs, for better or worse, and that the Commonwealth should consider when evaluating policy options that best align with the priorities of Pennsylvanians.

I am happy to answer any questions on the topics, but as a general observation, let me start with this: defining the goals and foundation principals of a future adult use program is critical and where the legislature should start. As discussed below in detail, the right policy can squeeze the illicit market to near extinction, while the wrong policy can keep it robust. And, the absence set policy priorities at the outset historically leads to disjointed, disorganized legislation that often is internally inconsistent, leaves statutory gaps on issues requiring incorporation into the program, a program that is inconsistent with citizens’ priorities and a program that is vulnerable to manipulation, circumvention and litigation.

Again, I am happy to answer any questions you may have.

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<sup>1</sup> "Black market cannabis investigations open door to labor trafficking." The Oklahoman, July 9, 2021. <https://www.oklahoman.com/story/news/2021/07/19/labor-trafficking-suspected-in-oklahomas-black-market-cannabis/7918167002/>

## **Extended remarks for the record:**

There are several states that have gone from allowing medical cannabis use to creating a controlled market for adult use. There are many policy decisions that drive that conversion, among them the capture of revenue currently going to criminal enterprises, creating a market with tested and labeled product sold only to age appropriate consumers, and the ultimate elimination of the illicit market to the extent practicable.

The revenue numbers are large and tend to attract the most public attention. Initial revenues at a 15% tax rate are in the hundreds of millions of dollars, and a mature market will drive that into ten figures as we displace the illicit market. But the transition must be done intelligently and the tax rate must be based on more considerations than simply the bottom line revenue numbers sought – as will be illustrated below, starting with a number first can end with a tax rate that fails to generate the desired revenue number because it pushes the price too high, with the added detriment of leaving the illicit market competitive.

The goals must be defined in order to get the policy right. The problem with early cannabis policy was it was often solely driven on reaching a dollar amount, rather than on finding a tax rate that would foster mature growth and starve the illicit market of consumers. Pennsylvania benefits from these early jurisdictions' trials and errors, as we now have a far better understanding of what market shape meets all of the Commonwealth's goals.

There are several states that provide examples to consider.

### **Illinois**

Illinois is a useful comparator for Pennsylvania for a number of reasons: similar population sizes, both have robust medical programs in place, and both have a mix of heavy urban and rural agriculture jurisdictions. Illinois legalized cannabis for adult use on January 1, 2020, by allowing the state medical dispensaries who paid a separate fee to sell to adults over 21.<sup>2</sup>

There were several steps to this process – especially to ensure that the medical market was not decimated by adult use sales. Illinois' law allowed for this transition to happen quickly while capacity grew – it authorized the existing market to serve both communities while issuing additional licenses to grow capacity as market adoption occurred.<sup>3</sup> Over time these additional licenses will drive down prices more and increase legal supply – necessary steps to eliminating as much as practicable the illegal market.<sup>4</sup> But Illinois has not had the type of success eliminating the illicit market as it could because its tax rate leaves the price higher than the

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<sup>2</sup> Cannabis Regulation and Tax Act, 410 ILCS Sec. 705

<https://www.ilga.gov/legislation/ilcs/ilcs5.asp?ActID=3992&ChapterID=35>

<sup>3</sup> Ibid

<sup>4</sup> Auriol, Emmanuelle et al. "Weeding Out the Dealers: The Economics of Cannabis Legalization." Attached to testimony; [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=4037049](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4037049)

illicit market. As the prices fall that will change, as seen in other jurisdictions with price more in line with the illicit market.

Even still Illinois, while having a tax rate that would be too high for Pennsylvania given the legal marketplaces on our border (New York, New Jersey and Connecticut will all have tax rates that are in the 10-18% range, far lower than Illinois' 30-40% range), does show the success of capturing revenue from the illicit market. In 2021 Illinois collected over \$440M in cannabis tax revenues with about half the number of operating dispensaries as in the Commonwealth.<sup>5</sup> This number was over \$100M more than Illinois collected in alcohol taxes in the same time period – in its first full year of operation.

Illinois is a model in another way for Pennsylvania – Illinois makes clear that the way to rapidly leverage the benefits of a legal, tested and controlled adult use market is to utilize the existing medical cannabis infrastructure. Illinois allowed existing grower/processors and dispensaries, for a fee, to also supply the adult use market. This immediately brought in all of the control aspects in the medical market, and it deprived the illicit market of a window to exploit legal possession without legal procurement.

Pennsylvania is in an even more advantageous position in this regard than Illinois was when it converted to adult use. The Commonwealth has almost twice as many dispensaries and significantly more grow capacity. And, as the last five years have demonstrated, medical cannabis companies achieved “proof of concept” in creating and maintaining points of control that prevent the diversion of cannabis under our control. If the Commonwealth wants that level of control in the existing illicit market, legalizing is the only way to access those tools.

Apart from a tax structure that would be unsupportable in the Pennsylvania market, Illinois is a good starting point for structuring a transition from a legal medical market to a legal adult use market.

## **California**

California was one of the early adopters of both medical and adult use cannabis, but remains one of the most difficult jurisdictions for legal industry members. The problem is multi-layered, but at the core is a tax structure that has kept the illicit market in place.<sup>6</sup> The original measure that legalized adult use left the door open for a tax to be imposed at several government levels, creating a tax rate that was so high the illicit market remains and thrives. The last estimation put the illicit market at \$8B annually in California – almost twice the size of the legal market.<sup>7</sup>

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<sup>5</sup> <https://www2.illinois.gov/rev/research/taxstats/CollectionsComptroller/Pages/default.aspx>

<sup>6</sup> Can Newsome Fix Cannabis' Problems? <https://calmatters.org/politics/2022/01/california-cannabis-newsom/>

<sup>7</sup> California Legal Weed Industry Can't Compete With Illicit Market.

<https://www.politico.com/news/2021/10/23/california-legal-illicit-weed-market-516868>

There are additional issues with California's adoption of adult use – with the local opt-out provision creating a void filled easily by the illegal operators – but its clear that the price of legal cannabis is a major stumbling block to reducing the illicit market. Allowing for multiple jurisdictions to impose taxes on the same transaction has led to tax rates at 50% in some areas. Tax rates this high keep prices above a point where legal cannabis can compete with illicit market supply.<sup>8</sup> The more robust the illicit market, the more uncontrolled access to untested product.

In this regard, its fair to say that California has had an “rocky” transition from a medical program to an adult use market because it defined the revenue it wanted and reverse engineered a tax structure to get there. Ignoring the existing illicit market was a major mistake and pricing legal cannabis far beyond the illicit market led to a policy outcome no one wanted. California itself recognizes this, as there are several attempts to reform the industry currently being considered. For our purposes, the outcomes in California do provide a useful cautionary tale about structuring a new adult use system.

## **Colorado**

Colorado was also an early adopter of adult use and currently here is a 15% retail tax, a portion of which remains local. There is also a 15% excise tax on wholesale transfer sales between entities. Colorado's tax structure earmarked revenue to specific purposes, but did so as a percentage of the whole to a maximum amount, rather than structure the tax rate around the desired revenue. Colorado defined its goals from adult use – to raise revenue to fund, in part, education initiatives, school construction, health care professional training, and agriculture programs.<sup>9</sup>

Colorado's initial transition to adult use was full of “fits and starts,” in part because it was first. But as the market has matured, the need to have a tax rate that is stable enough for prices to reach an equilibrium and displace the illicit market it must account for the conditions both within and around the state. Colorado's current system – with an excise tax dedicated to school construction and a retail sales tax that leaves 10% local – has provided stability in the marketplace.

Colorado's effective tax rate is 29% - lower than Illinois, but still too high for the Commonwealth and its goals. In Pennsylvania's case, its important to keep in mind that more than 80% of the state's population will live within 60 minutes of a legal marketplace by January 1, 2023. The tax rates in those states – ranging from 11% to 18% – will impact what is possible here more so than in more isolated jurisdictions such as Colorado or Illinois.

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<sup>8</sup> Auriol, Emmanuelle et al. “Weeding Out he Dealers: The Economics of Cannabis Legalization.” Attached to testimony; [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=4037049](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4037049)

<sup>9</sup> The success of Colorado's marijuana tax dollars. <https://www.forbes.com/sites/roberthoban/2021/05/23/the-success-of-colorados-marijuana-tax-dollars/?sh=34b394fe529d>



## **Nevada**

Nevada is one of the great success stories in cannabis from the point of view of eliminating as much of the illicit market as practicable. With the onset of covid Nevada legal cannabis companies saw a huge drop off in foot traffic due to travel restrictions and closures. Given the supply and the lower demand, the prices for legal adult use cannabis dropped, drawing in more of the illicit market at the new price point. Once these former illicit market consumers entered the legal market, they largely stayed there, and in a year where tourism dropped by millions of visitors sales stayed flat or even grew in some cases. The success was from taking customers out of the untested, untaxed illicit market and moving them into the legal market.<sup>10</sup>

No program will completely eliminate the illegal market but Nevada provides a stark contrast to a jurisdiction such as California, where the tax policy and opt out language create conditions where the illicit market thrives. The right tax rate allows the legal market to drive more of the illicit market from the field.

For the Commonwealth, part of the stated goal for adopting a regulated adult use market is to drive out the illicit market to the extent possible. The right policies can foster that.

## **Conclusion**

As Pennsylvania considers adopting a legal adult use program, the most important step is defining what goals the Commonwealth want it to achieve – raising tax revenues, starving criminal enterprises of money, and making our communities safer and better by taking control of the illicit market and applying points of control and testing to it. Utilizing the tested tools developed in the medical cannabis program, the Commonwealth can achieve those goals. We are certain that Pennsylvania has the right existing infrastructure to create the most successful adult use program in the country and achieve these goals.

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<sup>10</sup> Weeding Out the Dealers, *ibid.*

## Appendix A

### *Gallup Poll, December 1 – 19, 2021*

- Americans continue to support cannabis legalization
- 68% of U.S. adults said they back legalizing cannabis
- Only 32% of U.S. adults oppose legalization

## National Polling

Americans' Support for Legalizing Marijuana Among Demographic Groups		
Do you think the use of marijuana should be made legal, or not?		
	Yes, legal	No, not legal
	%	%
<b>Party identification</b>		
Republicans	50	49
Independents	71	28
Democrats	83	16
<b>Religious service attendance</b>		
Weekly	52	48
Nearly weekly/Monthly	52	48
Less often	78	22
Oct. 1-19, 2021		
GALLUP		

## Appendix B

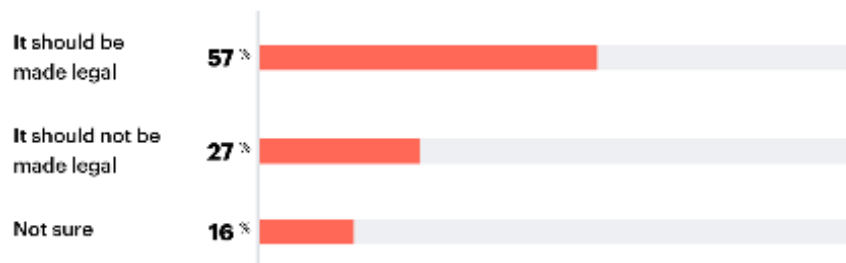
# Support Specifically for Adult Use Cannabis Legalization

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- The majority of Americans support legalizing adult use cannabis
- Support among Ds was 70%
- Support among Is was 61%
- Support among Rs was 40%

### Do you think that the recreational use of marijuana should be made legal in the United States or not?

All adults (40557 US adults - Nov 29, 2021)



# Weeding out the Dealers?

## The Economics of Cannabis Legalization \*

Emmanuelle Auriol<sup>†</sup> Alice Mesnard<sup>‡</sup> Tiffanie Perrault<sup>§</sup>

January 9, 2022

### Abstract

We model consumer choices for recreational cannabis in a risky environment and its supply under prohibition and legalization. While legalization reduces the profits of illegal providers, it increases cannabis consumption. This trade-off can be overcome by combining legalization with sanctions against the black market, and improvements to the quality of legal products. Numerical calibrations highlight how a policy mix can control the increase in cannabis consumption and throttle the illegal market. In the US, the eviction prices we predict to drive dealers out of business are much lower than the prices of legal cannabis in most of the states that opted for legalization, leaving room for the black market to flourish. Analyzing the compatibility of several policy goals sheds light on the less favorable outcomes of recent legalization reforms and suggests a new way forward.

JEL Classifications : I18, K32, K42, L51

Keywords : recreational cannabis, legalization, crime, policy, regulation

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# 1 Introduction

Prohibition policies, which target suppliers or consumers of illegal cannabis, are not very effective at controlling demand. With 192 million users, cannabis is the most popular illegal recreational drug on earth (UNODC, 2018) and accounts for half of global drug seizures and represents a black market worth 142 billion dollars (UNODC, 2017). Prohibition has failed to curb consumption and has fueled criminal activities - drug dealing being the first source of revenue for organized crime. At the same time cannabis is less addictive and less deadly than other psychotropic substances.<sup>1</sup> Governments from advanced and developing countries have decided to legalize the recreational use of cannabis. These legalization reforms have varied widely from one country/state to the next, reflecting different priorities, such as protecting the youth, improving the quality of the products consumed by adults, creating new legal jobs, or raising taxes. However, all reforms share the common goal of reducing criminal activity. We investigate theoretically the different ways legalization can be implemented to reach this objective and analyze how the objective of defeating crime may conflict with other objectives, such as raising taxes or decreasing consumption. The various trade-offs are illustrated with the help of calibrations based on US data.

Prohibition feeds an international market for drugs, which destabilizes the political economy of drug-producing countries and generates criminality in drug-consuming ones. Yet the costs of violence, instability and repression are generally overlooked by prohibitionists. Barro (2003) argues that legalizing and taxing drugs in advanced economies is a more effective way of controlling the drug market than prohibition. This paper explores a policy of legalization designed to strangle the illegal cannabis market and studies its impact on several outcomes, including price and drug consumption. We model the demand for cannabis from risk averse individuals in a general framework encompassing Expected Utility and Prospect Theory. If the sale of cannabis is illegal, consumers must weigh the benefits of consumption against the costs of participating in an illegal trade. Price is determined by illegal providers who maximize their profits. Our analysis highlights a policy trade-off: although a smart legalization policy may undermine the profits from illegal providers, it also increases cannabis use, which might be a sensitive issue politically. In contrast, prohibition decreases cannabis consumption but strengthens the cartelization of criminal networks and the price paid by their customers.

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<sup>1</sup>According to a 2017 meta analysis study of more than 10,000 articles, there are no proven serious adverse effects of moderate cannabis use on the health of adults. It is almost impossible to overdose with cannabis (see Nat. Ac. of Sc., 2017).

By illuminating the trade-offs inherent in legalization, our analysis warns policy makers against the unintended consequences of legalization if they neglect the black market responses or if they pursue incompatible objectives. Past reforms have often been disappointing. Canada and Uruguay fell short of eradicating the black market, which was their main objective. In both cases, the willingness of the governments to control consumption led to a severe underestimation of the consumers needs, in terms of both quantity and quality.<sup>2</sup> In California, the legalization reform even fueled the black market while generating only a fraction of the expected tax revenue. Confronted with high prices, due to high taxes in the legal market and new requirements for getting a medical card, many users have turned to illegal cannabis - in total contradiction with the initial objectives of the reform.<sup>3</sup> Our paper provides a general framework to analyze these failures.

We start from the simple idea, advocated recently by several policy makers, which is to sell legal cannabis at a price that competes with the black market. The analysis shows that this will not be sufficient to eliminate the black market. Prohibition creates barriers to entry, which foster cartelization of the sector by criminal organizations. These networks are able to respond to the legal competition by lowering their price and still make a profit, as demonstrated in Quebec and Uruguay. Hence, implemented at a competitive price, cannabis legalization may instead increase consumption of “low-cost” illegal cannabis, with all the negative externalities this entails for society. Next we examine a policy mix that combines pricing tools through the sale of legal cannabis – to push the criminals out of the market – and sanctions against illegal trade – to limit any subsequent increase in consumption.

We show that the eviction price of legal cannabis, which is set to drive illegal providers out of business, can be adjusted with sanctions and marketing tools. Based on evidence from cannabis markets in the U.S., the policy simulations highlight the complementarities between these different instruments, if a government’s objective is to limit the increase in consumption *post-legalization*. For instance, with a 0.1% probability of arrest and a USD 1000 fine for illegal purchase, a legal price around USD

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<sup>2</sup>In Uruguay, by the end of 2017, only two producers were approved for an annual volume of one ton each, while the market is estimated at between 35 and 40 tons. In addition, the hostility of pharmacists, charged by the State to sell cannabis, has made it even more difficult for users to obtain supplies. Similarly in 2019 in Quebec, public stores were only open from Wednesday to Sunday, “due to the current supply shortages (...) until product availability is more stable” (SQDC’s website, [www.sqdc.ca](http://www.sqdc.ca), March 19, 2019). Quantity has since increased but not quality. Consumers therefore continue to purchase on the black market.

<sup>3</sup>See <https://www.nytimes.com/2019/04/27/us/marijuana-california-legalization.html> Thomas Fueller “Getting Worse, Not Better: Illegal Pot Market Booming in California Despite Legalization” *New-York Times* 04 27 2019.

98 per ounce would evict illegal suppliers and increase consumption by 53% to 91%, depending on the elasticity of demand. If the probability of arrest reaches 2%, the eviction price goes up to USD 287 and consumption only increases by 20% to 32.5%. These results are in line with the legalization experiences of Colorado and Oregon, where relatively low prices for legal cannabis – around USD 135 per ounce – diverted consumers from the black market but increased consumption by almost 60%.

Interestingly, the eviction price can be further adjusted by improving the quality of legal cannabis relative to illegal products. Doubling its relative valuation by consumers would enable a government to set the eviction price at around USD 186 and to limit the rise in consumption to 37% to 63%. This “quality” channel has been neglected by most authorities, including in Canada and Uruguay. Yet, our simulations show that it is quite effective to modulate the eviction price and, thereby, to control consumption *post-legalization*.

Finally, we embed in our theoretical framework a larger set of policy objectives to provide further insight about current policies. We show that prohibition policies are optimal only if a government seeks to minimize total consumption of cannabis and neglects other objectives, such as minimizing the enforcement costs of prohibition. We also show that reducing crime through a regulated market of cannabis sold at the eviction price is compatible with the maximization of consumers’ surplus, the minimization of enforcement costs of repression measures, and with the minimization of negative externalities from illegal cannabis consumption. In contrast, the maximization of tax revenues would lead to the co-existence of legal and illegal markets.

The rest of the paper is organized as follows. In Section 2 we describe the evolution of the regulation of recreational cannabis markets and review the empirical literature on the impact of legalisation measures.

In Section 3 we present the set-up of the model, which explains the illegal market structure under *status quo* (prohibition). In Section 4 we analyze the effects of introducing pricing strategies combined with measures targeting consumers and suppliers to drive smugglers out of business and regulate the (legal) sale of cannabis. In Section 5 we calibrate the model based on evidence from the U.S. cannabis market and study its implications in terms of price and increase in consumption *post-legalization*. In Section 6 we enlarge the set of policy objectives to shed more light on current policies before concluding

in Section 7.

## 2 Legalization of recreational cannabis: an overview of policy impacts

In response to an increase in cannabis use, the seventies were characterized by a wave of decriminalization measures. In the United-States, possessing small amounts (usually up to 1 ounce) of cannabis was declassified to a misdemeanor in eleven states<sup>4</sup> and Alaska declared possession of small amounts of cannabis to be protected under the state constitutional right to privacy (see Appendix A for a chronology of cannabis laws across states in the US). Across the Atlantic, the Netherlands took a bold step by making cannabis available for recreational use in coffee shops. However, the attempts to legalize cannabis more generally stalled with the *War on Drugs* launched by Ronald Reagan in the eighties. Rising concerns about the legitimacy and efficacy of this war led to a second wave of decriminalization and the first laws in favor of medical use in the U.S. at the end of the nineties. This liberalization movement accelerated in the last decade.

In 2012, the Uruguayan government announced plans to legalize and control sales of recreational cannabis to counter drug-related crime. This initiative occurred as Colorado and Washington states passed bills legalizing recreational use of cannabis, following popular referendums. From 2014 onward, thirteen other American states and the District of Columbia followed, and in 2018 Canada, South Africa and Georgia also changed their legislation.<sup>5</sup> Legalization policies implemented so far are diverse. In Colorado and Washington states, the reforms have been market oriented, with a clear focus on consumers' needs and taxation. In Canada, retail sale of cannabis is legal although the policies vary across provinces, from Québec's government monopoly to Alberta's privately run stores. In Uruguay the market is under tight public control, which led to sluggish implementation and penury.<sup>6</sup> Based on these examples, a flourishing literature studies the impacts of legalization policies.

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<sup>4</sup>California, Colorado, Maine, Minnesota, Mississippi, Nebraska, New York, North Carolina, Ohio, Oregon and Washington

<sup>5</sup>Bills in favor of legalizing recreational cannabis have been passed in Alaska (2014), Oregon (2014), California (2016), Maine (2016), Massachusetts (2016), Nevada (2016), Michigan (2018), Vermont (2018), Illinois (2019), Arizona (2020), Montana (2020), New-Jersey (2020) and South Dakota (2020) (see further detail on the US states legislation in Appendix A).

<sup>6</sup>Although Uruguay was officially the first country to legalize recreational cannabis in 2012, public skepticism slowed the process and distribution was delayed until July 2017. Licensed farms are allowed to grow cannabis for the local market, citizens could run cannabis cooperatives, and selected pharmacies acted as dispensaries for both medical and recreational cannabis.



## 2.1 Impacts of legalization on crime and violence

The first strand of the literature highlights the costs, in term of criminal activities and violence, of drug prohibition. Resignato (2000) shows that most drug-related violent crimes are the consequence of systemic factors linked to the *War on Drugs* rather than of psycho-pharmacological effects of drug use on crime. Indeed, prohibition increases incentives to engage in criminal behavior (MacCoun and Reuter, 2001). It promotes violence as almost the only way to resolve conflicts and secure market power, encouraging market strategies based on violence (Miron, 1999, 2003). This strengthens cartelization and leads Miron and Zwiebel (1995) to the conclusion that a free market for drugs would probably outperform prohibition in terms of social costs. The social costs linked to prohibition are exacerbated by “zero-tolerance” policies, which may encourage users to hold higher quantities (Caulkins, 1993).

In line with these arguments, Dills et al. (2017) show that liberalizing cannabis across US states did not lead to a rise in crime. Other evidence by (Brinkman and Mok-Lamme, 2019) shows that overall crime in Colorado decreased in areas where cannabis dispensaries were added. In particular, cannabis legalization could be responsible for a drop in local rapes and property crimes (Dragone et al., 2019).

The benefits of legalization policies extend to organized crime. In the states bordering Mexico, legalization of cannabis for medical purposes has decreased drug-trafficking related crime (Morris et al., 2014; Gavrilova et al., 2019; Chang and Jacobson, 2017). Furthermore legalization policies have shrunk criminals’ profits, weakening their power. In Italy, a legislative loophole leading to an unintended liberalization of cannabis decreased revenues from cannabis sales on the black market by 90-170 million euro (Carrieri et al., 2019).

## 2.2 Impacts of legalization on drug consumption

Due to their prohibited nature, illicit drugs are difficult to access and of uncertain quality, adding a substantial searching cost for consumers (Galenianos et al., 2012). Using a structural approach, Jacobi and Sovinsky (2016) explore the idea that cannabis legalization reduces this cost and removes the stigma of illicit consumption. They find that legalizing recreational cannabis would increase its use by around 48%. This is supported by Miller et al. (2017), who use survey data on undergraduate students at Washington State University to show that cannabis legalization induced a rise in

consumption early after being implemented. Moreover, the ease of access to licit drugs encourages individuals to start consuming cannabis earlier, as shown in the Netherlands by Palali and van Ours (2015).

As consumers react to the risk of being caught while buying cannabis illegally (Jacobson, 2004), legalization is likely to affect consumer behavior by lowering their risk. Experiences of medical and recreational cannabis legalization, involving lower sanctions, are correlated with rises in cannabis use. This is suggested by Hunt et al. (2018), who find Marijuana Dispensary Laws in California to be associated with a significant increase in driving under influence arrests. This effect on demand contributes to explain why the reduction in risk faced by consumers following legalization of recreational use has driven up prices for illegal cannabis in the US (Pacula et al., 2010). In this, cannabis is a normal good, with consumers sensitive to variations in prices and risk.<sup>7</sup>

Finally legalization does not seem to lead to the feared socially undesirable gateway effects to other substance use (Dills et al., 2017). On the contrary, cannabis seems to act as a substitute for more powerful and addictive opioids (Powell et al., 2018).

### 2.3 Legalization and taxation

From a public policy viewpoint, legalization creates a new source of revenue along with the option of controlling consumption levels using tax instruments. Since consumers are price sensitive -with price elasticities of demand between -0.5 and -0.79 (Davis et al., 2016; van Ours and Williams, 2007)-, a government may use taxes to regulate the increase in cannabis use following legalization. Becker et al. (2006) show that policies controlling drug use by taxes are more efficient than quantity reductions through prohibition. Taxing cannabis consumption may discourage early initiation into cannabis use by younger users, who are very responsive to low prices (van Ours and Williams, 2007).

Moreover, cannabis legalization could generate substantial public resources through taxation (Capputo and Ostrom, 1994, 1996). For instance the states of Colorado and Washington collect between

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<sup>7</sup>Although increasing consumption among the adults, legalizing cannabis seems to decrease consumption among the young, provided legal retailers refuse to sell it to underage consumers. DiNardo and Lemieux (2001) do not find any effect of cannabis decriminalization on consumption among high school students, a result confirmed by a recent study in Oregon Kerr et al. (2017). Furthermore, consumption of cannabis by teenagers is estimated to have decreased by 12% following legalization in the states of Washington and Colorado (SAMHSA, 2014).

USD 200 million and USD 300 million a year in taxes through the cannabis industry. In the state of Washington, this tax revenue is secured by a substantial degree of market concentration, which results itself from the high taxes set by the authorities (Hollenbeck and Uetake, 2021). In the US, Jacobi and Sovinsky (2016) estimate at around USD 12 billion the tax revenue, which could be raised from country-wide cannabis legalization.

The literature on cannabis legalization is mainly empirical. The review shows that, while prohibition fuels criminality and violence, it also helps contain cannabis consumption. In contrast, legalization leads to a decrease in overall criminality and generates tax revenue but at the cost of increasing cannabis consumption. By their empirical focus the papers reviewed cannot explain these trade-offs in a comprehensive way. They are limited by data availability and focus on specific geographic areas and topics (e.g. violence, youth consumption, public finance, etc.). Yet, getting a clear view of the trade-offs inherent to legalization of recreational cannabis is important for policy makers, before they embark into such important and controversial reform. We complement this literature by studying the theory behind the policy trade-offs. We set up a general environment, encompassing both expected-utility theory and prospect theory, which ensures the robustness of our results.

### 3 Prohibition equilibrium

We start our analysis by studying the illegal market under prohibition. In the absence of a legal option, consumers can only purchase illegal cannabis from dealers, who charge the price  $p$ .

#### 3.1 Demand under prohibition

Potential customers for illegal cannabis are heterogeneous. They have different “taste” for the commodity,  $\theta$ , which is drawn from the distribution  $G(\theta)$ , twice differentiable, with support  $\mathbb{R}$  and density function  $g(\theta)$ . Individuals who like cannabis are characterized by a positive  $\theta$ , and those who dislike it, by a negative one. When the illegal cannabis is of quality  $v \geq 0$ , its value for individual  $\theta$  is given by  $\theta v$ . In other words, cannabis is vertically differentiated (i.e., a higher  $v$  corresponds to a better quality cannabis). This assumption is an improvement over the existing literature, in which cannabis is generally modelled as a uniform product.

Since illegal activities entail risk, a consumer who purchases black market cannabis is subject

to a probability  $q \in [0, 1]$  of being caught by the police. If caught, he/she loses the benefit of the commodity, the price paid for it,  $p$ , and faces a legal punishment  $F \geq 0$  (e.g. fine, prison term). The net payoff of a consumer caught by the police while purchasing illegally is:  $-p - F$ ; while the net payoff for an individual who is not caught is  $\theta v - p$ . Therefore, choosing to consume cannabis illegally is a lottery  $\mathcal{L}_{\text{illegal}} = [-p - F, \theta v - p; q, 1 - q]$ . For an individual with characteristic  $\theta \in \mathbb{R}$ , this lottery has an expected value of

$$w^+(1 - q)u(\theta v - p) + w^-(q)u(-p - F), \quad (1)$$

where the utility function  $u(x)$  is continuous, strictly increasing in  $x \in \mathbb{R}$  and such that  $u(0) = 0$ ,<sup>8</sup> while the probability weighting functions  $w^+(x)$  and  $w^-(x)$  are increasing in  $x \in [0, 1]$ , so that  $w^+(0) = w^-(0) = 0$  and  $w^+(1) = w^-(1) = 1$ .

This framework is general. It encompasses the standard Expected Utility approach by setting  $w^+(1 - q) = 1 - q$  and  $w^-(q) = q$  and considering an increasing, concave utility function (e.g., CARA). It also encompasses Tversky and Kahneman (1992)'s Cumulative Prospect Theory (CPT), where attitudes towards risk are reference-dependent, probability weighting functions are not linear and the value function  $u(x)$  is S-shaped, with an inflection point at zero.<sup>9</sup> Reference-dependent models are more realistic (see Post et al., 2008). So is the S-shaped value function, allowing for diminishing sensitivity and loss aversion. It accounts for the facts that “perceptions are a concave function of the magnitudes of change” and that “people dislike losses significantly more than they like gains” (Rabin, 1998). This attitude towards risk has been largely documented empirically and in the lab (see DellaVigna, 2009, for a review of the literature).

Moreover, CPT is particularly adapted to our context as it is reference dependent and thereby models framing effects, i.e. the effects of the environment on decision-making. This is key when comparing the *pre-* and *post-legalization* equilibria.

The consumer of type  $\theta^I$ , indifferent between illegal consumption and no consumption, is characterized as follows:

$$w^+(1 - q)u(\theta^I v - p) + w^-(q)u(-p - F) = 0 \quad (2)$$

We show in Appendix B that, under our assumptions,  $\theta^I > 0$  exists and is unique. Any consumer of type  $\theta \geq \theta^I$  purchases illegal cannabis, while consumer of type  $\theta < \theta^I$  does not. Without loss of

<sup>8</sup>This is a normalization, intuitively reflecting that losses lead to a negative value and gains lead to a positive value.

<sup>9</sup>This theory is the most prominent among non-expected utility theories. While expected utility theories focus on final wealth, CPT models variations in outcome from a given *status quo*.

generality, the demand for the illegal commodity can then be written:

$$D^I(p) = \int_{\theta^I}^{+\infty} g(\theta)d\theta = 1 - G(\theta^I) \quad (3)$$

where  $\theta^I$  is the solution of equation (2).

The following static comparative results regarding the marginal consumer and the price elasticity of demand for illegal cannabis are also derived in Appendix B.

First,  $\theta^I$  increases with  $q$ : the demand for the illegal commodity decreases with the probability of arrest, which is the desired effect of prohibition policies. It discourages individuals from purchasing illegally, which leads to a more positive selection of consumers. Second,  $\theta^I$  increases with  $p$  so that a higher price reduces the demand. However, this is not a policy instrument under prohibition, since the equilibrium price on the illegal market results from interactions between unregulated (and untaxed) criminals.

Finally, the absolute value of the price elasticity of demand,

$$\epsilon_{D^I,p} = \frac{-D^I(p)p}{D^I(p)} = \frac{g(\theta^I)}{1 - G(\theta^I)} \frac{d\theta^I}{dp} p, \quad (4)$$

increases with  $q \in [0, 1]$  under the assumption that the distribution  $G(\theta)$  satisfies the monotone hazard rate (MHR) property. Since the MHR property is satisfied by most usual distributions, our general framework establishes that, for these distributions, the price elasticity of demand for cannabis increases with the risk of being caught, an intuitive result.

### 3.2 Cannabis supply under prohibition

We model the oligopolistic market for illegal provision of cannabis as a generalized Cournot competition, where a few criminal networks,  $i = 1, \dots, N$ , operate. Assuming symmetrical cost functions:  $C_i(q_i) = cq_i + K$  where  $K \geq 0$  is the sunk cost to set up the illegal network and  $c \geq 0$  is the constant marginal cost of supplying the commodity, we focus on symmetric equilibrium. The generalized Cournot price  $p^N$  with  $N$  smugglers is such that (see Carlton and Perloff, 2015 chapter 6):

$$\frac{p^N - c}{p^N} = \frac{1}{N} \frac{1}{\epsilon_{D^I,p}} \quad (5)$$

where  $N$  is an integer greater than or equal to 1 and  $\epsilon_{D^I,p}$  is the price elasticity of demand defined in (4). It is easy to check that, all else being equal, the price in (5) is increasing in the marginal cost of production,  $c$ , an intuitive result, and decreasing in  $N$ : the higher the number of competing providers the lower their mark-up. The generalized Cournot competition demand,  $D^I(p^N)$ , is between two extreme cases:  $D^I(p^m) \leq D^I(p^N) \leq D^I(c)$  for all  $N \geq 1$  where  $p^m \equiv p^1$  in the monopoly case and  $p^\infty = c$  in the competitive case when  $N \rightarrow \infty$ .

We have established in the Appendix B that the price elasticity of demand,  $\epsilon_{D^I,p}$ , increases with  $q$ . Using (5) we deduce that the oligopolistic price is lower when the risk  $q$  increases. Risk-aversion implies that the price charged by smugglers is lower than the price they would impose on risk neutral individuals with the same expected payoff from consumption.<sup>10</sup>

In a more dynamic setting, one can endogenize  $N$ . Since  $K$  is the sunk cost to enter the illegal market, the maximal number of criminal organizations  $N$  that can operate profitably is the integer part of  $n$  such that  $\pi(n) = K$ , where  $\pi(n) = (p^n - c) \frac{D^I(p^n)}{n}$  is the firm rent. Therefore, any repressive measure increasing  $c$  or  $K$  reduces the number of criminal networks active on the market,  $N$ , and increases the price they charge (see equation 5).

## 4 Legalization

To drive the dealers out of business, different policy makers including Québec's Minister of Public Health, Lucie Charlebois,<sup>11</sup> have used the intuitive approach of matching the price of legal cannabis to the black market price:  $p^L = p$ . We show easily that this policy increases consumption without necessarily eradicating crime.

Let  $\theta bv$  denote the value of consumption for an individual of type  $\theta$  considering the purchase of legal cannabis of quality  $bv$ . The parameter  $b \geq 1$ , hereafter called "quality differential", captures the fact that, unlike illegal products, legal products are certified and their potency and composition, including pesticide and other chemicals, are known to consumers at the time of purchase.<sup>12</sup> Moreover, purchasing legally alleviates search costs and personal cost in terms of ethics and social stigma. Finally, the purchase experience is usually better in a shop than on the street. So, in general, for the same

<sup>10</sup>Smugglers also face different types of consumers. If they can identify them, they may apply different prices. As is standard with third degree price discrimination, groups with the largest price elasticity get the smallest price. In contrast, captive consumers (i.e., groups with low price elasticity) are charged higher prices.

<sup>11</sup>See "Environ '7-8 dollars le gramme' pour du pot légal" by Martin Croteau in *La Presse*, September 21 2017.

<sup>12</sup>Quality certification under legalization usually involves regulating cropping techniques; in particular the use of pesticides, which are shown to be harmful for health (Subritzky et al., 2017).

type of product (e.g., weed), quality is better in the legal sector.

If it is possible to purchase cannabis at price  $p^L = p$  without risk of getting caught, the marginal consumer indifferent between consuming legal cannabis or not consuming at all is such that:

$$\theta^0(p) = \frac{p}{bv} \quad (6)$$

Comparing the legal threshold,  $\theta^0(p)$ , with the illegal threshold implicitly determined by (2) for a given price  $p$ , we show that the legal demand is higher than the demand for the illegal product:  $\theta^0(p) < \theta^I(p) \forall p > 0$ .<sup>13</sup> For a given price, the value of consuming legal cannabis is higher and there is no risk of being sanctioned, such that the demand for cannabis increases.

Moreover, a government setting a competitive price for legal cannabis such that  $p^L = p$ , ignores the fact that dealers may lower their price to keep some customers. In addition to increasing consumption, such a policy does not necessarily eradicate crime.

#### 4.1 Response of illegal suppliers to cannabis legalization

To determine a price of legal cannabis that would drive dealers out of business the government, a Stackelberg leader, needs to take into account the impact of response of illegal providers to its policy. As shown in Appendices B through F, all our results hold whether we model behavior under Expected Utility Theory or Prospect Theory. Only the way the marginal consumer is derived under legalization differs slightly in these two frameworks. In Prospect Theory, the marginal type,  $\theta^L(p, p^L)$ , indifferent between legal and illegal consumption, is the solution of :<sup>14</sup>

$$w^+(1 - q)u(p^L - p - \theta v(b - 1)) + w^-(q)u(p^L - p - \theta bv - F) = 0, \quad (7)$$

while, if individuals are expected utility maximizers, the marginal consumer is the solution of:  $(1 - q)u(\theta v - p) + qu(-p - F) = u(\theta bv - p^L)$ . For example, with a CARA utility function  $\theta^L(p, p^L)$  is such that  $(1 - q)u(p^L - p - \theta v(b - 1)) + qu(p^L - p - \theta bv - F) = 1$ , which is similar to (7) but not equal. Appendix C shows that, in both cases, there is a range of legal prices such that  $\theta^L(p, p^L)$  exists and is unique. Any individual above this threshold prefers to purchase legally rather than illegally.

<sup>13</sup>Indeed, when there is no risk of detection (i.e.  $q = 0$ ) then  $\theta^I_{q=0}(p) = \frac{p}{v} \geq \theta^0(p) = \frac{p}{bv} \forall b \geq 1$ . Since  $\theta^I$  increases with  $q$ , we deduce that:  $\theta^I(p) > \theta^I_{q=0}(p) \geq \theta^0(p) \forall b \geq 1$  and  $q > 0$ .

<sup>14</sup>In Prospect Theory individuals deciding between legal and illegal consumption take the certain payoff associated with the legal option,  $\theta bv - p^L$ , as reference. Engaging in illegal consumption is then modeled as a lottery  $[p^L - p - \theta bv - F, p^L - p - \theta(b - 1)v; q, 1 - q]$  which yields (7).

Recall that  $\theta^I$  defined in (2) is the threshold above which an individual prefers to make an illegal purchase rather than no purchase at all and that  $\theta^0$  defined in (6) is the threshold above which an individual prefers to purchase legally rather than not purchase. Let  $\tilde{p}^L(p)$  be the value of  $p^L$  such that

$$w^+(1-q)u\left(\frac{p^L-bp}{b}\right) = -w^-(q)u(-p-F), \quad (8)$$

with the probability weighting function being the identity under Expected Utility Theory. Two cases may occur following legalization, as shown in Appendix D.1.

1.  $p^L \leq \tilde{p}^L(p)$ . The legal price is low enough and legalization shows the intended effect of pushing the illegal providers out of the cannabis market:  $\theta^L \leq \theta^0 \leq \theta^I$ . In this case,  $\int_{\theta^0}^{\theta^I} g(\theta)d\theta$  new cannabis consumers appear as illustrated in Figure 1.

Figure 1: Change in consumers choice *post-legalization* when  $p^L \leq \tilde{p}^L(p)$

no cannabis consumption (no change)	New users (legal cannabis)	Switchers (from illegal to legal cannabis)
$\theta^L$	$\theta^0$	$\theta^I$

2.  $p^L > \tilde{p}^L(p)$ . The legal price is too high to undermine the dealers and  $\theta^I < \theta^0 < \theta^L$ . In this case, if the illegal providers maintained the same price as under prohibition, the overall demand for cannabis would not change. Consumers with valuation above  $\theta^L$  would switch to the legal market as shown in Figure 2 and the residual demand for illegal cannabis would become:

$$D^I(p, p^L) = \int_{\theta^I(p)}^{\theta^L(p, p^L)} g(\theta)d\theta. \quad (9)$$

Figure 2: Change in consumers choice *post-legalization* when  $p^L > \tilde{p}^L(p)$

no cannabis (no change)	illegal cannabis (no change)	Switchers (from illegal to legal cannabis)
$\theta^I$	$\theta^0$	$\theta^L$

A high-type segment of the former black market customers is captured by the new legal market. Under legalization, individuals with a high valuation for cannabis turn to the legal market and pay attention to quality, while they neglect it under prohibition where products are not certified.

Moreover, to keep some consumers and maximize their profits, illegal providers adjust their price,



$p$ . Let  $p^N(p^L)$  be the solution of (5) computed with  $\varepsilon_{D^I,p} = -\frac{\partial D^I(p,p^L)}{\partial p} \frac{p}{D^I(p,p^L)}$ , the direct price elasticity of the demand  $D^I(p,p^L)$  defined in (9), which depends on  $p^L$ . The price reaction function of the smugglers is the solution of the following equation:

$$p(p^L) = \begin{cases} p^N(p^L) & \text{if } c \leq p^N(p^L) < \frac{p^L}{b} \\ \emptyset & \text{otherwise} \end{cases} \quad (10)$$

As long as the illegal providers are active, i.e. have positive profits, their reaction price is increasing in their marginal operating costs,  $c$ , and in the price on the legal market,  $p^L$ ; and is decreasing in the number of active criminal networks in the market,  $N$ . Symmetrically, the higher the value of legal cannabis relative to illegal cannabis (the higher  $b$ ) and the lower the legal price,  $p^L$ , the lower  $\theta^L$  defined in (7) and the more difficult it is for criminals to attract consumers by decreasing their prices.<sup>15</sup>

After the illegal providers respond to the sale of legal cannabis, if the value for money of black market cannabis is sufficiently attractive relative to legal cannabis (i.e., if the price differential between the markets is high enough given the quality differential), we have  $\theta^I < \theta^0 < \theta^L$ , and the black market survives. Facing competition from the legal market to attract the high segment of the consumer distribution, illegal providers push down their prices, which increases the overall demand for cannabis. So far, this has been observed everywhere that cannabis has been legalized.

**Proposition 1.** *Once legal cannabis is introduced to the market, if the costs of operating on the black market and the repression against illegal purchases are held constant, for any level of quality differential,  $b \geq 1$ , the overall demand for cannabis increases.*

*Proof.* See Appendix D.2. □

This proposition highlights that if policy makers only use one instrument in case of legalization, which is to implement a legal market for cannabis by a price setting strategy, then they have to choose between the objective of controlling cannabis consumption with the help of a cartelized illegal market (the *status-quo* in many countries), or implementing a legal market, which increases cannabis consumption.

The flourishing opium market at the beginning of the 19th century illustrates this policy trade-off. To control the opium market in the East-Indies, the Dutch government imposed a state monopoly and

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<sup>15</sup>We show in Appendix C that  $\theta^L$  increases with  $p^L$ , while it decreases with  $b$  and  $p$ .

provided licences to consumers in what was called *opium regie*. Although the aim was to regulate the market and tax it better, it had to compromise between imposing low prices (getting lower revenues) and having fewer smugglers on the market, or getting higher revenues with a high regulated price, which allowed smugglers to enter the market and compete on price (van Ours, 1995).

## 4.2 Eradicating organized crime through legalization

Since many legalization reforms aim to eradicate crime, we now consider a price setting strategy for the legal supply which destroys economic incentives for dealers to operate illegally. The strategy is such that the price of dealers is pushed below their marginal costs after they respond to the policy, i.e.  $p(p^L) \leq c$ . Let  $\theta^I(p)$  be defined in (2). We deduce the next proposition.

**Proposition 2.** *To drive illegal suppliers out of business, the legal price of cannabis should be set below the eviction price  $\underline{p}^L = bv\theta^I(c)$ , which, without additional measures, yields the same level of consumption as under perfect competition among illegal suppliers:  $D^L(\underline{p}^L) = D^I(c)$ .*

*Proof.* See Appendix E. □

This result is general. Irrespective of the way we model consumers' behavior (i.e. EUT or Prospect Theory) and the initial market conditions (i.e. monopolist, oligopolistic or competitive), if the government wants to drive out illegal providers, it has to apply a price lower than the threshold price  $\underline{p}^L = bv\theta^I(c)$ , which is such that their mark-up vanishes after they respond to the policy. We refer to the price  $\underline{p}^L$  as the *eviction price*. Since  $\theta^I(c)v - c > 0$  it follows that  $\underline{p}^L > c$ : the threshold price for eliminating illegal suppliers is higher than smugglers' marginal cost,  $c$ . Nevertheless, in *post-legalization* equilibrium, the demand, which is now legal, is at the same level as if illegal suppliers were pricing at marginal cost under status-quo.

Compared to the status-quo situation of an oligopolistic illegal market, Proposition 2 shows that legalizing the cannabis market through setting the eviction price  $\underline{p}^L = bv\theta^I(c)$  would bring the demand of (legal) cannabis to the level of a perfectly competitive illegal market or higher. Public authorities therefore face a trade-off between an increase in cannabis consumption and crime eradication.

## 4.3 Eradicating organized crime while controlling cannabis use

Increases in drug consumption following legalization may not be desirable for the society, nor politically sustainable. In fact, to date, not a single politician proponent of legalization has disputed this. The

increase in cannabis consumption, if anticipated, will prompt opposition to legalization by many citizens, health workers and anti-drug associations. Policy makers need more sophisticated tools to regulate the demand for cannabis *post-legalization*. Our theoretical framework shows that the price that drives criminals out of business can be adjusted.

**Corollary 1.** *The eviction price  $\underline{p}^L$  increases with the marginal costs of illegal providers  $c$ , the probability of arrest of illegal consumers  $q$ , the associated fine amount  $F$ , and the quality differential between legal and illegal cannabis  $b$ .*

*Proof.* See Appendix F □

Intuitively, additional measures affecting  $c$ ,  $q$ ,  $F$  and  $b$  make competing with the legal provision of cannabis more difficult for illegal providers. Combining these four instruments helps contain the increase in cannabis consumption following legalization. This is either because consumers have higher relative expected payoffs if they consume legally, or because illegal providers operate with increased costs. Their economic activities can be throttled more easily such that the eviction price can be set higher. This dampens the increase in demand following legalization. The optimal combination of these instruments is discussed with the objectives of the reforms in Section 6.

## 5 Policy Implications

In this section we illustrate the implications of the theory, which combines legalization, sanctions, and investments in quality differentiation, in order to drive illegal providers out of business. The calibration exercise is based on the CPT functional forms derived by Tversky and Kahneman (1992). Our use of CPT is consistent with agents' behavior while considering risky gambles (for a literature review see Rabin, 1998; Barberis and Thaler, 2003; Barberis, 2013). In particular, this theory provides realistic predictions for individual behavior when confronted to risky choices, both inside (Glöckner and Betsch, 2008; Baltussen et al., 2016) and outside (Barberis et al., 2016; Post et al., 2008) the lab.

Tversky and Kahneman (1992) generalize the seminal paper by Kahneman and Tversky (1972), which was one of the first to show that individuals have a poor ability to assess probabilities. They tend to overestimate the odds of rare salient events, while they underestimate the odds of more common events. Criminal behavior is not exempt from this cognitive bias: the general public overestimates the probability of getting arrested (Chalfin and McCrary, 2017). Probability weighting functions ac-

count for individuals' distorted perceptions of probabilities.<sup>16</sup> In our framework, individuals choosing to purchase cannabis on the black market face a binary lottery, with a low probability  $q$  of being arrested (Nguyen and Reuter, 2012). The weighting function  $w^+(1 - q)$  (respectively  $w^-(q)$ ) applied to probabilities associated with positive (respectively negative) outcomes, proposed by Tversky and Kahneman (1992) is:

$$w^t(q) = \frac{q^{\gamma^t}}{(q^{\gamma^t} + (1 - q)^{\gamma^t})^{\frac{1}{\gamma^t}}} \quad \text{with } t = +, -. \quad (11)$$

and the value function is

$$u(x) = \begin{cases} x^\alpha, & \text{if } x > 0 \\ -\lambda(-x)^\alpha, & \text{if } x \leq 0 \end{cases} \quad \text{with } \alpha \in (0, 1) \text{ and } \lambda \geq 1. \quad (12)$$

Substituting (11) and (12) in (2), the marginal consumer is characterized by (see Appendix G):

$$\theta^I(p) = \frac{1}{v} \left[ \left( \lambda \frac{w^-(q)}{w^+(1 - q)} \right)^{\frac{1}{\alpha}} (F + p) + p \right]. \quad (13)$$

The legal price threshold  $\underline{p}^L = bv\theta^I(c)$  is then such that:

$$\underline{p}^L = b \left[ \left( \lambda \frac{w^-(q)}{w^+(1 - q)} \right)^{\frac{1}{\alpha}} (F + c) + c \right]. \quad (14)$$

Below we calibrate the eviction price  $\underline{p}^L$ , as well as the increase in (legal) cannabis consumption at this price and compare it to the level of illegal consumption under prohibition.

## 5.1 Benchmark values

The exogenous parameters calibrated by Tversky and Kahneman (1992) are  $\lambda = 2.25$ ,  $\alpha = 0.88$ ,  $\gamma^+ = 0.61$  and  $\gamma^- = 0.69$ . The remaining relevant policy parameters are  $q$ ,  $F$ ,  $c$ , and  $b$ . Our simulations aim to show how they interact, which is key to inform legalization policies and to set out a consistent set of objectives. For instance, most policy makers tend to frame legalization and repression policies as oppositional. Our simulations show that these two type of policies are complementary.

Since most studies so far focus on the US, our calibrations are based on US data. While the current

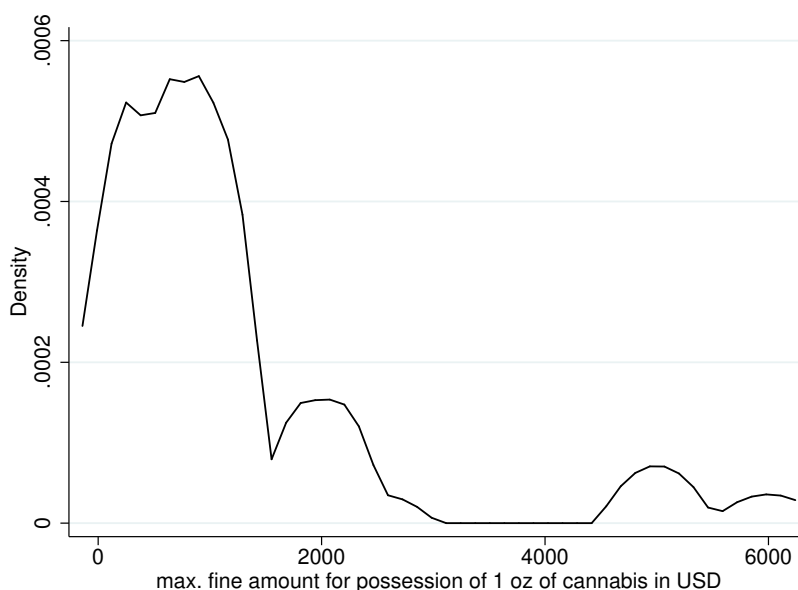
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<sup>16</sup>These functions are simply increasing mappings  $w : [0, 1] \mapsto [0, 1]$ , such that  $w(0) = 0$ ,  $w(1) = 1$ , and for  $x$  in the neighborhood of 0 (respectively 1)  $w(x) \geq x$  ( $w(x) \leq x$ ).

level of fines,  $F$ , the marginal costs of production of illegal suppliers,  $c$ , and the probability of arrest,  $q$ , are documented in several studies,  $b$ , the higher valuation of legal cannabis, requires more indirect inference.

The maximum fines applied for possession of illegal cannabis on a first offense vary across states, as represented in Figure 3 (NORML, 2020).<sup>17</sup> A non-negligible proportion of states apply fines of USD 1,000. This value is also the median value of the fines applied *on a first offense* across the United States as of March 2020, which we use as a benchmark. Since in some states fines are higher, and in other lower we perform a sensitivity analysis on a range of realistic values described in Figure 3.

Figure 3: Distribution of state maximum fine amounts for possession of 1 ounce of cannabis across the United States (in states where cannabis is prohibited, as of March 2020)



Using various assumptions, Caulkins (2010) estimates production costs of cannabis *post-legalization* between 70\$ and 400\$ per pound (i.e. approximately 80\$ and 470\$ in 2020), depending on the production method used. However, this estimate does not take into account distribution costs under prohibition, which are quite large. The LSE Expert Group on the Economics of Drug Policy (Quah et al., 2014) estimates the wholesale price of a pound of illegal cannabis under prohibition to be around 3,500\$ (i.e. 218.75\$ per ounce, or 237.5\$ in 2020), and about 10 times smaller under legalization – which is consistent with Caulkins (2010). The LSE Expert Group also reports the typical farmgate

<sup>17</sup>Note that we excluded Arizona from the sample, for this state does not set sanctions for possession of small amounts and features a maximum fine of USD 150,000 for the possession of any amount of cannabis.

price quoted in the media to be around 2,000\$ per pound (i.e. 125\$ per ounce). Accordingly, the marginal cost for an ounce of illegal cannabis *post-legalization* ranges between 25\$ and 125\$. We choose 50\$ as our benchmark value. This marginal cost of operation by illegal providers is hard to estimate more precisely. Besides, this cost increases with sanctions against black market suppliers, who incur losses and – costly – adapt their behavior. Therefore, a government willing to inflate the equilibrium price of black market cannabis can do so by intensifying repression against illegal producers and retailers. The marginal cost  $c$  being a policy tool, rather than an exogenous parameter, motivates our sensitivity analysis using a large range of values.

The probability of being arrested in possession of illegal cannabis in the United States varies across settings. Nguyen and Reuter (2012) highlight that sex, age, and ethnicity influence the probability of being stopped by the police, and therefore of being arrested. The authors argue that in most groups, the average probability of being arrested is around 1%. This characterizes the situation under prohibition. Following the legalization of recreational cannabis, illegal users are more difficult to detect. We therefore set the benchmark value for the probability of arrest at  $q = 0.1\%$  *post-legalization*. As this policy parameter varies across settings and groups, and is strongly affected by repressive policies against the residual black market, we perform a sensitivity analysis using a large range of values for  $q$ . This includes a 0 probability of being arrested to reflect lax enforcement against the illegal market.

The parameter  $b$  describes the higher valuation of legal cannabis relative to cannabis bought on the black market for a similar type of product. This gap is difficult to measure. Not only does it encompass product attributes in terms of chemical composition (e.g. potency, taste), but it also includes quality standards, both at the upstream (cropping and processing) and the retail (shopping experience) levels. To anchor the simulations on quantifiable measures, the benchmark value of the parameter  $b$  is set using the relative THC potency of cannabis bought legally or illegally. Taking the potency or purity as a measure of quality is relatively standard in the literature on markets for illicit drugs (see for instance Galenianos et al., 2012; Galenianos and Gavazza, 2017). According to ElSohly et al. (2016), the average THC potency of cannabis seized in the US in 2014 was 11.84%, while around the same time, the THC potency on Colorado’s legal market was 18.7%.<sup>18</sup> Based on this difference, a benchmark measure for  $b$  could be  $\frac{18.7}{11.84} \approx 1.58$ . The fact that consumers treat legal

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<sup>18</sup>Briggs, Bill. 2015 “Colorado Marijuana Study Finds Legal Weed Contains Potent THC Levels”. *CNBC News*, March 23.

cannabis as a superior commodity compared with illegal cannabis is also in line with experimental findings on the substitutability of legal and illegal cannabis in catchment areas where the two types of products are available (Amlung et al., 2019). The sensitivity analysis will consider a large range of values for the parameter  $b$  as it can be fine-tuned by public policies.<sup>19</sup> This will also include values below 1, reflecting poor quality of products as initially experienced by consumers in Canada following the legalization reform.

Using the benchmark values  $F = 1,000$ ,  $c = 50$ ,  $q = 0.1\%$  and  $b = 1.58$ , together with the parameters  $\lambda = 2.25$ ,  $\alpha = 0.88$ ,  $\gamma^+ = 0.61$ ,  $\gamma^- = 0.69$  estimated by Tversky and Kahneman (1992), we use equation (14) to calibrate the eviction price for legal cannabis at around USD 97.79 per ounce (see row 1 of Table 2). For comparison, we present in Table 1 the illegal and legal prices,  $p$  and  $p^L$  respectively, observed in 7 states of the U.S., in 2018. We report the number of licensed recreational retailers, which we compare to the number of McDonald's restaurants. We also present each state's share of the U.S. legal market for cannabis. These figures give an idea of the degree of liberalization of the market for recreational cannabis in each state and of the relative position of the black market, which are discussed in Section 6.

With the exception of Colorado and Oregon, our eviction price for legal cannabis is significantly lower than the legal prices on these markets, which helps explaining why the black market is thriving in some of them, especially California. In line with our analysis, consumers in Colorado and Oregon have massively shifted toward the legal market for their purchase of cannabis, thanks to prices in the range of the eviction price.<sup>20</sup> The research firm New Frontier Data (NFD) estimates Oregon's legal market share at 86% in 2020, just behind its share in Colorado, at 87% (New Frontier Data, 2020). In the same report, NFD forecasts that by 2025, 93% of cannabis demand in Oregon will be met with legal products.

This shift toward legal cannabis was accompanied by a bump in overall demand: the National Survey on Drug Use and Health reports cannabis prevalence in Oregon to have increased by almost 60% between 2014 and 2017. Colorado saw a similar evolution of its demand between 2012 and 2015, having preceded Oregon in its legalization reform.<sup>21</sup>

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<sup>19</sup>First, the composition of legal products is certified, which implies that consumers are *able* to choose between different potency, according to their taste. Second, the legal market is subject to quality regulation and controls, including those regarding the use of pesticides and other health-damaging substances. Third, the purchase experience is more pleasant and safer in a shop than under cover in the street.

<sup>20</sup>Oregon commission reports from 2019 and 2021 both demonstrate that this state, where legal prices are the lowest and where licences have been flourishing, has been successful in “[offering] the illicit market steep competition” (Oregon Liquor Control Commission, 2021).

<sup>21</sup>The NSDUH bases these estimates of prevalence of cannabis use upon the extensive margin of consumption over

Table 1: Legal markets across the U.S.

State	$p$	$p^L$	Recreational retailers	McDonald's restaurants	Share of US legal market	Population
AK	298.24	361.57	123	32	0.63%	0.7
CA	256.57	344.45	901	1,279	34.9%	39.5
CO	241.75	143.07	587	209	15.1%	5.6
MA	339.68	354.25	113	170	4.2%	6.9
NV	270.57	295.54	70	134	2.6%	3.0
OR	210.39	127.06	661	130	7.7%	4.2
WA	233.73	$\approx$ 196	512	167	12.8%	7.5

Prices are in USD per ounce, as of fall 2018. The legal price for Washington State is extrapolated from Jeanne Lang Jones and Rob Smith. 2019. "Tight Regulations, High Taxes May Keep Washington State's \$1.4B Cannabis Industry from Really Blooming". *Seattle Business*. January. All other legal prices are state averages quoted from New Frontier Data (2019), while state average black market prices were retrieved from the crowd-sourced website [priceofweed.com](http://priceofweed.com), which was accessed using the Internet archive Wayback Machine. Numbers of retailers and testing facilities were retrieved from New Frontier Data's "Cannabis Legalized States" interactive map, as of July 2020. The number of McDonald's restaurants in each state was scraped from Google Places, as of August 2020. Shares of the US legal market are projections quoted from New Frontier Data (2017). Population is expressed in million inhabitants, as of 2018.

Finally, we want to compute the increase in demand following the legalization at eviction price. This requires an estimate of the price elasticity of demand of cannabis. Van Ours and Williams (2007) estimate that the price elasticity of demand ranges between -0.50 and -0.70, while Davis et al. (2016) find a price elasticity between -0.67 and -0.79. In line with this empirical evidence, our calibrations allow for a range of price elasticities of demand between -0.5 and -0.8. Assuming that the taste for cannabis  $\theta$  is normally distributed, we calibrate in Appendix H.1 the distribution parameters of the Gaussian distribution using our model and the literature on cannabis demand. Appendix H.1 shows that the mean value of  $\theta$  varies between -436.4 and -1090.9 when the elasticity varies between -0.8 and -0.5. This negative average "taste" parameter for cannabis is consistent with surveys in the US reporting negative attitudes towards cannabis consumption on average.

The first row of Table 2 presents the benchmark values of the policy parameters in columns 1 to 4, the eviction legal price  $p^L$  around USD 98, and the resulting relative increase in the extensive margin of consumption *post-legalization*. It shows that the increase in demand is predicted to be between 53% and 92% depending on the price elasticity of demand used for the calibrations.

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a 12-month period, for a population aged over 12. In Colorado, the estimated prevalence was 10.41% in 2011-2012 and 16.57% in 2014-2015. In Oregon, it was 12.38% in 2013-2014, 12.73% in 2014-2015 and 19.23% in 2016-2017. These figures were retrieved online using the Substance Abuse and Mental Health Data Archive public data analysis system (<https://pdas.samhsa.gov/saes/state>).



## 5.2 Effects of policies on post-legalization equilibrium

This section studies the sensitivity of the eviction price and of the *post-legalization* demand to parameters that can be influenced by policies. Several instruments are considered: reinforcing sanctions may increase the marginal cost of operations for illegal suppliers,  $c$ , the probability of arrest,  $q$ , or fines to illegal consumers,  $F$ . Moreover, investing in the quality of the legal cannabis, including the purchasing experience, taste of the product, certification of potency and of the healthiness of the production process, and information/education campaigns about the danger of consuming illegal cannabis will increase the relative valuation of consumption of legal cannabis,  $b$ . This aspect is generally overlooked by proponents of cannabis legalization. Yet our simulations show that it is an important instrument of any successful reform.

Rows 2 to 7 of Table 2 present several scenarios regarding the marginal cost of operating on the black market. In the first scenario, the marginal cost for illegal production and distribution of cannabis drops to 15\$ per ounce. This captures a situation in which controls are very lax and hence are not inflating the marginal cost of operation for illegal suppliers, which comes close to the estimates given by Caulkins (2010). We then present other cases where increasing and enforcing the sanctions against illegal producers and retailers raises the marginal cost of production on the black market up to 250\$.

Another parameter whose evolution is hard to predict is  $b$ . Indeed, when retail sales for cannabis are legal, certified products appear, which is likely to increase  $b$ . Moreover, legalization decreases search costs, which also contributes to raising  $b$ . Meanwhile, being challenged by a newly legalized market, black market producers and retailers may decide to invest in better products and services. For instance, some consumers may not want to be seen coming in person to a dispensary, due to social stigma or professional constraints that strictly forbid them to consume cannabis (in the case of truck drivers for example), and may turn to a black market delivery service. This may reduce the relative value of legal cannabis. Starting from our benchmark value,  $b = 1.58$ , rows 8 to 12 consider alternative cases, for  $b$  increasing to 3.00 or falling to 0.50.<sup>22</sup>

Rows 13 to 18 vary the probability of being caught on the black market,  $q$ . Once a legal market is established, it may become more costly to detect consumers of illegal cannabis than it was under strict prohibition, such that  $q$  may decrease. On the other hand, it may be politically more feasible to

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<sup>22</sup>Appendix H.4 discusses the case with  $b < 1$ .

Table 2: Sensitivity of legalization price (in USD per ounce) and change in *post-legalization* demand (in percentage)

Policy parameters				Eviction price	Increase in demand			
$c$	$b$	$q$	$F$	$\underline{p}^L$	$\epsilon = -0.5$	$\epsilon = -0.6$	$\epsilon = -0.7$	$\epsilon = -0.8$
50	1.58	0.1%	1000	97.79	53%	65%	78%	91%
15	1.58	0.1%	1000	41.86	64%	79%	95%	111%
25	1.58	0.1%	1000	57.84	61%	75%	90%	105%
75	1.58	0.1%	1000	137.74	46%	56%	67%	78%
100	1.58	0.1%	1000	177.68	38%	47%	56%	65%
150	1.58	0.1%	1000	257.58	25%	30%	35%	41%
250	1.58	0.1%	1000	417.37	0%	-1%	-1%	-1%
50	0.50	0.1%	1000	30.95	66%	82%	98%	115%
50	0.75	0.1%	1000	46.42	63%	78%	93%	109%
50	1.00	0.1%	1000	61.89	60%	74%	89%	104%
50	2.00	0.1%	1000	123.78	48%	59%	71%	83%
50	3.00	0.1%	1000	185.68	37%	45%	54%	63%
50	1.58	0.0%	-	79.0	57%	70%	84%	98%
50	1.58	0.01%	1000	82.06	56%	69%	83%	97%
50	1.58	0.2%	1000	111.56	51%	62%	74%	87%
50	1.58	0.5%	1000	146.68	44%	54%	64%	75%
50	1.58	1.0%	1000	197.33	35%	43%	51%	59%
50	1.58	2.0%	1000	287.37	20%	24%	28%	33%
50	1.58	0.1%	500	88.84	55%	68%	81%	95%
50	1.58	0.1%	1500	106.74	52%	63%	76%	88%
50	1.58	0.1%	2000	115.68	50%	61%	73%	85%
50	1.58	0.1%	3000	133.58	46%	57%	68%	79%
50	1.58	0.1%	5000	169.37	40%	49%	58%	68%

Notes: Behavioral parameters are set at  $\lambda = 2.25$ ,  $\alpha = 0.88$ ,  $\gamma^+ = 0.61$ , and  $\gamma^- = 0.69$  as estimated by Tversky and Kahneman (1992). Variation in demand relies on the baseline estimates for the parameters of the distribution of  $\theta$  corresponding to different price elasticities of demand, as described in Table 5.

be tough on consumers of illegal cannabis, such that  $q$  may increase. Rows 19 to 23 allow for several values of fines,  $F$ . For similar reasons, it may or may not be easier to implement higher fines with legalization, which is captured by the range of values chosen for the sensitivity analysis. In particular, it might be politically easier to implement higher fines when a legal alternative exists.

The results highlight that the recommended eviction price, presented in column 4, and the rise in cannabis consumption *post-legalization*, in columns 5 to 8, respond strongly to each policy parameter,  $c$ ,  $b$ ,  $q$  and  $F$ . Yet some are easier to change than others. An intuitive idea to increase the eviction price  $\underline{p}^L$ , at seemingly low costs, would be to increase the fine  $F$ . For example, with a USD 5000 fine

for illegal purchase and other parameters set at their benchmark values then a legal price around USD 169 per ounce would evict illegal providers and contain the increase in consumption below 40% to 68%. However, this ignores the fact that high fines are expensive to enforce as they crowd the judicial system. For similar reasons, it is costly to enforce arrests of users of recreational cannabis.<sup>23</sup>

More promising are policies enforcing sanctions against providers, instead of consumers. Our simulations show that marginal costs of production for illegal providers play a large role in the control of cannabis consumption *post-legalization*. For example, not enforcing repression against illegal providers would entail low production costs at around USD 15 per ounce and push the eviction price of cannabis down to USD 42. This would increase consumption *post-legalization* by 64% to 111%. So maintaining pressure on criminal networks is key to the success of any legalization reform, whether the objective is to raise fiscal revenues or to control consumption of psychoactive substance. This shows again that legalization and sanctions against illicit activities are complementary policies.

An under-explored channel highlighted by the calibrations is to strengthen the quality differential between legal and illegal cannabis. From a policy perspective it may seem counter-intuitive to invest in quality control and marketing of legal cannabis to promote the *post-legalization* demand, especially when a large fraction of the population is opposed to the legalization. Yet, the eviction price strongly increases with the differential in quality valuation,  $b$ , such that total consumption decreases with it. For example, doubling it from 1.58 to 3 pushes the eviction price of cannabis up to USD 186, limiting the increase in consumption to 37% to 63% *post-legalization*. Although this channel is effective at tilting consumption towards the legal sector and controlling it, effort to improve quality of legal products and advertise it has been generally neglected by public authorities. This explains in part some countries' disappointing experience with reform (see more on this in Section 6). It has also been largely overlooked by researchers in economics. To the best of our knowledge we are the first to look into this important aspect of cannabis legalization policies.

The policy scenarios discussed so far only affected one parameter at a time. In practice, these measures can be combined, which, with convex cost functions, is more cost-effective (see Section 6). For instance if the probability of arrest goes up to 0.5% *post-legalization* and fines are set to USD 4000,

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<sup>23</sup>Yet maintaining the probability of arrest to the prohibition level,  $q = 1\%$ , entails an increase in the price of legal cannabis up to USD 197 per ounce, which would contain the increase in consumption below 35% to 60%.

a quality differential of 2 enables to set the eviction price at USD 422, which maintains consumption at the prohibition level. This is only one illustrative example. Other more realistic examples and a discussion of the sensitivity analysis of eviction price and *post-legalization* consumption to combined measures can be found in Table 10 in Appendix H.3. Both sets of results highlight that, unless significant investments in the quality of legal products and controls against the illegal market are made, the eviction price is around USD 100 USD or below. This implies an increase in demand by more than 50% to more than 100% depending on the price elasticity considered.

## 6 Enlarging the set of policy objectives

We have focused on policies that try to eliminate the black market while controlling the subsequent increase in consumption, but governments pursue a larger set of objectives when they implement legalization policies. These include restricting access to psychotropic drugs for the youngest users, reducing the negative externalities generated by the consumption of uncertified psychoactive substances, redeploying police forces and relieving congestion in courts and prisons to reduce enforcement costs, increasing consumer surplus, developing a sector that generates legal activities and employment while controlling the quality of products and generating new tax revenues. Although current reforms share most of these objectives, they may have different priorities.

In this section we model a (utilitarian) government's objective function as a linear combination of these objectives and study how they interact. We show that they sometimes reinforce each other, while in other cases they are conflicting. This offers an explanation as to why some reforms have been disappointing in the past.

The timing is as follows.

1. The government chooses the price of the legal cannabis  $p^L = (1 + \tau)c^L$ , where  $c^L$  is the marginal cost of producing the commodity legally and  $\tau$  is the level of excise tax.<sup>24</sup>

In other words, it chooses the final price paid by consumers by choosing the tax rate. It also

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<sup>24</sup>Cannabis is an agricultural product easy to grow as it is highly adaptable to various conditions. When the government encourages competition among the growers and the retailers, they do not make any rent. It can then modulate the final price by imposing an excise tax (e.g. as is widely done for the retail of tobacco). We focus on this case, for the sake of simplicity. More generally, the government may influence the concentration on the legal market by artificially raising its cost of entry (e.g. limiting the number of licenses). Yet, the Cournot price when legal retailers compete among themselves, net of taxes, is proportional to the marginal cost. Our results therefore extend easily to an oligopoly setting. The share of the sector rent captured by the government is simply smaller with an oligopoly.

sets the level of repression by influencing, on the demand side, the probability of arrest  $q$  and the fine  $F$ , and on the supply side, the increase in marginal cost to produce illegally due to repression,  $\delta \geq 0$ , such that  $c = (1 + \delta)c^L$ . Finally, the government takes measures to boost the quality differential between legal and illegal products,  $b \geq 1$ .

2. The consumers decide whether to consume or not, and on which market. Depending on the relative prices of legal and illegal products and the quality differential, the black market survives or is eradicated (see Appendix I.1 for more details).

Let's note  $e = (F, q, \delta)$  the level of enforcement of repression against consumers and producers of illegal cannabis. The government objective function is:

$$W^G(e, b, \tau) = \alpha_T T(e, b, \tau) - \alpha_C C(e, b, \tau) + \alpha_S S^c(e, b, \tau) - \alpha_\xi \xi(e, b, \tau) \quad (15)$$

where  $\alpha_T \geq 0$ ,  $\alpha_C \geq 0$ ,  $\alpha_S \geq 0$ ,  $\alpha_\xi \geq 0$  and where

- $T(e, b, \tau) = \tau c^L D^L(p, (1 + \tau)c^L | b)$  is the revenue from excise taxes on legal cannabis.
- $C(e, b, \tau) = E(\delta, q) - q D^I(p, (1 + \tau)c^L | b) F$  is the enforcement cost net of the fines, with the gross cost of enforcement,  $E(\delta, q)$ , being increasing and convex in  $\delta$  and  $q$ .
- $S^c(e, b, \tau) = S^L(p, (1 + \tau)c^L | b) + S^I(p, (1 + \tau)c^L | b) - \Psi(b)$  is the sum of the consumer surpluses on the legal and illegal markets, net of  $\Psi(b)$ , the cost of legal cannabis quality improvement, which is strictly increasing and convex.

–  $S^L(p, (1 + \tau)c^L | b) = \int_{(1 + \tau)c^L}^{\infty} D^L(p, t | b) dt$  is the net consumer surplus on the legal market.

–  $S^I(p, (1 + \tau)c^L | b) = (1 - q) \int_p^{\bar{p}^I} D^I(t, (1 + \tau)c^L | b) dt - q D^I(p, (1 + \tau)c^L | b) F$  is the net consumer surplus on the illegal market, with  $\bar{p}^I$  being the choke-off price on the illegal market. It is defined as the price  $p$  such that equation (8) holds with equality for  $p^L = (1 + \tau)c^L$ .

- Finally the negative externalities generated by the legal and the illegal sectors are increasing in their respective demands:  $\xi(\tau, e, b) = \xi_I D^I(p, (1 + \tau)c^L | b) + \xi_L D^L(p, (1 + \tau)c^L | b)$ , with  $\xi_I \geq 0$  and  $\xi_L \geq 0$ .

We consider in turn four different objectives that can be decentralized through the choice of enforcement of sanctions against the illegal sector,  $e = (F, q, \delta)$ , and regulation of the legal sector  $(b, \tau)$ , and study whether they are compatible with the goal of deflating organized crime by setting an eviction price for legal cannabis.

**Minimizing negative externalities:**  $\alpha_T = \alpha_S = \alpha_C = 0$  and  $\alpha_\xi > 0$

Because both legal and illegal consumption of psychotropic substances entail health hazards, a government focusing on such externalities minimizes  $\xi(\tau, e, b) = \xi_I D^I(p, (1 + \tau)c^L|b) + \xi_L D^L(p, (1 + \tau)c^L|b)$ .

Prohibition corresponds to the case in which legal use of cannabis is perceived as having larger negative externalities than illegal use:  $\xi_I \leq \xi_L$ . Only in this case does the government minimize total consumption. All else being equal (i.e., for the same investment level in repression) legalization inevitably leads to an increase in demand as shown in Section 4. Therefore, for a given repression budget, prohibition is the policy that minimizes total consumption of cannabis. To limit the (black market) demand for cannabis, the government should invest in repression. Increasing the sunk costs and the marginal cost of producing illegally pushes the number of illegal providers  $N$  down and their prices up. The highest price and lowest demand is achieved by a criminal monopolist. It should also increase the repression against users (i.e.,  $q$  and  $F$ ) to decrease the number of people willing to purchase the illegal substance (i.e., to increase  $\theta^I$  in 3).

In contrast, a government may consider that illegal cannabis is more harmful than legal cannabis for several reasons. The quality of legal products can be certified and health damages reduced. Illegal cannabis can be sold to minors or vulnerable groups, who are at risk of developing psychosis. The ban of sale to the under-aged cannot be enforced on the black market: many criminals do not mind who is buying their products, as long as they get paid. Finally, it generates a whole range of criminal activities, including violence, corruption and money laundering (see Section 2). This case corresponds to  $\xi_I > \xi_L \geq 0$ . Clearly if  $\xi_L = 0$ , the legalization at eviction price  $\underline{p}^L = bv\theta^I(c)$  is optimal. Indeed if consumers derive utility from cannabis consumption without incurring, nor generating, any negative externality, then reducing use is a cost, not a benefit. Certain practices, such as driving or working under the influence, should still clearly be prohibited but might be appropriate targets for a different kind of selective policies.<sup>25</sup> If  $\xi_L > 0$ , the government seeks to annihilate illegal consumption while controlling legal demand, which is achieved through the policy mix described in the corollary 1.

<sup>25</sup>We are grateful to Jeffrey Miron for this comment.

**Minimizing net enforcement cost:**  $\alpha_T = \alpha_S = \alpha_\xi = 0$  and  $\alpha_C > 0$

A government may want to minimize the burden for tax payers of the net enforcement cost of repression,  $C(\tau, e, b) = E(\delta, q) - qD^I(p, (1 + \tau)c^L|b)F$ . In practice,  $qD^I(p, (1 + \tau)c^L|b)F$ , the revenue from arrests, is always lower than the gross cost of enforcement,  $E(\delta, q)$ . The solution consists in implementing the eviction price  $\underline{p}^L = bv\theta^I(c)$ . The government avoids investing too much in repression ( $q$  and  $\delta$  should be minimal) as it is costly. It implies that  $\theta^I(c)$  in (3) will be low in equilibrium. It also implies that the level of taxes will have to be relatively low at  $\tau^{\alpha_C} = \frac{bv\theta^I(c)}{c^L} - 1 > 0$  since  $v\theta^I(c) > c \geq c^L$ . In other words, minimizing the cost of enforcement in a regulated cannabis market is best achieved by implementing a relatively low eviction price, which means that the subsequent increase in demand for cannabis is large. To manage the demand, the government should encourage investment in quality of the legal products, which increases the eviction price and implies a lower increase in *post-legalization* demand. This obviously comes at a cost, which is not internalized in this objective as it is borne by the private sector (i.e., the firms that sell legal cannabis).

A government concerned with the increase in consumption related to legalization at the eviction price may try to minimize the net enforcement cost, while containing consumption. This is typically the objective of most prohibitionist governments, which corresponds to  $\alpha_C > 0$  and  $\alpha_\xi > 0$  with  $\xi_I < \xi_L$ . The problem they solve is to minimize  $C(e) = E(\delta, q) - qD^I(p, (1 + \tau)c^L|b)F$  subject to  $D^I(p) \leq \bar{D}$ . Since reducing the illegal demand is only made possible by further – costly – investments, for a given level of fine  $F$ , the constraint is binding:  $D^I(p, (1 + \tau)c^L|b) = \bar{D}$  and the optimal levels of  $q$  and  $\delta$  then satisfy

$$\frac{\frac{\partial D^I(p, (1+\tau)c^L|b)}{\partial q}}{\frac{\partial D^I(p, (1+\tau)c^L|b)}{\partial \delta}} = \frac{\frac{\partial E(\delta, q)}{\partial q} - F\bar{D}}{\frac{\partial E(\delta, q)}{\partial \delta}} \quad (16)$$

Equation (16) is a standard result: to optimize the utilization of inputs (here law enforcement resources) the marginal rate of transformation between  $q$  and  $\delta$  in terms of reduction of demand should be equal to their relative marginal cost. Interestingly, everything else being equal, increasing  $q$  is more cost effective than increasing  $\delta$  as the government collects fines when users are arrested. Technically, the Lagrange multiplier of the optimization problem is increasing in the fine amount  $F$ . In theory, fixing a very large value for  $F$  is a cheap way to control demand. Yet, as mentioned in Section 5, very high fines are not feasible in practice, as most individuals caught would not be able to pay them. This would result in – costly – congestion of the judicial system.

Finally the way repression is targeted and enforced matters too. For the sake of simplicity, we

focus on vertically integrated drug dealers, which abstracts from the fine tuning of repression policies. Yet, unpacking the vertical relationship between traffickers and retailers yields interesting and subtle insights (Poret, 2002, 2009). The effects of tougher drug law enforcement policies, depending on whether they target retailers or traffickers, have different effects on wholesale and retail prices of drugs. Poret (2002) hence shows that ill targeted efforts to increase repression can, by disrupting well organized drug cartels, decrease final users' prices and increase the number of consumers.

**Maximizing consumer surplus:**  $\alpha_T = \alpha_\xi = \alpha_C = 0$  and  $\alpha_S > 0$

If a government focuses on consumer surplus, it should choose a price  $p^L$  lower than (or equal to) the eviction price  $\underline{p}^L = bv\theta^I(c)$ . Indeed, for the same quantity consumed, the surplus of users is larger with a legal option than an illegal one. The government should therefore implement a legalization policy with a price low enough to shut down the illegal market. In the limit, when it has no other objective, it should set the tax at  $\tau = 0$ , so that  $p^L = c^L$ . The government should also aim to improve the quality of cannabis products (notably in terms of variety, availability, marketing and packaging). The quality investment that maximizes consumer surplus equalizes the marginal surplus of consumers with the marginal cost of quality improvement:  $\int_{(1+\tau)c^L}^{\infty} \frac{\partial D^L(t|b)}{\partial b} dt = \Psi'(b)$ .

**Maximizing tax revenue:**  $\alpha_S = \alpha_\xi = \alpha_C = 0$  and  $\alpha_T > 0$

When focusing on tax revenue, the government will choose  $\tau^{\alpha_T} > 0$  such that  $\frac{\partial T}{\partial \tau} = 0$ , assuming an interior solution exists. This is equivalent to:

$$1 - G(\theta^l) = \tau c^L g(\theta^l) \frac{\partial \theta^l}{\partial p^L}, \quad (17)$$

with  $\theta^l = \theta^0 = \frac{p^L}{bv}$  if in the initial situation the black market has been eliminated, and  $\theta^l = \theta^L$  defined in (7) if not. In Appendix I.2, we develop an example where  $\theta$  follows an exponential distribution on the positive real line so that we can derive closed form solutions. This simple example highlights that the unconstrained solution (i.e., in the absence of competition by the black market) leads to a larger excise tax than the constrained solution:  $\tau_0^{\alpha_T} \geq \tau^{\alpha_T}$ ,<sup>26</sup> which is intuitive. When the government does not have to deal with competition it can impose higher taxes, as the consumers are captive. Unsurprisingly, the price resulting from the tax optimization problem is generally higher than the eviction price  $\underline{p}^L = bv\theta^I((1 + \delta)c^L)$ .

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<sup>26</sup>They are equal only when  $q = 1$ .



More generally, when the government aims to maximise tax revenue, a portion of the black market will survive. As in Section 5, we run calibrations to compute the prices in both the legal and the illegal markets when the government focuses on maximizing tax revenues. We use the same benchmark values of the policy parameters as in Section 5 and a value for the marginal costs to produce in the legal sector around USD 25 in line with Quah et al. (2014) and Caulkins (2010). Methodological detail, as well as further examples, can be found in Appendix I.3. Table 3 explores different scenarios in terms of enforcement and quality.

The first column presents the *post-legalization* concentration on the illegal market. Using the Cournot optimality condition with the benchmark black market price and marginal cost valued at USD 320 and USD 50 respectively, yields a concentration on the black market under prohibition of between 0.42 and 0.68, when the price demand elasticity varies between 0.5 and 0.8. We therefore chose 0.55 as a benchmark value for this parameter. Although the concentration on the black market is not a policy parameter *per se*, the legalization may generate changes in the concentration on the black market, which is why we study scenarios where this parameter varies from 0.10 to 1.00. Columns 2 to 5 describe the values of the other policy parameters, whose notations are unchanged. Columns 6 and 7 provide the equilibrium prices on the black market and on the legal market, while columns 8 and 9 give the overall increase in demand  $\Delta D(p, p^L)$ , as well as the share of the black market in the total demand,  $\%D^I$ . Column 10 describes the tax revenue in USD *per capita* and *per annum* derived from state cannabis sales for the specified price and demand on the legal market. The last three columns provide the eviction price, as well as the corresponding increase in demand and tax revenue in USD *per capita* and *per annum*.

The results highlight that in most cases, the price on the legal market maximizing the tax revenue from legal sales, roughly USD 300 per ounce, is much higher than the eviction price. This result is consistent with the fact that the state of Washington, where the average legal price for cannabis is around 200 USD per ounce (see Table 1), would position itself on the ascending portion of the Laffer curve as argued by Hollenbeck and Uetake (2021). In the baseline scenario price that maximizes tax revenue is three time higher than the eviction price, which is roughly USD 100 per ounce. In this case, the black market survives and accounts for a third of the overall market. Depending on the setting, it may account for 15% to up to 44% of the market. This result is consistent with the black-market to be responsible for 15% to 50% of the transactions in the state of Washington (Arcview Market Research and BDS Analytics, 2019), as the the average legal price for cannabis is roughly the double of the

Table 3: Legalization price and demand when the government maximizes tax revenue

$\frac{1}{N}$	Policy parameters				Equilibrium prices		Demand and revenue			Eviction scenario		
	$c$	$b$	$q$	$F$	$p$	$p^L$	$\Delta D(p, p^L)$	$\%D^I$	$R$	$\underline{p}^L$	$\Delta D(\underline{p}^L)$	$\underline{R}$
0.55	50	1.58	0.1%	1000	95.33	297.47	33%	35%	341	97.79	104%	151
0.55	25	1.58	0.1%	1000	78.60	292.94	29%	39%	320	57.84	113%	71
0.55	125	1.58	0.1%	1000	146.13	311.84	45%	18%	409	217.63	78%	350
0.55	200	1.58	0.1%	1000	200.42	338.15	54%	0%	491	337.47	54%	490
0.10	50	1.58	0.1%	1000	61.33	288.35	25%	44%	300	97.79	104%	151
0.25	50	1.58	0.1%	1000	75.15	292.01	28%	40%	316	97.79	104%	151
0.75	50	1.58	0.1%	1000	105.23	300.20	35%	32%	353	97.79	104%	151
1.00	50	1.58	0.1%	1000	115.05	302.94	37%	29%	366	97.79	104%	151
0.55	50	1.00	0.1%	1000	56.11	67.85	102%	0%	88	61.89	104%	77
0.55	50	1.10	0.1%	1000	55.20	84.04	76%	15%	103	68.08	104%	90
0.55	50	1.30	0.1%	1000	76.13	173.87	44%	31%	205	80.46	104%	115
0.55	50	1.80	0.1%	1000	105.56	393.40	28%	36%	443	111.41	104%	180
0.55	50	1.58	0.2%	1000	92.88	302.42	33%	33%	351	111.56	101%	177
0.55	50	1.58	0.5%	1000	86.81	314.70	36%	29%	377	146.68	93%	240
0.55	50	1.58	1.0%	1000	78.42	331.60	38%	23%	413	197.33	82%	320
0.55	50	1.58	0.0%	1000	98.73	290.60	31%	37%	327	79.00	108%	115
0.55	50	1.58	0.1%	100	98.65	295.63	31%	37%	333	81.68	108%	120
0.55	50	1.58	0.1%	500	97.17	296.45	32%	36%	336	88.84	106%	134
0.55	50	1.58	0.1%	1500	93.49	298.51	33%	34%	346	106.74	102%	168
0.55	50	1.58	0.1%	2000	91.66	299.55	34%	32%	350	115.68	100%	185

Notes: The above results are based on a price demand elasticity of 0.8 and the corresponding distribution parameters (see Table 5). The marginal cost on the legal market,  $c^L$ , is USD 25 per ounce. The tax revenue in USD *per capita* and *per annum* is given as the product of the difference  $p^L - c^L$  with the extensive and intensive margins of consumption. The intensive margin is approximated using Orens et al. (2018) estimates for consumption in Colorado in 2017.

eviction price. Unless marginal costs are relatively high, the overall extensive margin for cannabis consumption is higher under the eviction price scheme than with a tax maximizing objective.

Interestingly, when the quality on the legal market is not different from the illegal market, the legal price that maximizes tax revenue is relatively close to the eviction price and very little black market survives. This shows a case where maximizing tax revenue and eradicating the black market are compatible. However, with a legal cannabis of low quality, the level of tax revenue is very low. We show in Appendix I.3 that these results are robust to a setting where, post legalization, consumers are not arrested for illegal purchases – i.e.  $q = 0$ .

**Discussion of the implementation of reforms** This review of legalization reform objectives shows that deflating crime through an eviction price is compatible with the maximization of consumer surplus, the minimization of enforcement cost related to the regulation of cannabis market, and the minimization of health hazards and other negative externalities connected with illegal cannabis consumption. Interestingly enough, current dominant policies of prohibition are optimal only when the government wants to minimize total consumption of cannabis. Justifying prohibition based on

our general economic framework requires that public authorities consider health hazards due to legal cannabis consumption equal or worse than for illegal cannabis, and that the costs of prohibition enforcement are neglected. Finally, the maximization of tax revenue will generally conflict with the eradication of the black market. Without reinforcing repression, it leads to higher final prices of legal cannabis than eviction prices, leaving room for illegal providers to operate.

Moreover, we have shown that for legalization reforms to succeed, the quantity, quality, and purchasing experience for legal cannabis must be high. An important and generally overlooked tool the government can use to regulate the cannabis market is to improve the quality of legal cannabis relative to illegal cannabis. To fight the black market, an abundant provision of products of good quality is key. This effort should be increased as governments put more weight on health externalities, consumer surplus, enforcement cost or tax revenue. Since the government is generally a poor grower and an even worse retailer of cannabis, the private sector may do a better job of meeting customer demand than civil servants. Since it is a basic agricultural crop, the government should license enough producers to maintain a steady supply of cannabis and avoid high markups by the private sector. Production should be tightly monitored through satellite images and drones to avoid having over-production feed the black market. Sanctions in case of misconduct should be harsh. At the same time, the licensed retailers should be sufficiently numerous to give choices to customers and keep a low pre-tax price (as for tobacco retailers in the EU). The final price should be adjusted by the government by setting the level of the excise tax based on its objectives.

## **Legalization reforms and their discontent**

Following citizens' initiative referendums in November 2012, there was legislative change in Colorado and Washington State to end cannabis prohibition in 2013 and 2014. The reforms gave priority to reducing the costs of prohibition, developing a new sector of activity, and generating tax revenue.<sup>27</sup> Since the initial goal was to meet consumers' needs, production, distribution and sale were entrusted to private operators, who invested in market-driven R&D and quality development. A legal industrial sector has since developed: as of today, each of these states accounts nearly three times more recreational cannabis retailers than McDonald's restaurants (see Table 1). This booming legal market

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<sup>27</sup>The *Colorado Marijuana Legalization Amendment*, or *Amendment 64*, claims that cannabis legalization is “*in the interest of the efficient use of law enforcement resources, enhancing revenue for public purposes, and individual freedom*”.

generates a substantial revenue, estimated at around USD 1 billion in 2016 in each of these states (for a population of 5.6 million in Colorado and 7.4 million in Washington State).

In Washington State, where the final price is close to USD 200 per ounce, the level of taxes is high, as are quality requirements. This explains why the black market still represents 15 % to 50 % of the cannabis transactions (Arcview Market Research and BDS Analytics, 2019).<sup>28</sup> Nevertheless, a few years after legalization, both states are quite happy with the impact of the reforms on their local finances and economy, while adult consumers enjoy a great variety of high quality cannabis products. These two states had a clear set of compatible priorities that were achieved by combining a market orientation for customers with relatively high taxation.

In a similar line, Governor Cuomo signed legislation S.854-A/A.1248-A on 2021, March 31, legalizing the recreational use of cannabis in the state of New York.<sup>29</sup> This reform was presented as a social measure, putting an end and repairing severe repression disproportionately affecting minorities. It is expected to generate a tax revenue of USD 350 million *per annum* as well as to create 30,000 to 60,000 jobs. The relatively low point of sale retail tax rate – a 9% state tax combined with a 4% local tax – suggests that the state black market is likely to be eradicated fairly quickly.<sup>30</sup>

This is in contrast with the legalization reform in California, whose main objective was to raise substantial new tax revenue. In an environment where the Medical Marijuana Laws had made the grey economy prosperous, the introduction price/quality ratio of the legal cannabis was too high compared to the price/quality ratio on the illegal market. Since the cannabis industry was already well established under prohibition, consistently with our predictions, it reacted swiftly to the legal offer by lowering its prices. It has since grown, absorbing customers who previously were purchasing medical cannabis legally. Illicit transactions account for approximately 80% of the Californian cannabis market.<sup>31</sup> The tax revenue is a fraction of what was expected and the government of the state is quite disappointed by the reform. A better policy would have been to fix a lower introduction price of

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<sup>28</sup>According to New Frontier Data economist Beau Whitney, cited by Jeanne Lang Jones and Rob Smith. 2019. “Tight Regulations, High Taxes May Keep Washington State’s \$1.4B Cannabis Industry from Really Blooming”. *Seattle Business*. January.

<sup>29</sup>See New York State Government, 2021. “Governor Cuomo Signs Legislation Legalizing Adult-Use Cannabis” <https://www.governor.ny.gov/news/governor-cuomo-signs-legislation-legalizing-adult-use-cannabis>

<sup>30</sup>Interestingly, this point of sale retail tax is coupled with a THC-potency-based tax on distributors, providing a comparative advantage to low-potency products resembling medical cannabis.

<sup>31</sup>Kevin Murphy. 2019. “Cannabis’ Black Market Problem”. *Forbes*. April 4..

legal cannabis (i.e., lower tax rate, at least initially), combined with investments to raise quality and marketing to give a competitive edge to the legal products, and a stronger push back against illegal cannabis producers and consumers, in line with the policy mix we describe in Section 4.

The reform in Uruguay also failed to reach its main objectives, which were to annihilate the black market and strengthen the protection of minors and the safety of adult users, while controlling total consumption. This led the government to create a state monopoly, which delegated the production of cannabis to strictly regulated private companies. To eradicate the black market, Uruguay had initially set the price of legal cannabis at the same level as the black market. However, the government's attempt to control consumption led to a severe underestimation of the size of the market and rationing.<sup>32</sup> Thus, several years after the official legalization in 2012, a majority of consumers continue to turn to the black market for their consumption, defeating the initial objective of the reform.

With similar objectives of eradicating the black market and drug-related crime, Canada made the same mistake as Uruguay in underestimating the needs of the consumers of cannabis, both in quantity and in quality. This created rationing and the users had to turn to the black market for their consumption. Since the federal government gave the Provinces the responsibility of implementing the new policy by regulating the retail markets, as well as setting possession, use, and cultivation limits for personal use, the nation-wide legalization policy adopted in 2017 and 2018 took different forms across Provinces.

For instance in Alberta, home-cultivation is allowed<sup>33</sup> and online retail sales are managed by a government monopoly, while retail sales are left to private licensed stores. In Québec, one cannot home-grow cannabis and retail sales are organized by the government. The *Société Québécoise du Cannabis (SQDC)*, a subsidiary of the provincial society for alcohols, provides cannabis both in shops and online.<sup>34</sup> Dried flower products are priced between CAD 8 and 10 per gram by the SQDC, depending on potency and strain type, which is close to the *pre-legalization* black market price ( $p^L = p$ ). As discussed in Section 4, this policy did not anticipate the response of smugglers on the black market

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<sup>32</sup>By the end of 2017, only two producers were approved for an annual volume of one ton each, while the market has been estimated at between 35 and 40 tons. In addition, the hostility of pharmacists, charged by the State to sell cannabis, has made it more difficult and unpleasant for users to obtain supplies. The authorization of self-cultivation or small producers' clubs, also tightly limited and regulated, has not compensated for the inadequacy of the public offer.

<sup>33</sup>Up to four active plants for personal use.

<sup>34</sup>As of March 2019, SQDC stores only open from Wednesday to Sunday, "due to the current supply shortages (...) until product availability is more stable" (SQDC's website, [www.sqdc.ca](http://www.sqdc.ca), March 19, 2019). A year later, SQDC stores' schedule covers the whole week and about 40 stores are expected throughout Québec.

and the average black market price in Québec fell to below CAD 6 per gram, as reported Mid March 2019 by the crowd-sourced website [priceofweed.com](http://priceofweed.com).

It is still too early to assess precisely the effects of legalization on overall consumption and the size of the black market. Using monetary circulation in Canada, Goodhart and Ashworth (2019) show that the need for cash decreased in the country just after the legalization, which they interpret as a decrease in black market cannabis transactions. For them, the country is heading towards one of the goals Trudeau had set in 2015: “[keeping] profits out of the hands of criminals”.<sup>35</sup> However, this optimism is contradicted by the recent evolution of the market. Facing a shortage on the supply side, legal providers have focused on increasing their production (i.e. quantity), with no effort to improve the quality of their products, nor the purchasing experience of the consumers (resulting in a low *b*). As a result of this failure to meet consumers’ needs, the black market has survived by lowering its prices, which is consistent with the theory, and the stock market prices of the new legal firms have plummeted.<sup>36</sup> Statistics Canada, the national statistical agency, estimated that about 75% of cannabis users were still using illegal cannabis in 2019. It implies that the overall (legal plus illegal) demand for cannabis has increased in Canada, with a thriving black market. Here again, the failure to anticipate the reaction of the black market to legalization and to internalize consumers’ demand for quality led to poorly designed reforms, at least initially.

## 7 Conclusion

Designing a policy that both eliminates organized crime and limits the increase in cannabis use *post-legalization* is not trivial. Examples of what can go wrong include situations in which cannabis is legal but too expensive (e.g., California) or rationed and of low quality (e.g., Uruguay or Canada). Both scenarios result in flourishing illegal businesses with no significant decrease in crime. We explore how to avoid such unexpected effects of legalization policies. The policy mix we propose enables public authorities to throttle the cannabis black market by implementing a legal alternative and to control the increase in cannabis consumption *post-legalization*.

Our findings highlight the complementarities between legalization of high quality cannabis (in

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<sup>35</sup>Liberal Party. 2015. “Real change: a new plan for a strong middle class”. <https://www.liberal.ca/wp-content/uploads/2015/10/New-plan-for-a-strong-middle-class.pdf>

<sup>36</sup>Levinson-King, Robin. 2019. “Why Canada’s cannabis bubble burst”. *BBC News*. December 29. <https://www.bbc.com/news/world-us-canada-50664578>

terms of purchasing experience, gustatory quality of the product, potency and purity) and sanctions against illegal trade, providing policymakers with guidelines to overcome the legalization/prohibition trade-off. Legalization will be effective at regulating the demand for cannabis if consumers are compelled to buy on a legal market rather than illegally, and, at the same time, if illegal suppliers are targeted by repressive measures that drive them out of business. Raising the level of punishment and enforcing sanctions not only against users of illegal drugs but more effectively against suppliers, enable authorities to implement higher legal prices for cannabis while undermining dealers.

Although our analysis focuses on how to achieve full legalization by eliminating the black market while containing consumption *post-legalization*, our general framework can be used to study a broader set of objectives. Extensions we discuss show that our policy mix enables governments to reach different objectives, such as the minimization of externalities or of enforcement costs, or the maximization of consumer surplus. Again, the analysis highlights the importance of offering high quality legal products to achieve these objectives. Finally, to shed more light on consumption behavior *post-legalization*, future research should account for the large heterogeneity of consumers, in particular regarding their risk aversion, intensive margin of consumption and liquidity constraints.

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# Appendix

## A Cannabis laws in the U.S.

As of December 2020, fifteen states and the District of Columbia have legalized the use of recreational cannabis and four additional legalization ballots are expected to take place in November 2022. Cannabis possession remains a felony in other states such as Arizona, where sanctions and fines to enforce the law differ a lot. For example in Arizona, there is no guideline for punishment regarding small amounts of cannabis and possessing 2 pounds or less entails a risk of incarceration of up to 2 years and a fine of up to USD 150,000. In contrast, any amount on a first offense in Iowa is only a misdemeanor punishable by a maximum prison sentence of 6 months and a USD 1,000 fine.

The table below offers a synthetic overview of state cannabis laws across the United States. For each state, we reported the year during which cannabis was decriminalized in the second column. The third column records the year of the first ballot to legalize the use of medical cannabis, i.e. to instate a *Medical Marijuana Law* (MML), while the fourth column gives the year during which such a law was passed. The fifth column lists the year of the first ballot to legalize the recreational use of cannabis, and the sixth column the year of such a law being passed. The final column reports the year of the first legal retail sales of cannabis. Dashes represent the absence of the event described in the corresponding column.

State	Decrim.	1st MML ballot	MML	1st rec. ballot	Rec.	Retail
AL	-	-	-	-	-	-
AK	1975 <sup>a</sup>	1998	1998	2000	2014	2016
AZ	-	1996	2010	2016	2020	-
AR	- <sup>b</sup>	2012	2016	- <sup>c</sup>	-	-

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<sup>a</sup>Alaska issued a cannabis decriminalization bill on May 16, 1975, which is two weeks before the famous *Ravin* decision, protecting the possession of small amounts under constitutional privacy rights, was issued. Decriminalization of cannabis came into effect on June 5, 1975. The timeline of cannabis policy in Alaska then becomes fuzzy: further decriminalization was billed in 1982, then cannabis was recriminalized in 1990, decriminalized in 2003, then recriminalized in 2006; while the *Ravin* caselaw would still interact with the criminal state law (Brandeis, 2012). Legalization approved in 2014 ended this confusion.

<sup>b</sup>Although cannabis use remains a crime under state law, it is decriminalized locally.

<sup>c</sup> A cannabis legalization initiative is expected to be on the ballot in November 2022 (“Marijuana on the ballot”, *Ballotpedia*. Retrieved online December 2020, [https://ballotpedia.org/Marijuana\\_on\\_the\\_ballot](https://ballotpedia.org/Marijuana_on_the_ballot))

State	Decrim.	1st MML ballot	MML	1st rec. ballot	Rec.	Retail
CA	1975	1996	1996	1972	2016	2018
CO	1975	2000	2000	2012	2012	2014
CT	2011	- <sup>d</sup>	2012	-	-	-
DE	2015	- <sup>d</sup>	2011	-	-	-
D.C.	2014	1998	2010	2014	2014	-
FL	- <sup>e</sup>	2014	2016	- <sup>c</sup>	-	-
GA	- <sup>e</sup>	-	-	-	-	-
HI	2020	- <sup>d</sup>	2000	-	-	-
ID	-	-	-	-	-	-
IL	2016	- <sup>d</sup>	2013	- <sup>f</sup>	2019	2020
IN	-	-	-	-	-	-
IA	-	-	-	-	-	-
KS	-	-	-	-	-	-
KY	- <sup>e</sup>	-	- <sup>g</sup>	-	-	-
LA	- <sup>e</sup>	- <sup>d</sup>	2015 <sup>h</sup>	-	-	-
ME	1975	1999	1999	2016	2016	2020
MD	2014	- <sup>d</sup>	2013	-	-	-
MA	2008	2012	2012	2016	2016	2018
MI	2018	2008	2008	2018	2018	2019
MN	1976	- <sup>d</sup>	2014	-	-	-
MS	1978	2020	2020	- <sup>c</sup>	-	-
MO	2014	2018	2018	-	-	-
MT	- <sup>e</sup>	2004	2004	2020	2020	-
NE	1979	- <sup>i</sup>	-	-	-	-
NV	2016	1998	1998	2006	2016	2017

<sup>d</sup> *Medical Marijuana* was not on the ballot: instead, it was signed into law after legislative approval.

<sup>e</sup> Although cannabis use remains a crime under state law, it is decriminalized locally.

<sup>f</sup> The recreational use of cannabis was not on the ballot: instead, it was signed into law after legislative approval.

<sup>g</sup> A *Medical Marijuana* bill was presented to the House of Kentucky in January 2020. It is presently under evaluation by the Senate Judiciary Committee (Kentucky General Assembly, *House Bill 136*; retrieved online 3rd December 2020, url: <https://apps.legislature.ky.gov/record/20rs/hb136.html>).

<sup>h</sup> Although *Medical Marijuana* was signed into law in 2015, it did not become effective before 2019.

<sup>i</sup> A *Medical Marijuana* ballot is expected to be on the ballot in November 2022 (“Marijuana on the ballot”,

State	Decrim.	1st MML ballot	MML	1st rec. ballot	Rec.	Retail
NH	2017	- <sup>d</sup>	2013	-	-	-
NJ	-	- <sup>d</sup>	2010	2020	2020	-
NM	2019	- <sup>d</sup>	2007	-	-	-
NY	1977	- <sup>d</sup>	2014	- <sup>f</sup>	2021	- <sup>37</sup>
NC	1977	-	-	-	-	-
ND	2019	2016	2016	2018	<sup>c</sup>	-
OH	1975	- <sup>d</sup>	2016	2015	-	-
OK	- <sup>j</sup>	2018	2018	- <sup>c</sup>	-	-
OR	1973	1998	1998	2012	2014	2015
PA	- <sup>e</sup>	- <sup>d</sup>	2016	-	-	-
RI	2012	- <sup>d</sup>	2005	-	-	-
SC	-	-	-	-	-	-
SD	-	2006	2020	2020	2020	-
TN	-	-	-	-	-	-
TX	- <sup>e</sup>	-	-	-	-	-
UT	-	2018	2018	-	-	-
VT	2013	- <sup>d</sup>	2004	- <sup>f</sup>	2018	2020
VA	-	-	-	-	-	-
WA	2012	1998	1998	2012	2012	2014
WV	-	-	2017 <sup>k</sup>	-	-	-
WI	- <sup>e</sup>	-	-	-	-	-
WY	-	-	-	-	-	-

<sup>37</sup>Not until 2022. Ferré-Sadurní, Luis. 2021 “New York Legalizes Recreational Marijuana, Tying Move to Racial Equity”. *The New York Times*, March 31. <https://www.nytimes.com/2021/03/31/nyregion/cuomo-ny-legal-weed.html>

*Ballotpedia*. Retrieved online December 2020, [https://ballotpedia.org/Marijuana\\_on\\_the\\_ballot](https://ballotpedia.org/Marijuana_on_the_ballot)).

<sup>j</sup>A cannabis decriminalization initiative is expected to be on the ballot in November 2022 (“Oklahoma State Question 812, Marijuana Decriminalization Initiative (2022)”, retrieved online on Ballotpedia; url: [https://ballotpedia.org/Oklahoma\\_State\\_Question\\_812,\\_Marijuana\\_Decriminalization\\_Initiative\\_\(2022\)](https://ballotpedia.org/Oklahoma_State_Question_812,_Marijuana_Decriminalization_Initiative_(2022))).

<sup>k</sup>Although a bill regulating medical use of cannabis was signed in April 2017, Medical Marijuana Laws have not been implemented yet in West Virginia.



## B Characterizing the marginal type of consumer $\theta^I$ , indifferent between no consumption and illegal consumption

An individual of type  $\theta$  deciding between illegal consumption and no consumption considers the lottery  $[-p - F, \theta v - p; q, 1 - q]$ . Not consuming entails a zero payoff. The utility associated with illegal consumption is given by:  $w^+(1 - q)u(\theta v - p) + w^-(q)u(-p - F)$ , where  $u$  is a value function which is continuous, derivable and strictly increasing on  $\mathbb{R}$ , and such that  $u(0) = 0$ .

The consumption condition is written as:  $w^+(1 - q)u(\theta v - p) + w^-(q)u(-p - F) > 0$ .

Let us define  $V_I(\theta) = w^+(1 - q)u(\theta v - p) + w^-(q)u(-p - F)$

The marginal individual  $\theta^I$ , indifferent between illegal consumption and no consumption, is characterized by:

$$V_I(\theta) = 0 \tag{18}$$

Since the value function  $u$  from not consuming is such that  $u(0) = 0$ , this condition is the same, whether  $\theta^I$  is derived using Expected Utility Theory or Prospect Theory. The only difference is that under Expected Utility Theory, the weighting functions  $w^+$  and  $w^-$  are equal to the identity. Since  $u$  is a function which is continuous, derivable, strictly increasing on  $\mathbb{R}$ , it admits a reciprocal function  $u^{-1}$  which is also strictly increasing and such that  $u^{-1}(0) = 0$ . Condition (18) is equivalent to:

$$\theta^I = \frac{u^{-1}\left(\frac{-w^-(q)u(-p-F)}{w^+(1-q)}\right) + p}{v} \tag{19}$$

We deduce that  $\theta^I$  exists and is unique, with  $\theta^I > \frac{p}{v}$  if  $q > 0$  and  $\theta^I = \frac{p}{v}$  if  $q = 0$ .

Expression (19) clearly shows that  $\theta^I$  increases with  $q$ ,  $p$  and  $F$ , since the value function  $u$ , its reciprocal and the weight functions are strictly increasing.

Finally, we focus on the absolute value of the price elasticity of demand,  $\epsilon_{D,p}$ , as defined in (4). After differentiating  $\epsilon_{D,p}$  with respect to  $q$ , one can check that:

$$\frac{d\epsilon_{D,p}}{dq} = \frac{d\left\{\frac{g(\theta^I)}{1-G(\theta^I)}\right\}}{d\theta^I} \frac{d\theta^I}{dq} \frac{d\theta^I}{dp} p + \frac{g(\theta^I)}{1-G(\theta^I)} \frac{d^2\theta^I}{dpdq} p. \tag{20}$$

As  $\theta^I$  increases with  $p$  and  $q$  it follows that  $\epsilon_{D,p}$  increases with  $q \in [0, 1]$  if the cross-derivative of  $\theta^I$  with  $p$  and  $q$  is positive and if the distribution  $G(\theta)$  satisfies the monotone hazard rate (MHR) property. We next check under what condition this cross derivative is positive.

Differentiating equation (18) yields:  $\sum_{i \in \{p, q, \theta, F\}} \alpha_i di = 0$ , with

$$\begin{cases} \alpha_\theta = vw^+(1-q)u'(\theta v - p) \\ \alpha_q = -w^{+'}(1-q)u(\theta v - p) + w^{-'}(q)u(-p - F) \\ \alpha_p = -w^+(1-q)u'(\theta v - p) - w^-(q)u'(-p - F) \\ \alpha_F = -w^-(q)u'(-p - F) \end{cases}$$

In particular, it yields  $\frac{d\theta^I}{dp} = -\frac{\alpha_p}{\alpha_\theta}$ . From this follows that

$$\frac{d^2\theta^I}{dpdq} = \frac{\alpha_p\alpha_{\theta q} - \alpha_{pq}\alpha_\theta}{\alpha_\theta^2}$$

where

$$\begin{cases} \alpha_{pq} = \frac{\partial\alpha_p}{\partial q} = w^{+'}(1-q)u'(\theta v - p) - w^{-'}(q)u'(-p - F) \\ \alpha_{\theta q} = \frac{\partial\alpha_\theta}{\partial q} = -vw^{+'}(1-q)u'(\theta v - p) \end{cases}$$

Since the function  $u$  is increasing and the weight functions are positive and increasing, we show that  $\alpha_p\alpha_{\theta q} - \alpha_{pq}\alpha_\theta > 0$  as follows:

$$\begin{aligned} & \left[ w^-(q)w^{+'}(1-q) + w^{-'}(q)w^+(1-q) \right] vu'(\theta v - p)u'(-p - F) > 0 \\ \Rightarrow & w^-(q)u'(-p - F)vw^{+'}(1-q)u'(\theta v - p) + w^{-'}(q)u'(-p - F)vw^+(1-q)u'(\theta v - p) > 0 \\ \Rightarrow & \alpha_p\alpha_{\theta q} - \alpha_{pq}\alpha_\theta > 0 \end{aligned}$$

We conclude that  $\frac{d^2\theta^I}{dpdq} > 0$  and that  $\epsilon_{D^I, p}$  increases with  $q \in [0, 1]$  if the distribution  $G(\theta)$  satisfies the monotone hazard rate (MHR) property.

## C Characterizing the marginal consumer $\theta^L(p, p^L)$ , indifferent between legal and illegal consumption

A consumer of type  $\theta$  deciding between legal and illegal consumption faces a choice between a certain payoff of  $\theta bv - p^L$  and the lottery  $[-p - F, \theta v - p; q, 1 - q]$ . Note first that individuals with  $\theta \leq 0$  will never purchase cannabis, whether it is legal or not. Second if  $\theta v - p \leq \theta bv - p^L$  the only possibility is that the individual buys either the legal product or nothing. Symmetrically if  $\theta v - p > 0 > \theta bv - p^L$

the only possibility is that he/she either purchases on the black market or not at all. It implies that a necessary condition for some consumers being willing to purchase cannabis illegally, while others prefer to purchase it legally, is that there exists some  $\theta > 0$  such that  $\theta v - p > \theta b v - p^L > 0$ , or equivalently  $\frac{p^L - p}{(b-1)v} > \theta > \frac{p^L}{bv}$ . This requires that  $\frac{p^L - p}{(b-1)v} > \frac{p^L}{bv}$  or equivalently  $p^L > bp$ .

### C.1 Under Expected Utility Theory

If individuals are expected utility maximizers the marginal consumer, indifferent between legal and illegal consumption, solves the following equation:  $(1 - q)u(\theta v - p) + qu(-p - F) = u(\theta b v - p^L)$ .

Let

$$V_1(\theta) \equiv (1 - q)u(\theta v - p) + qu(-p - F) - u(\theta b v - p^L) \quad (21)$$

If  $\theta^L > 0$  exists, it is such that  $V_1(\theta) = 0$ .

We deduce that for  $\frac{p^L - p}{(b-1)v} > \theta > \frac{p^L}{bv}$ ,  $V_1'(\theta) = (1 - q)vu'(\theta v - p) - bvu'(\theta b v - p^L) < 0$  since  $u'$  is decreasing (i.e.,  $u$  is concave) and  $1 - q \leq 1$ ,  $\theta v - p > \theta b v - p^L$ ,  $b > 1$ . Hence, if  $\theta^L > 0$  exists, it is unique. We have that:  $V_1\left(\frac{p^L - p}{(b-1)v}\right) = -q\left[u\left(\frac{p^L - bp}{b-1}\right) - u(-p - F)\right] < 0$ . Since  $V_1(\theta)$  is decreasing for  $\theta \in \left[\frac{p^L}{bv}, \frac{p^L - p}{(b-1)v}\right]$ , to finish the proof we need to find the condition under which  $V_1\left(\frac{p^L}{bv}\right) > 0$ . Therefore, whenever

$$(1 - q)u\left(\frac{p^L - bp}{b}\right) > -qu(-p - F) \quad (22)$$

the equation  $V_1(\theta) = 0$  admits a unique solution.

Differentiating equation (21) yields  $\alpha_q dq + \alpha_{p^L} dp^L + \alpha_p dp + \alpha_F dF + \alpha_{\theta^L} d\theta^L + \alpha_b db = 0$  with

$$\begin{cases} \alpha_q = u(-p - F) - u(\theta^L v - p) < 0 \\ \alpha_{p^L} = u'(\theta^L v - p^L) > 0 \\ \alpha_p = -qu'(-p - F) - (1 - q)u'(\theta^L v - p) < 0 \\ \alpha_F = -qu'(-p - F) < 0 \\ \alpha_{\theta^L} = v(1 - q)u'(\theta^L v - p) - bvu'(\theta^L b v - p^L) < 0 \\ \alpha_b = -\theta^L vu'(\theta^L b v - p^L) < 0 \end{cases}$$

It is straightforward to show that  $\theta^L$  decreases with  $q$ ,  $p$ ,  $F$  and  $b$ , while it increases with  $p^L$ .

## C.2 Under Prospect Theory

Under PT the consumer's reference level of wealth is provided by the risk free option,  $\theta bv - p^L$ . A potential cannabis consumer deciding between buying from the black market or from the legal sector considers the lottery  $[p^L - p - F - \theta bv, p^L - p + \theta(1 - b)v; q, 1 - q]$ . Let

$$V_2(\theta) = w^+(1 - q)u(p^L - p - (b - 1)v\theta) + w^-(q)u(-p - F - \theta bv + p^L). \quad (23)$$

The marginal consumer,  $\theta^L(p, p^L)$ , indifferent between legal and illegal consumption solves  $V_2(\theta) = 0$ . We have  $V_2'(\theta) = -(b - 1)vw^+(1 - q)u'(\theta(1 - b)v - p + p^L) - bvw^-(q)u'(-p - F - \theta bv + p^L) < 0$  since  $b \geq 1$  and  $u$  is strictly increasing.

We have:  $V_2\left(\frac{p^L - p}{(b - 1)v}\right) = w^-(q)u(p - p^L - (b - 1)F) < 0$  since  $p^L > bp \geq p$ . The strict monotonicity of  $V_2(\theta)$  implies that  $\theta^L$  exists and is unique whenever  $V_2\left(\frac{p^L}{bv}\right) > 0$ . This is equivalent to:

$$w^+(1 - q)u\left(\frac{p^L - bp}{b}\right) > -w^-(q)u(-p - F) \quad (24)$$

Condition (24) under PT is equivalent to (22) under EUT, where the probability weighting function is the identity. In both cases these conditions imply that  $\theta^L > 0$  exists and is unique. It is easy to check that the conditions (22) and (24) are equivalent to  $p^L > \tilde{p}^L(p)$  with  $\tilde{p}^L(p)$  defined in (8), with the probability weighting functions equal to the identity in the case of EUT.

Differentiating equation (23) yields:  $\alpha_{\theta^L}d\theta^L + \alpha_qdq + \alpha_{p^L}dp^L + \alpha_pdp + \alpha_FdF + \alpha_ddd = 0$  with

$$\left\{ \begin{array}{l} \alpha_{\theta^L} = -w^-(q)vu'(p^L - p - F - \theta^L bv) - w^+(1 - q)(d - 1)vu'(p^L - p + \theta^L(1 - b)v) < 0 \\ \alpha_q = w^{-'}(q)u(p^L - p - F - \theta^L bv) - w^{+'}(1 - q)u(p^L - p + \theta^L(1 - b)v) < 0 \\ \alpha_{p^L} = w^-(q)u'(p^L - p - F - \theta^L bv) + w^+(1 - q)u'(p^L - p + \theta^L(1 - b)v) > 0 \\ \alpha_p = -w^-(q)u'(p^L - p - F - \theta^L bv) - w^+(1 - q)u'(p^L - p + \theta^L(1 - b)v) < 0 \\ \alpha_F = -w^-(q)u'(p^L - p - F - \theta^L bv) < 0 \\ \alpha_b = -\theta^L vw^+(1 - q)u'(p^L - p + \theta^L(1 - b)v) - \theta vqu'(-p - F - \theta bv + p^L) < 0 \end{array} \right.$$

It is straightforward to show that  $\theta^L$  decreases with  $q$ ,  $p$ ,  $F$  and  $b$ , while it increases with  $p^L$ .

## D Consumers facing legalization

### D.1 Consumer choices

Appendix B characterizes the consumer  $\theta^I$  indifferent, under prohibition, between not consuming and consuming illegally :  $V_I(\theta) = w^+(1-q)u(\theta^I v - p) + w^-(q)u(-p - F) = 0$ . Any consumer with type higher than  $\theta^I$  prefers to purchase cannabis on the black market than not to consume cannabis.

Under legalization, the consumer  $\theta^0$ , indifferent between legal consumption and no consumption, is characterized by  $u(\theta^0 b v - p^L) = 0$ . Any consumer with type higher than  $\theta^0 = \frac{p^L}{bv}$  prefers to purchase cannabis legally than not consume cannabis.

Appendix C shows that consumer  $\theta^L \in \left[ \frac{p^L}{bv}, \frac{p^L - p}{(b-1)v} \right]$ , indifferent between legal and illegal consumption, solves under

- Expected Utility Theory:  $V_1(\theta) = (1-q)u(\theta v - p) + qu(-p - F) - u(\theta b v - p^L) = 0$
- Prospect Theory:  $V_2(\theta) = w^+(1-q)u(p^L - p - \theta(b-1)v) + w^-(q)u(-p - F - \theta b v + p^L) = 0$   
With  $V_i(\theta)$  ( $i = 1, 2$ ) decreasing for  $\theta \in \left[ \frac{p^L}{bv}, \frac{p^L - p}{(b-1)v} \right]$ . Any consumer with type higher than  $\theta^L$  prefers to purchase cannabis legally than illegally.

We next compare the thresholds  $\theta^0$ ,  $\theta^L$ , and  $\theta^I$ . Depending on whether the legal price,  $p^L$ , is larger than  $\tilde{p}^L(p)$  defined in (8) or not (i.e., depending whether condition (24) holds or not), two cases occur.

**Condition (24) does not hold ( $p^L \leq \tilde{p}^L(p)$ ):**  $\theta^L \leq \theta^0 \leq \theta^I$ . We have, for  $i = 1, 2$ ,  $V_i(\theta^0) = w^+(1-q)u(p^L - bp) + w^-(q)u(-p - F)$ , with the weighting functions being the identity function under EUT, while by definition of  $\theta^L$ ,  $V_i(\theta^L) = 0$ . We deduce that, when condition (24) does not hold,  $V_i(\theta^0) < 0 = V_i(\theta^L)$ , since the function  $V_i(\theta)$  is decreasing in  $\theta$ ,  $\theta^L \leq \theta^0$ . When the legalization environment is such that an individual  $\theta^L$  indifferent between legal and illegal purchases is of lower type than an individual  $\theta^0$  indifferent between legal purchase and no purchase at all, the individual  $\theta^0$  retrieves a negative payoff from illegal consumption.

Finally, since  $V_i(\theta)$  is strictly increasing in  $\theta$ ,  $\theta^0 < \theta^I \Leftrightarrow V_i(\theta^0) = w^+(1-q)u\left(\frac{p^L - bp}{b}\right) + w^-(q)u(-p - F) < 0$ . We deduce that  $\theta^L < \theta^0 \Rightarrow \theta^0 < \theta^I$ . Therefore, the condition  $w^+(1-q)u\left(\frac{p^L - bp}{b}\right) < -w^-(q)u(-p - F)$ , which means that (24) does not hold, characterizes the legalization environment where  $\theta^L < \theta^0 < \theta^I$ . For instance, this condition is always true if  $p^L = p$ , as it leads to  $u\left(\frac{p^L - bp}{b}\right) = u((1-b)p) < 0$  since  $b > 1$ . More generally condition (24) does not hold when the price on the legal market adjusted for the product quality,  $\frac{p^L}{v}$ , is low enough compared to the black market price and

the level of repression. In this case the legal market replaces the black market and  $\int_{\theta^0}^{\theta^I} g(\theta)d\theta$  new consumers appear as illustrated in Figure 1.

When the probability of arrest and the fine are unchanged, legalization necessarily increases the overall demand for cannabis. Individuals with types lower than  $\theta^0$  never purchase cannabis, as they prefer not purchasing cannabis to purchasing both legal and black market cannabis. Individuals with types  $\theta^0 < \theta < \theta^I$  prefer purchasing legal cannabis to black market cannabis or to not purchasing cannabis at all. They also prefer not purchasing cannabis to purchasing it illegally. These individuals constitute new customers for the newly legalized cannabis market. The better value for money on the legal market (i.e., the higher  $b$ ), the lower  $\theta^0$  and the more new consumers emerge. Individuals with types  $\theta^I < \theta$  always purchase cannabis, whether retail sales are legal or not; nevertheless, they purchase cannabis legally when they can.

**Condition (24) holds ( $p^L > \tilde{p}^L(p)$ ):**  $\theta^I < \theta^0 < \theta^L$ . The reasoning is similar to the previous case but the inequalities are inverted. Condition (24) is equivalent to  $V_i(\theta^0) > V_i(\theta^L) = 0$  such that  $\theta^0 < \theta^L$  when  $w^+(1 - q)u(\frac{p^L - bp}{b}) > -w^-(q)u(-p - F)$ . Similarly  $\theta^I < \theta^0 \Leftrightarrow V_I(\theta^0) = w^+(1 - q)u(\frac{p^L - bp}{b}) + w^-(q)u(-p - F) > 0$  such that  $\theta^I < \theta^0$  under (24).

Here, the quality adjusted price differential between the legal market and the black market is too high for the legal market to entirely replace the black market, given the black market price and the repression parameters. Consumers with a low valuation for cannabis continue to purchase illegally. If the black market did not react to the legalization policy (i.e., assuming  $p$  is fixed), there would be no new consumers once the legal market is created and whatever the value of the quality parameter  $b$ , the overall demand for cannabis would remain at  $1 - G(\theta^I)$ . In practice and as is shown in Appendix D.2, the criminals react to the introduction of legal cannabis by lowering their prices  $p$ , such that  $\theta^I$  decreases and new consumers, with a lower valuation for cannabis, appear.

## D.2 The demand (proof of Proposition 1)

The above analysis reveals the following partial equilibrium result.

**Lemma.** *Everything else being held constant, including the price on the black market, after a legal cannabis market is established, the overall demand for cannabis either increases, if the price of legal cannabis is not too high ( $p^L \leq \tilde{p}^L(p)$ ); otherwise it does not change.*

The black market responds strategically to the legal market by lowering its price to  $p^N(p^L)$ , the

solution of (5) computed with  $\varepsilon_{D^I, p} = -\frac{\partial D^I(p, p^L)}{\partial p} \frac{p}{D^I(p, p^L)}$ , the direct price elasticity of the demand  $D^I(p, p^L)$  defined in (9), which depends on  $p^L$ . The price reaction function of the black market sellers solves the following equation:

$$p(p^L) = \begin{cases} p^N(p^L) & \text{if } c \leq p^N(p^L) < \frac{p^L}{b} \\ \emptyset & \text{otherwise} \end{cases} \quad (25)$$

Since  $\theta$  is distributed on  $\mathbb{R}$ , as long as  $p^L < \infty$ , there is a positive demand for legal cannabis ( $1 - G(\theta^L(p, p^L)) > 0$ ).

If  $p^L > \tilde{p}^L(p)$  ( $\theta^I < \theta^0 < \theta^L$ ) and other policy parameters ( $c, b, q, F$ ) are held constant, the demand for the black market product decreases following legalization and the absolute value of the price elasticity of the black market demand increases. Therefore, for any finite legal retail price  $p^L$ , the black market price  $p$  decreases after legalization. This implies that the demand for cannabis increases ( $\theta^I$  decreases).

If  $p^L \leq \tilde{p}^L(p)$  ( $\theta^L \leq \theta^0 \leq \theta^I$ ), it is obvious that the overall demand for legal cannabis increases following legalization. We deduce that legalization always increases the overall demand for cannabis, when the operation costs of illegal providers, the quality differential and the repression of demand on the black market are held constant.

## E Proof of Proposition 2

Under Prospect Theory the threshold price, denoted  $\underline{p}^L$ , below which the criminals exit the market is such that  $\theta^L(c, \underline{p}^L) = \theta^I(c)$ , where  $\theta^I(c)$  and  $\theta^L(c, \underline{p}^L)$  are defined in equations (2) and (7) with  $p = c$ . Therefore,  $\theta^I(c)$  (or equivalently  $\theta^L(c, \underline{p}^L)$ ) is determined by the following system of equations:

$$\begin{cases} w^+(1-q)u(\theta v - c) + w^-(q)u(-c - F) = 0 \\ w^+(1-q)u(\theta v - \theta b v + \underline{p}^L - c) + w^-(q)u(-\theta b v + \underline{p}^L - c - F) = 0 \end{cases}$$

Under Expected Utility Theory, the same reasoning yields the following system of equations

$$\begin{cases} (1-q)u(\theta v - c) + qu(-c - F) = 0 \\ (1-q)u(\theta v - c) + qu(-c - F) = u(\theta b v - p^L) \end{cases}$$

In both cases, this yields  $\underline{p}^L = dv\theta^I(c)$ .

The legal demand is at the same level as if illegal suppliers were pricing at marginal cost:

$$D^L(\underline{p}^L) = \int_{\theta^L(\underline{p}^L, c)}^{+\infty} g(\theta)d\theta = 1 - G(\theta^L(\underline{p}^L, c)) = 1 - G(\theta^I(c)) = D^I(c). \quad (26)$$

## F Proof of the corollary of Proposition 1

The price  $\underline{p}^L = bv\theta^I(c)$  being linear in the quality differential  $b$  and the parameters  $\theta^I$  and  $v$  being positive, it is straightforward that  $\underline{p}^L$  increases with  $b$ . Regarding the other parameters, comparative statics are derived in Appendix B with  $p = c$ .

## G Application to Tversky and Kahneman (1992)

Tversky and Kahneman (1992) suggest a model featuring loss aversion, diminishing sensitivity for gains and losses and diminishing sensitivity regarding probabilities. Agents' appreciation for gains and losses is represented by a value function  $u(x)$ , which is S-shaped and has an inflection point in zero. This describes individuals being empirically risk-averse for gains and risk-seeking for losses; denoted by Kahneman and Tversky (1979) as the *reflection effect*.

More specifically, the authors calibrate the following functional form for the value function:

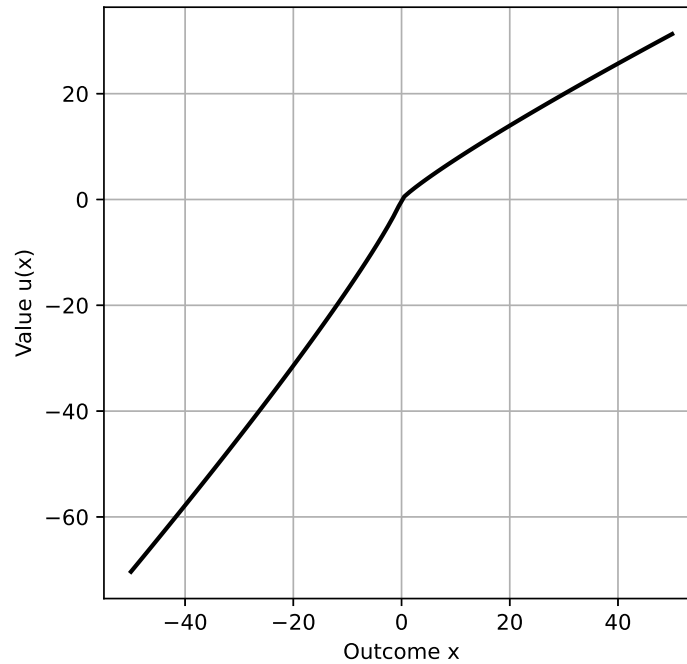
$$u(x) = \begin{cases} x^\alpha, & \text{if } x > 0 \\ -\lambda(-x)^\beta, & \text{if } x \leq 0 \end{cases} \quad (27)$$

where  $\alpha, \beta \in (0, 1)$  reflect the curvature and indicate the degree of risk preference; i.e. the degree of risk-aversion for gains and the degree of risk-seeking in the domain of losses.  $\lambda \geq 1$  is the *coefficient of loss aversion*, which reflects that the decrease in utility from a loss is greater than the increase in utility from a gain of the same amount. In line with Tversky and Kahneman (1992) estimates, we assume  $\alpha = \beta$ .

The weighting functions  $w^+$ , for gains,  $w^-$ , for losses are concave near 0 and convex near 1 to capture diminishing sensitivity for probabilities. Tversky and Kahneman (1992) specify the weighting



Figure 4: Value function as calibrated by Tversky and Kahneman (1992)



functions as follows :

$$w^x(q) = \frac{q^{\gamma^x}}{(q^{\gamma^x} + (1-q)^{\gamma^x})^{\frac{1}{\gamma^x}}} \quad \text{with } x = +, -.$$

The form of such weighting functions is represented in Figure 5. For  $\gamma = 1$ ,  $w^x : q \mapsto \frac{q^\gamma}{(q^\gamma + (1-q)^\gamma)^{\frac{1}{\gamma}}}$  is the identity. The closer  $\gamma$  is to 0, the more distorted the probability weights are. When  $\gamma \rightarrow 0$ , the function  $w^x$  has an L-shape.

In line with Tversky and Kahneman (1992), we assume that  $\gamma^+ < \gamma^-$ .

### Eviction price under Tversky and Kahneman (1992)

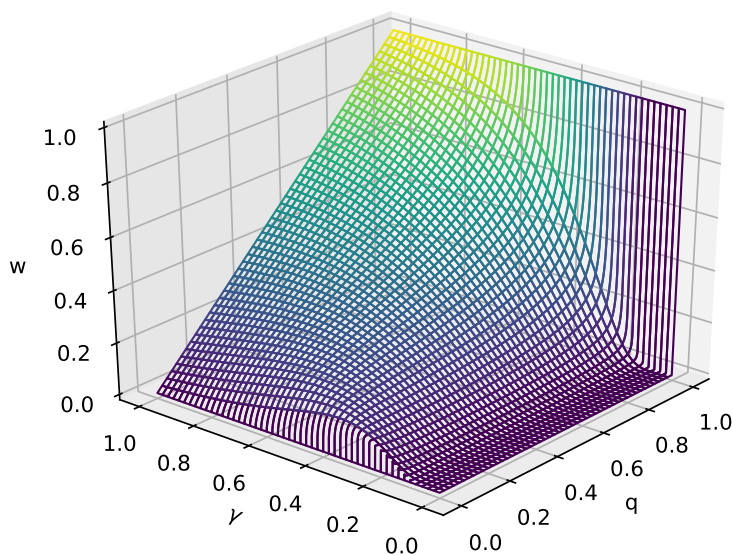
Substituting the function (27) in (19), the type  $\theta^I$  indifferent between consuming illegally and not consuming is given by:

$$\theta^I = \frac{1}{v} \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} (F + p) + p \right] \quad (28)$$

This implies that:

$$\frac{\partial \theta^I}{\partial p} = \frac{1}{v} \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} + 1 \right] > 0$$

Figure 5: Probability weighting functions for  $\gamma \in (0, 1]$



Let us note  $\omega(q) \equiv \frac{w^-(q)}{w^+(1-q)}$ , which is strictly increasing since  $w^x$  is increasing for  $x = +, -$ . It yields:

$$\frac{\partial \theta^I}{\partial q} = \frac{\lambda^{\frac{1}{\alpha}} (F + p)}{\alpha v} \omega'(q) [\omega(q)]^{\frac{1-\alpha}{\alpha}} > 0.$$

We deduce that the eviction price  $\underline{p}^L = bv\theta^I(c)$  under Tversky and Kahneman (1992)'s specification is:

$$\underline{p}^L = b \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} (F + c) + c \right]. \quad (29)$$

### Static comparative of the eviction price

We now study how the eviction price varies when the policy parameters change.

•

$$\frac{\partial \underline{p}^L}{\partial F} = b \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} > 0$$

•

$$\frac{\partial \underline{p}^L}{\partial c} = b \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} + 1 \right] > 0$$

•

$$\frac{\partial p^L}{\partial b} = \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} (F+c) + c \right] > 0$$

•

$$\frac{\partial p^L}{\partial q} = -b \frac{(F+c) \lambda^{\frac{1}{\alpha}} \omega'(q)}{\alpha \omega^2(q)} > 0$$

### Marginal consumer indifferent between legal and illegal consumption

Under the Tversky and Kahneman (1992) specification, one can solve for the type  $\theta^L$  indifferent between consuming legal and black market cannabis, substituting the function (27) in equation (7).

This parameter is given as follows.

$$\theta^L = \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} b + b - 1 \right]^{-1} \left[ (p^L - p) \left( 1 + \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} \right) - \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} F \right] \quad (30)$$

## H The policy mix: a numerical application

This Appendix completes the policy implications discussed in Section 5 with further explanations of the calibrations, as well as with further sensitivity analyses of the *post-legalization* equilibrium to the behavioral and policy parameters.

### H.1 Calibration of the distribution of “taste” for cannabis

We calibrate the distribution of the “taste” for cannabis using our model and the literature on demand for cannabis, which estimates the range of price elasticities of demand,  $\epsilon_{D^I p}$ , between -0.5 and -0.8. Let us assume the “taste” for cannabis,  $\theta \in \mathbb{R}$ , is drawn from a normal distribution  $\mathcal{N}(\mu, \sigma^2)$ . The expression of the price elasticity of demand in equation (4) becomes

$$\epsilon_{D^I p} = \frac{p}{v} \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} + 1 \right] \frac{1}{\sigma \sqrt{2\pi}} \frac{e^{-\frac{(\theta^I - \mu)^2}{2\sigma^2}}}{1 - \phi\left(\frac{\theta^I - \mu}{\sigma}\right)} \quad (31)$$

In 2017, 15% of Americans are estimated to have used cannabis in the past year (CBHSQ, 2018). This margin is simply given by:

$$\varsigma = 1 - \phi \left( \frac{\theta^I - \mu}{\sigma} \right) \quad (32)$$

Using the estimates of  $\epsilon$  and  $\varsigma$  discussed in the literature, we calibrate the parameters  $\mu$  and  $\sigma$  solving the system defined by equations (31) and (32), normalizing  $v \equiv 1$  and using the benchmark values for the model parameters described in Section 5.1. Using an iterative solver, we obtain the set of solutions described in Table 5 for  $\mu$  and  $\sigma$ , as well as the benchmark values for the *post-legalization* increase in consumption implementing the eviction price  $\underline{p}^L = 97.79$ <sup>38</sup>,  $\Delta\%D(\underline{p}^L)$ . As the demand becomes more inelastic, the distribution tail becomes fatter and the mean taste lower. The more inelastic the demand, the lower the *post-legalization* increase in demand.

Table 5: Distribution parameters and *post-legalization* increases in consumption

$\epsilon_{D^I p}$	$\hat{\mu}$	$\hat{\sigma}$	$\Delta\%D(\underline{p}^L)$
0.5	-690.4	1065.8	53%
0.6	-506.3	888.1	65%
0.7	-374.8	761.3	78%
0.8	-276.2	666.1	91%

Notes: Behavioral parameters are set based on Tversky and Kahneman (1992):  $\lambda = 2.25$ ,  $\alpha = 0.88$ ,  $\gamma^+ = 0.61$ ,  $\gamma^- = 0.69$ . Variation in demand relies on the baseline estimate of  $\underline{p}^L = 97.79$ .

The sensitivity of the distribution parameters and of the predictions of the models to the behavioral parameters  $\gamma^+$ ,  $\gamma^-$ ,  $\alpha$  and  $\lambda$  is discussed in Appendix H.2. This Appendix also shows that small variations around the values calibrated by Tversky and Kahneman (1992) induce relatively little change in the predicted policy price  $\underline{p}^L$  and subsequent increases in consumption.

## H.2 Sensitivity analysis of $\underline{p}^L$ to the behavioral parameters

Policy parameters are set at benchmark values  $q_L = 0.1\%$ ,  $F = 1,000$ ,  $b = 1.58$ , and  $c = 50$ . Prices and costs are for one ounce of cannabis.  $\Delta\%D(\underline{p}^L)$  is the percentage predicted increase in consumption following a legalization process that drives dealers out of business.

We study the sensitivity of the eviction price,  $\underline{p}^L$ , to the exogenous behavioral parameters  $\gamma^+$ ,  $\gamma^-$ ,  $\alpha$  and  $\lambda$ . The benchmark values are:  $\alpha = 0.88$ ,  $\lambda = 2.25$ ,  $\gamma^+ = 0.61$  and  $\gamma^- = 0.69$ .

<sup>38</sup>This eviction price assumes that, under legalization, the probability of arrest is ten times smaller ( $q_L = 0.1\%$ ) than under prohibition ( $q = 1\%$ ); and that the marginal cost on the black market is USD 50 *post-legalization*.

Table 6: Sensitivity of eviction price and demand to behavioral parameters for  $\epsilon = -0.5$

parameter	variation	$\hat{\mu}$	$\hat{\sigma}$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$
$\gamma^+ = 0.61$	+10%	0.1%	-0.22%	-0.21%	-0.3%
	+5%	0.06%	-0.12%	-0.12%	-0.16%
	-5%	-0.06%	0.15%	0.16%	0.2%
	-10%	-0.14%	0.33%	0.36%	0.46%
$\gamma^- = 0.69$	+10%	0.86%	-1.91%	-7.97%	-2.63%
	+5%	0.47%	-1.03%	-4.51%	-1.41%
	-5%	-0.53%	1.19%	5.86%	1.61%
	-10%	-1.15%	2.57%	13.45%	3.44%
$\alpha = 0.88$	+10%	-0.8%	1.8%	9.66%	2.43%
	+5%	-0.39%	0.89%	4.57%	1.21%
	-5%	0.39%	-0.87%	-4.04%	-1.18%
	-10%	0.77%	-1.7%	-7.54%	-2.33%
$\lambda = 2.25$	+10%	-0.33%	0.76%	2.2%	1.03%
	+5%	-0.16%	0.38%	1.1%	0.52%
	-5%	0.18%	-0.38%	-1.09%	-0.51%
	-10%	0.34%	-0.75%	-2.17%	-1.03%

Benchmark values in column 1 are  $\hat{\mu} = -690.4$ ,  $\hat{\sigma} = 1065.8$ ,  $\underline{p}^L = 97.79$  and  $\Delta\%D(\underline{p}^L) = 53.18\%$ .

Tables 6 to 9 present in columns 3 and 4 the sensitivity of the distribution parameters, and in columns 5 and 6 the sensitivity of both the eviction price and the subsequent increase in consumption *post-legalization*. The magnitude of variations of the behavioral parameters around the benchmark values are presented in column 2.

Overall, the distribution parameters are not very sensitive to the variations in the behavioral parameters: variations in the behavioral parameters by 10% entail variations in the distribution parameters of less than 8% for most cases. The policy price seems fairly sensitive to the parameter  $\gamma^-$ : a 10% variation in this parameter causes a change in price of up to 13.5%. This is also true for the parameter  $\alpha$ . Finally, *post-legalization* cannabis consumption is not very responsive to small variations in the behavioral parameters (by less than 10%) as it changes by less than 2% in most cases.

### H.3 Sensitivity analysis to policy parameters

To illustrate how governments may use a combination of policy instruments to regulate the market for cannabis *post-legalization*, Table 10 exploits combined variations in several policy parameters.

The first row presents the current benchmark values for the different policy parameters, the recommended legal price  $\underline{p}^L$  and the *post-legalization* increase in the extensive margin of consumption.

Table 7: Sensitivity of eviction price and demand to behavioral parameters for  $\epsilon = -0.6$

parameter	variation	$\hat{\mu}$	$\hat{\sigma}$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$
$\gamma^+ = 0.61$	+10%	0.22%	-0.21%	-0.21%	-0.34%
	+5%	0.13%	-0.12%	-0.12%	-0.19%
	-5%	-0.14%	0.15%	0.16%	0.24%
	-10%	-0.32%	0.34%	0.36%	0.53%
$\gamma^- = 0.69$	+10%	1.87%	-1.91%	-7.97%	-3.05%
	+5%	1.01%	-1.03%	-4.51%	-1.63%
	-5%	-1.16%	1.2%	5.86%	1.87%
	-10%	-2.5%	2.57%	13.45%	3.99%
$\alpha = 0.88$	+10%	-1.75%	1.81%	9.66%	2.82%
	+5%	-0.86%	0.9%	4.57%	1.4%
	-5%	0.85%	-0.86%	-4.04%	-1.37%
	-10%	1.66%	-1.69%	-7.54%	-2.7%
$\lambda = 2.25$	+10%	-0.73%	0.77%	2.2%	1.2%
	+5%	-0.36%	0.38%	1.1%	0.6%
	-5%	0.38%	-0.37%	-1.09%	-0.6%
	-10%	0.74%	-0.75%	-2.17%	-1.19%

Benchmark values in column 1  $\hat{\mu} = -506.3$ ,  $\hat{\sigma} = 888.1$ ,  $\underline{p}^L = 97.79$  and  $\Delta\%D(\underline{p}^L) = 65.45\%$ .

Table 8: Sensitivity of eviction price and demand to behavioral parameters for  $\epsilon = -0.7$

parameter	variation	$\hat{\mu}$	$\hat{\sigma}$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$
$\gamma^+ = 0.61$	+10%	0.37%	-0.22%	-0.21%	-0.39%
	+5%	0.21%	-0.12%	-0.12%	-0.21%
	-5%	-0.24%	0.14%	0.16%	0.27%
	-10%	-0.55%	0.33%	0.36%	0.6%
$\gamma^- = 0.69$	+10%	3.2%	-1.92%	-7.97%	-3.43%
	+5%	1.73%	-1.03%	-4.51%	-1.84%
	-5%	-1.98%	1.19%	5.86%	2.11%
	-10%	-4.27%	2.56%	13.45%	4.49%
$\alpha = 0.88$	+10%	-3.0%	1.8%	9.66%	3.17%
	+5%	-1.48%	0.89%	4.57%	1.58%
	-5%	1.45%	-0.87%	-4.04%	-1.54%
	-10%	2.84%	-1.7%	-7.54%	-3.03%
$\lambda = 2.25$	+10%	-1.26%	0.76%	2.2%	1.35%
	+5%	-0.62%	0.37%	1.1%	0.67%
	-5%	0.64%	-0.38%	-1.09%	-0.67%
	-10%	1.27%	-0.76%	-2.17%	-1.34%

Benchmark values in column 1  $\hat{\mu} = -374.8$ ,  $\hat{\sigma} = 761.3$ ,  $\underline{p}^L = 97.79$  and  $\Delta\%D(\underline{p}^L) = 78.23\%$ .

Table 9: Sensitivity of eviction price and demand to the behavioral parameters for  $\epsilon = -0.8$

parameter	variation	$\hat{\mu}$	$\hat{\sigma}$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$
$\gamma^+ = 0.61$	+10%	0.58%	-0.22%	-0.21%	-0.42%
	+5%	0.32%	-0.12%	-0.12%	-0.23%
	-5%	-0.38%	0.15%	0.16%	0.29%
	-10%	-0.88%	0.34%	0.36%	0.66%
$\gamma^- = 0.69$	+10%	5.02%	-1.91%	-7.97%	-3.78%
	+5%	2.71%	-1.03%	-4.51%	-2.02%
	-5%	-3.12%	1.2%	5.86%	2.32%
	-10%	-6.72%	2.57%	13.45%	4.95%
$\alpha = 0.88$	+10%	-4.73%	1.81%	9.66%	3.5%
	+5%	-2.33%	0.89%	4.57%	1.74%
	-5%	2.27%	-0.86%	-4.04%	-1.7%
	-10%	4.44%	-1.69%	-7.54%	-3.34%
$\lambda = 2.25$	+10%	-1.99%	0.76%	2.2%	1.48%
	+5%	-0.99%	0.38%	1.1%	0.74%
	-5%	1.0%	-0.38%	-1.09%	-0.74%
	-10%	1.98%	-0.75%	-2.17%	-1.47%

Benchmark values in column 1  $\hat{\mu} = -276.2$ ,  $\hat{\sigma} = 666.1$ ,  $\underline{p}^L = 97.79$ ,  $\Delta\%D(\underline{p}^L) = 91.49\%$ .

Rows 2 to 5 present scenarios in which the government certifies the quality of legal cannabis, such that  $b$  goes up to 2, and does not invest a lot in detecting illegal purchases, such that the probability of arrest  $q$  is half the benchmark value, but doubles the fines for illegal purchase ( $F=2000$ ). At the same time it may choose or not to enforce repression against illegal providers, the marginal cost  $c$  varying from 15 – i.e. less than a third of the benchmark value – to 200 – i.e. four times the benchmark value. Simulations show that the government is able to contain consumption at the *pre-legalization* level when the marginal cost is four times the benchmark value ( $c = 200$ ).

Rows 6 to 11 show that investing in quality differentiation (increasing  $b$ ) is effective at reducing cannabis consumption. Even with lax enforcement of arrest of illegal users ( $q = 0.05\%$ ), row 11 shows that limiting the consumption increase *post-legalization* can be achieved by investing in quality differentiation and certification of legal cannabis, such that  $b = 4$ .

Rows 12 to 16 show simulations of policies which increase repression on the demand side through various intensities of arrests  $q$  and fine amounts  $F$ , while the other parameters are kept at benchmark values. While increasing the level of fines seems to be an effective way to limit *post-legalization* consumption, high fines may be neither cost-effective nor fair, especially to low income users. Similarly, increased enforcement of arrests combined with statistical discrimination may also result in an uneven burden on some populations.

Table 10: Sensitivity analysis of eviction price and post-legalization demand

$c$	Policy parameters			Eviction Price	Increase in Demand			
	$b$	$q$	$F$	$\underline{p}^L$	$\epsilon = -0.5$	$\epsilon = -0.6$	$\epsilon = -0.7$	$\epsilon = -0.8$
50	1.58	0.1%	1000.0	97.79	53%	65%	78%	91%
15	2.00	0.05%	2000.0	56.39	61%	75%	90%	106%
25	2.00	0.05%	2000.0	76.52	57%	71%	84%	99%
100	2.00	0.05%	2000.0	227.5	30%	36%	43%	50%
200	2.00	0.05%	2000.0	428.81	-2%	-3%	-3%	-3%
50	1.00	0.05%	1000.0	56.88	61%	75%	90%	106%
50	1.25	0.05%	1000.0	71.09	58%	72%	86%	101%
50	1.58	0.05%	1000.0	89.86	55%	67%	81%	94%
50	2.00	0.05%	1000.0	113.75	50%	62%	74%	86%
50	3.00	0.05%	1000.0	170.63	40%	49%	58%	67%
50	4.00	0.05%	1000.0	227.5	30%	36%	43%	50%
50	1.58	0.05%	1000.0	89.86	55%	67%	81%	94%
50	1.58	0.1%	2000.0	115.68	50%	61%	73%	85%
50	1.58	0.05%	3000.0	110.55	51%	62%	75%	87%
50	1.58	0.2%	500.0	96.06	54%	66%	79%	92%
50	1.58	0.5%	5000.0	404.51	1%	2%	2%	2%
50	2.00	1.0%	2000.0	392.45	3%	4%	5%	5%
100	1.58	1.5%	1500.0	408.79	1%	1%	1%	1%
50	2.00	0.5%	4000.0	430.44	-2%	-3%	-3%	-4%
100	2.25	1.0%	1000.0	401.54	2%	2%	3%	3%
15	2.50	1.0%	2000.0	396.82	3%	3%	4%	4%
15	1.58	0.5%	6000.0	411.41	0%	0%	1%	1%
25	1.25	2.0%	2500.0	427.67	-2%	-2%	-3%	-3%
50	1.58	2.0%	1500.0	386.59	4%	5%	6%	7%
50	3.00	1.0%	1000.0	374.68	6%	7%	8%	9%
15	1.00	0%	-	15.0	69%	86%	103%	121%
25	1.00	0%	-	25.0	67%	83%	100%	117%
50	1.00	0%	-	50.0	62%	77%	92%	108%
75	1.00	0%	-	75.0	58%	71%	85%	99%
100	1.00	0%	-	100.0	53%	65%	78%	91%
125	1.00	0%	-	125.0	48%	59%	70%	82%

Notes: Behavioral parameters are set at values calibrated by Tversky and Kahneman (1992):  $\lambda = 2.25$ ,  $\alpha = 0.88$ ,  $\gamma^+ = 0.61$ , and  $\gamma^- = 0.69$ . Variation in demand relies on the baseline estimates for the parameters of the distribution of  $\theta$  corresponding to different price elasticities of demand, as described in Table 5.



The fourth part of the table (rows 17 to 25) presents results where the *post-legalization* consumption is contained around the *pre-legalization* level. They highlight that a government aiming at controlling cannabis consumption through legalization would have to invest in strict repression of either the supply or the demand side, as well as in product differentiation, certification and information campaigns. For instance, a legalization policy combined with significant investments in quality differentiation of legal cannabis ( $b = 2$ ) and increased fines for illegal consumption up to USD 4000 would lead to the eviction price of USD 430 per ounce, decreasing cannabis consumption by 2.35% to 3.75%.

The last exercise illustrates an extreme case of no differentiation between legal and illegal products in a liberal state without repression on the demand and supply sides of the market, thus pricing legal cannabis at the marginal cost of production, which is the same on the illegal market. The absence of regulation results in large increases in *post-legalization* consumption, larger than 50% in most scenarios and more than 100% with large price elasticities of demand or low production costs.

#### H.4 On the existence of $\theta^L$ when $b < 1$

In the theory, for the sake of simplicity, we prove the existence and uniqueness of  $\theta^L$  under the sufficient condition  $b \geq 1$ . However, this condition is not necessary.

Take the weighting and value functions calibrated in Tversky and Kahneman (1992), as well as  $v = 1$ . In this case,

$$\underline{p}^L = b \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} (F + c) + c \right],$$

while

$$\theta^L = \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} b + b - 1 \right]^{-1} \left[ \left( \lambda \frac{w^-(q)}{w^+(1-q)} \right)^{\frac{1}{\alpha}} (p^L - p - F) + p^L - p \right];$$

which does not require that  $b \geq 1$ . For instance, when  $c = 50$ ,  $b = 0.5$ ,  $q = 0.1\%$  and  $F = 1000$ , the legal price threshold  $\underline{p}^L$  is around 31\$ and  $\theta^L(c, \underline{p}^L)$  exists and is unique – it is approximately equal to 61.89.

## I Exploring other tools and policy objectives

### I.1 Survival of the black market

After the government chooses the price of the legal cannabis,  $p^L = (1 + \tau)c^L$ , the repression (i.e. the probability of arrest  $q$ , the fine  $F$  and the increase in marginal cost to produce illegally  $\delta \geq 0$ ), as well

as the quality differential between legal and illegal products,  $b \geq 1$ , the consumers decide whether to consume or not, and on which market. From here, two cases may occur.

1. Taxes are set low enough such that, given the level of repression on both the demand and supply sides and the quality differential, the black market does not survive. In this case  $\tau$  satisfies  $1 + \tau \leq bv \frac{\theta^I((1+\delta)c^L)}{c^L}$  where  $\theta^I((1+\delta)c^L)$  is defined in (2). Let  $\theta^0 = \frac{(1+\tau)c^L}{vb}$  be the agent indifferent between consuming legal cannabis at price  $p^L = (1+\tau)c^L$  and not consuming. The demand for (legal) cannabis is given by:  $D^L((1+\tau)c^L) = 1 - G\left(\frac{(1+\tau)c^L}{vb}\right)$ .
2. If the government sets taxes too high, such that  $(1+\tau)c^L > bv\theta^I((1+\delta)c^L)$ , then the demand is split between the legal and illegal markets, as follows:

$$D^L(p, (1+\tau)c^L|b) = 1 - G(\theta^L(p, (1+\tau)c^L|b))$$

$$D^I(p, (1+\tau)c^L|b) = G(\theta^L(p, (1+\tau)c^L|b)) - G(\theta^I(p))$$

where  $\theta^I(p)$  is defined in (2) and  $\theta^L(p, (1+\tau)c^L|b)$  in (7). Illegal providers set the black market price  $p$  as defined in (5). The price reaction function of the illegal sector is analogous to the best response described in (10) with  $p^L = (1+\tau)c^L$ .

## I.2 Maximizing tax revenue when $\theta$ follows an exponential distribution

Let us assume that on the positive real line,  $\theta$  follows an exponential distribution  $G(\theta) \equiv 1 - e^{-\eta\theta}$ , with  $0 < \eta < 1$ , (17) becomes

$$1 = \eta c^L \tau \frac{\partial \theta^I}{\partial p^L}. \quad (33)$$

If the black market has been initially shut down, then (33) yields  $\tau_0^{\alpha T} = \frac{bv}{\eta c^L}$ . If the black market is not shut down, with risk-neutral consumers we have  $\theta^L = \frac{p^L - p - qF}{(b+q-1)v}$ , so that (33) yields:  $\tau^{\alpha T} = \frac{b+q-1}{\eta c^L} v \geq 0$ . This is the optimal solution if the demand for cannabis is strictly positive for this level of taxes which requires that  $\theta^L(\tau^{\alpha T}) = \frac{(1+\tau^{\alpha T})c^L - p - qF}{(b+q-1)v} > 0$ . This is equivalent to  $\eta < \frac{v(b+q-1)}{qF+p-c^L} \leq \frac{v(b+q-1)}{qF+\delta c^L} = \eta^{\alpha T}$ . We deduce that the unconstrained solution (i.e., in the absence of competition by the black market) leads to a larger excise tax than the constrained solution:  $\tau_0^{\alpha T} \geq \tau^{\alpha T}$ ,<sup>39</sup> which is intuitive.

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<sup>39</sup>They are equal only when  $q = 1$ .

When the government does not have to deal with competition it can impose higher taxes, as the consumers are captive. In both cases, the tax rate increases with  $vb$ , the quality of the legal product, and decreases with  $c^L$ , the marginal cost of production of legal cannabis, and with  $\eta$ , the distribution of consumers' type parameter. Indeed, a higher  $\eta$  implies that the distribution of taste is skewed towards the low values of  $\theta$ : few people are willing to pay a high price for cannabis, which implies that the tax rate should be relatively low.

Next, we check under which conditions the optimal tax level  $\tau^{\alpha_T}$  is such that the final price  $p^L(\tau^{\alpha_T}) = (1 + \tau^{\alpha_T})c^L$  is lower than the eviction price  $\underline{p}^L = bv\theta^I((1 + \delta)c^L) = b\frac{(1+\delta)c^L+qF}{1-q}$ . Let  $\eta^{evic} = \frac{(1-q)(b+q-1)v}{b(\delta c^L+qF)+(b+q-1)c^L} > 0$ . It is easy to check that if  $\eta \geq \eta^{evic}$ , then  $p^L(\tau^{\alpha_T}) \leq \underline{p}^L$ . Under our assumptions,  $0 < \eta^{evic} < \eta^{\alpha_T}$ . Only when  $\eta^{evic} \leq \eta < \eta^{\alpha_T}$  is it possible to maximize tax revenues while simultaneously eradicating the black market through an eviction price.

Based on the number of users of cannabis worldwide, it is unrealistic to assume that the distribution of tastes for cannabis in the general population is skewed towards the low values of  $\theta$  (i.e., it is unrealistic to consider large values for  $\eta$ ). Yet, if  $\eta < \eta^{evic} < \eta^{\alpha_T}$ , then the price that maximizes tax revenue is higher than the eviction price. In other words, when there is a large demand for cannabis, maximizing tax revenue implies setting the price of the legal products relatively high, such that the black market can survive by selling illegal cannabis at a discount.

### I.3 Maximizing tax revenues: a numerical application

This section provides detail on the tax policy application discussed in Section 6. It also presents the results for the other values of the price demand elasticity, as well as other examples, where there is very lax enforcement on the demand side of the market, leading to a probability of arrest close to zero,  $q = 0$ .

The methodology of this numerical exercise relies on the same principle as in Section 5 and Appendix H, as well as the calibration results of Appendix 5. We use an iterative solver on the system of equations (17) and (10) with  $p^L = (1 + \tau)c^L$ .

#### Results with elasticities varying from -0.7 to -0.5

We present, in Tables 11 to 13, the results of the numerical exercise from Section 6 for higher values of the demand price elasticity (-0.5, -0.6 and -0.7). As expected, the more inelastic the demand, the higher the equilibrium prices and the government revenue. Again we find that the price maximizing

Table 11: Legalization price and resulting demand when the government maximizes tax revenue ( $\epsilon = -0.5$ )

$\frac{1}{N}$	Policy parameters				Equilibrium prices		Equilibrium demand and revenue			Eviction scenario		
	$c$	$b$	$q$	$F$	$p$	$p^L$	$\Delta\%D(p, p^L)$	$s^I(p, p^L)$	$R$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$	$\underline{R}$
0.55	50	1.58	0.1%	1000	122.89	417.78	-1%	38%	363	97.79	60%	119
0.55	25	1.58	0.1%	1000	106.32	413.84	-3%	41%	348	57.84	65%	55
0.55	125	1.58	0.1%	1000	172.96	430.04	5%	27%	412	217.63	46%	286
0.55	200	1.58	0.1%	1000	223.61	442.94	12%	15%	466	337.47	32%	421
0.10	50	1.58	0.1%	1000	68.37	404.99	-7%	48%	315	97.79	60%	119
0.25	50	1.58	0.1%	1000	90.64	410.15	-5%	44%	334	97.79	60%	119
0.75	50	1.58	0.1%	1000	138.60	421.58	1%	35%	378	97.79	60%	119
1.00	50	1.58	0.1%	1000	154.09	425.36	3%	31%	393	97.79	60%	119
0.55	50	1.00	0.1%	1000	53.11	65.03	59%	0%	65	61.89	60%	60
0.55	50	1.10	0.1%	1000	62.68	106.11	25%	24%	99	68.08	60%	70
0.55	50	1.30	0.1%	1000	94.38	237.41	7%	35%	213	80.46	60%	90
0.55	50	1.80	0.1%	1000	137.95	557.87	-4%	39%	475	111.41	60%	141
0.55	50	1.58	0.2%	1000	120.48	424.13	-1%	37%	372	111.56	58%	140
0.55	50	1.58	0.5%	1000	114.49	439.87	0%	34%	394	146.68	54%	191
0.55	50	1.58	1.0%	1000	106.15	461.47	2%	30%	424	197.33	48%	260
0.55	50	1.58	0.0%	1000	126.22	408.95	-2%	39%	351	79.00	62%	89
0.55	50	1.58	0.1%	100	126.28	416.18	-2%	39%	357	81.68	62%	94
0.55	50	1.58	0.1%	500	124.77	416.89	-1%	39%	360	88.84	61%	105
0.55	50	1.58	0.1%	1500	121.01	418.68	-1%	37%	367	106.74	59%	132
0.55	50	1.58	0.1%	2000	119.13	419.57	0%	36%	370	115.68	58%	146

Notes: The above results are based on a price demand elasticity of 0.5 and the corresponding distribution parameters (see Table 5). The marginal cost on the legal market,  $c^L$ , is USD 25 per ounce. The tax revenue in USD *per capita* and *per annum* is given as the product of the difference  $p^L - c^L$  with the extensive and intensive margins of consumption. The intensive margin is approximated using Orens et al. (2018) estimates for consumption in Colorado in 2017.

tax revenue is generally well above the eviction price (except when the quality is the same on both markets) and the corresponding extensive margins of consumption are of the same magnitude.

### Results with $q = 0$

We detail in Tables 14 to 17 scenarios where consumers going to the illegal market are not arrested. Since the case where  $b = 1$  and  $q = 0$  yields perfect competition between the legal and the illegal markets, we prefer to present a case where there is very little quality differentiation ( $b = 1.01$ ), rather than no differentiation. When there are no arrests on the demand side, individuals are all the more sensitive to quality. For a government maximizing tax revenue, quality has a large influence on the optimal price: when the quality differential is 1.01, the equilibrium price on the legal market,  $p^L$ , is between USD 54 and 57 per ounce, depending on the elasticity; when  $b = 1.80$ , this price rises up to USD 387 to 549 per ounce.

Table 12: Legalization price and resulting demand when the government maximizes tax revenue ( $\epsilon = -0.6$ )

$\frac{1}{N}$	Policy parameters				Equilibrium prices		Equilibrium demand and revenue			Eviction scenario		
	$c$	$b$	$q$	$F$	$p$	$p^L$	$\Delta\%D(p, p^L)$	$s^I(p, p^L)$	$R$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$	$\underline{R}$
0.55	50	1.58	0.1%	1000	110.50	363.72	10%	37%	348	97.79	74%	129
0.55	25	1.58	0.1%	1000	93.89	359.59	7%	41%	331	57.84	80%	60
0.55	125	1.58	0.1%	1000	160.82	376.65	18%	24%	403	217.63	56%	306
0.55	200	1.58	0.1%	1000	211.81	390.40	26%	9%	464	337.47	39%	443
0.10	50	1.58	0.1%	1000	65.21	352.61	3%	47%	304	97.79	74%	129
0.25	50	1.58	0.1%	1000	83.68	357.08	6%	43%	321	97.79	74%	129
0.75	50	1.58	0.1%	1000	123.60	367.03	12%	34%	362	97.79	74%	129
1.00	50	1.58	0.1%	1000	136.54	370.34	14%	30%	376	97.79	74%	129
0.55	50	1.00	0.1%	1000	51.86	63.69	74%	0%	68	61.89	74%	65
0.55	50	1.10	0.1%	1000	59.24	96.04	41%	21%	98	68.08	74%	76
0.55	50	1.30	0.1%	1000	86.15	208.78	18%	33%	206	80.46	74%	98
0.55	50	1.80	0.1%	1000	123.41	484.03	6%	38%	454	111.41	74%	153
0.55	50	1.58	0.2%	1000	108.07	369.42	10%	36%	357	111.56	72%	152
0.55	50	1.58	0.5%	1000	102.03	383.54	12%	32%	380	146.68	67%	207
0.55	50	1.58	1.0%	1000	93.64	402.94	13%	28%	412	197.33	59%	279
0.55	50	1.58	0.0%	1000	113.88	355.81	9%	38%	335	79.00	77%	97
0.55	50	1.58	0.1%	100	113.87	362.05	9%	38%	341	81.68	77%	102
0.55	50	1.58	0.1%	500	112.38	362.79	9%	38%	344	88.84	75%	114
0.55	50	1.58	0.1%	1500	108.64	364.66	10%	36%	352	106.74	73%	144
0.55	50	1.58	0.1%	2000	106.77	365.60	11%	35%	356	115.68	71%	158

Notes: The above results are based on a price demand elasticity of 0.6 and the corresponding distribution parameters (see Table 5). The marginal cost on the legal market,  $c^L$ , is USD 25 per ounce. The tax revenue in USD *per capita* and *per annum* is given as the product of the difference  $p^L - c^L$  with the extensive and intensive margins of consumption. The intensive margin is approximated using Orens et al. (2018) estimates for consumption in Colorado in 2017.

Table 13: Legalization price and resulting demand when the government maximizes tax revenue ( $\epsilon = -0.7$ )

$\frac{1}{N}$	Policy parameters				Equilibrium prices		Equilibrium demand and revenue			Eviction scenario		
	$c$	$b$	$q$	$F$	$p$	$p^L$	$\Delta\%D(p, p^L)$	$s^I(p, p^L)$	$R$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$	$\underline{R}$
0.55	50	1.58	0.1%	1000	101.78	325.65	21%	36%	342	97.79	89%	140
0.55	25	1.58	0.1%	1000	85.11	321.32	18%	40%	323	57.84	96%	66
0.55	125	1.58	0.1%	1000	152.34	339.28	31%	21%	403	217.63	67%	328
0.55	200	1.58	0.1%	1000	203.66	353.91	42%	3%	473	337.47	47%	467
0.10	50	1.58	0.1%	1000	62.98	315.69	14%	45%	300	97.79	89%	140
0.25	50	1.58	0.1%	1000	78.78	319.69	17%	42%	316	97.79	89%	140
0.75	50	1.58	0.1%	1000	113.04	328.62	23%	33%	355	97.79	89%	140
1.00	50	1.58	0.1%	1000	124.19	331.60	25%	30%	368	97.79	89%	140
0.55	50	1.00	0.1%	1000	57.06	69.03	87%	0%	84	61.89	89%	71
0.55	50	1.10	0.1%	1000	56.88	89.07	58%	18%	100	68.08	89%	83
0.55	50	1.30	0.1%	1000	80.38	188.68	31%	32%	204	80.46	89%	107
0.55	50	1.80	0.1%	1000	113.15	431.97	17%	37%	445	111.41	89%	166
0.55	50	1.58	0.2%	1000	99.34	330.90	22%	34%	351	111.56	86%	164
0.55	50	1.58	0.5%	1000	93.27	343.94	23%	31%	376	146.68	80%	223
0.55	50	1.58	1.0%	1000	84.87	361.86	25%	26%	409	197.33	71%	299
0.55	50	1.58	0.0%	1000	105.18	318.35	20%	38%	328	79.00	92%	106
0.55	50	1.58	0.1%	100	105.13	323.89	20%	37%	334	81.68	92%	111
0.55	50	1.58	0.1%	500	103.64	324.67	20%	37%	337	88.84	90%	124
0.55	50	1.58	0.1%	1500	99.93	326.63	22%	35%	346	106.74	87%	156
0.55	50	1.58	0.1%	2000	98.08	327.62	22%	34%	350	115.68	85%	171

Notes: The above results are based on a price demand elasticity of 0.7 and the corresponding distribution parameters (see Table 5). The marginal cost on the legal market,  $c^L$ , is USD 25 per ounce. The tax revenue in USD *per capita* and *per annum* is given as the product of the difference  $p^L - c^L$  with the extensive and intensive margins of consumption. The intensive margin is approximated using Orens et al. (2018) estimates for consumption in Colorado in 2017.

Table 14: Legalization price and resulting demand when the government maximizes tax revenue and  $q = 0$ , for  $\epsilon = -0.5$

$\frac{1}{N}$	Policy parameters		Equilibrium prices		Equilibrium demand and revenue			Eviction scenario		
	$c$	$b$	$p$	$p^L$	$\Delta\%D(p, p^L)$	$s^I(p, p^L)$	$R$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$	$\underline{R}$
0.55	50	1.58	126.22	408.95	48%	39%	351	79.0	62%	89
0.55	25	1.58	109.70	405.04	51%	43%	336	39.5	67%	25
0.55	125	1.58	176.18	421.13	39%	29%	399	197.5	48%	260
0.55	200	1.58	226.76	433.97	30%	16%	452	316.0	34%	399
0.10	50	1.58	69.26	395.67	59%	50%	302	79.0	62%	89
0.25	50	1.58	92.55	401.03	54%	46%	321	79.0	62%	89
0.75	50	1.58	142.60	412.89	45%	36%	366	79.0	62%	89
1.00	50	1.58	158.75	416.82	42%	33%	382	79.0	62%	89
0.55	50	1.01	53.84	54.37	62%	0%	48	50.5	62%	42
0.55	50	1.10	64.21	96.67	60%	29%	83	55.0	62%	50
0.55	50	1.30	96.96	228.35	53%	37%	200	65.0	62%	66
0.55	50	1.80	141.64	549.15	45%	40%	463	90.0	62%	108

Notes: The above results are based on a price demand elasticity of 0.5 and the corresponding distribution parameters (see Table 5). The marginal cost on the legal market,  $c^L$ , is USD 25 per ounce. The tax revenue in USD *per capita* and *per annum* is given as the product of the difference  $p^L - c^L$  with the extensive and intensive margins of consumption. The intensive margin is approximated using Orens et al. (2018) estimates for consumption in Colorado in 2017.

Table 15: Legalization price and resulting demand when the government maximizes tax revenue and  $q = 0$ , for  $\epsilon = -0.6$

$\frac{1}{N}$	Policy parameters		Equilibrium prices		Equilibrium demand and revenue			Eviction scenario		
	$c$	$b$	$p$	$p^L$	$\Delta\%D(p, p^L)$	$s^I(p, p^L)$	$R$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$	$\underline{R}$
0.55	50	1.58	113.88	355.81	62%	38%	335	79.0	77%	97
0.55	25	1.58	97.31	351.71	66%	42%	319	39.5	83%	27
0.55	125	1.58	164.07	368.64	50%	26%	389	197.5	59%	280
0.55	200	1.58	214.98	382.30	39%	11%	450	316.0	42%	421
0.10	50	1.58	66.10	344.17	73%	49%	289	79.0	77%	97
0.25	50	1.58	85.61	348.86	68%	45%	308	79.0	77%	97
0.75	50	1.58	127.66	359.27	58%	35%	350	79.0	77%	97
1.00	50	1.58	141.27	362.73	55%	32%	364	79.0	77%	97
0.55	50	1.01	53.56	54.08	76%	0%	52	50.5	77%	46
0.55	50	1.10	61.00	87.50	74%	26%	82	55.0	77%	54
0.55	50	1.30	88.87	200.65	68%	36%	192	65.0	77%	72
0.55	50	1.80	127.09	476.21	59%	39%	442	90.0	77%	117

Notes: The above results are based on a price demand elasticity of 0.6 and the corresponding distribution parameters (see Table 5). The marginal cost on the legal market,  $c^L$ , is USD 25 per ounce. The tax revenue in USD *per capita* and *per annum* is given as the product of the difference  $p^L - c^L$  with the extensive and intensive margins of consumption. The intensive margin is approximated using Orens et al. (2018) estimates for consumption in Colorado in 2017.

Table 16: Legalization price and resulting demand when the government maximizes tax revenue and  $q = 0$ , for  $\epsilon = -0.7$

$\frac{1}{N}$	Policy parameters		Equilibrium prices		Equilibrium demand and revenue			Eviction scenario		
	$c$	$b$	$p$	$p^L$	$\Delta\%D(p, p^L)$	$s^I(p, p^L)$	$R$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$	$\underline{R}$
0.55	50	1.58	105.18	318.35	76%	38%	328	79.0	92%	106
0.55	25	1.58	88.56	314.06	81%	42%	310	39.5	100%	30
0.55	125	1.58	155.60	331.86	62%	23%	388	197.5	70%	300
0.55	200	1.58	206.85	346.39	48%	6%	457	316.0	50%	445
0.10	50	1.58	63.87	307.84	88%	48%	284	79.0	92%	106
0.25	50	1.58	80.71	312.06	83%	44%	302	79.0	92%	106
0.75	50	1.58	117.13	321.48	73%	34%	342	79.0	92%	106
1.00	50	1.58	128.96	324.63	69%	31%	356	79.0	92%	106
0.55	50	1.01	55.18	55.71	91%	0%	60	50.5	92%	50
0.55	50	1.10	58.78	81.12	90%	24%	82	55.0	92%	59
0.55	50	1.30	83.18	181.16	82%	35%	189	65.0	92%	78
0.55	50	1.80	116.83	424.77	73%	39%	432	90.0	92%	127

Notes: The above results are based on a price demand elasticity of 0.7 and the corresponding distribution parameters (see Table 5). The marginal cost on the legal market,  $c^L$ , is USD 25 per ounce. The tax revenue in USD *per capita* and *per annum* is given as the product of the difference  $p^L - c^L$  with the extensive and intensive margins of consumption. The intensive margin is approximated using Orens et al. (2018) estimates for consumption in Colorado in 2017.

Table 17: Legalization price and resulting demand when the government maximizes tax revenue and  $q = 0$ , for  $\epsilon = -0.8$

$\frac{1}{N}$	Policy parameters		Equilibrium prices		Equilibrium demand and revenue			Eviction scenario		
	$c$	$b$	$p$	$p^L$	$\Delta\%D(p, p^L)$	$s^I(p, p^L)$	$R$	$\underline{p}^L$	$\Delta\%D(\underline{p}^L)$	$\underline{R}$
0.55	50	1.58	98.73	290.60	91%	37%	327	79.0	108%	115
0.55	25	1.58	82.06	286.12	97%	41%	307	39.5	117%	32
0.55	125	1.58	149.39	304.83	74%	21%	393	197.5	82%	320
0.55	200	1.58	200.96	320.27	58%	1%	471	316.0	58%	469
0.10	50	1.58	62.22	280.90	104%	47%	284	79.0	108%	115
0.25	50	1.58	77.08	284.80	99%	43%	301	79.0	108%	115
0.75	50	1.58	109.34	293.51	88%	34%	340	79.0	108%	115
1.00	50	1.58	119.85	296.42	84%	31%	353	79.0	108%	115
0.55	50	1.01	56.78	57.33	106%	0%	68	50.5	108%	54
0.55	50	1.10	57.17	76.48	106%	22%	84	55.0	108%	64
0.55	50	1.30	78.97	166.77	98%	34%	189	65.0	108%	85
0.55	50	1.80	109.22	386.64	88%	38%	429	90.0	108%	138

Notes: The above results are based on a price demand elasticity of 0.8 and the corresponding distribution parameters (see Table 5). The marginal cost on the legal market,  $c^L$ , is USD 25 per ounce. The tax revenue in USD *per capita* and *per annum* is given as the product of the difference  $p^L - c^L$  with the extensive and intensive margins of consumption. The intensive margin is approximated using Orens et al. (2018) estimates for consumption in Colorado in 2017.

# Weeding out the Dealers?

## The Economics of Cannabis Legalization \*

Emmanuelle Auriol<sup>†</sup> Alice Mesnard<sup>‡</sup> Tiffanie Perrault<sup>§</sup>

January 9, 2022

### Abstract

We model consumer choices for recreational cannabis in a risky environment and its supply under prohibition and legalization. While legalization reduces the profits of illegal providers, it increases cannabis consumption. This trade-off can be overcome by combining legalization with sanctions against the black market, and improvements to the quality of legal products. Numerical calibrations highlight how a policy mix can control the increase in cannabis consumption and throttle the illegal market. In the US, the eviction prices we predict to drive dealers out of business are much lower than the prices of legal cannabis in most of the states that opted for legalization, leaving room for the black market to flourish. Analyzing the compatibility of several policy goals sheds light on the less favorable outcomes of recent legalization reforms and suggests a new way forward.

JEL Classifications : I18, K32, K42, L51

Keywords : recreational cannabis, legalization, crime, policy, regulation

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Testimony of Patrick K. Nightingale, Esquire  
before the Pennsylvania Senate Law & Justice Committee  
February 28, 2022

I would like to thank Sen. Regan and Sen. Brewster and all of the members of the Law & Justice Committee for giving me the opportunity to address Driving Under the Influence of Cannabis in states that have fully legalized adult use. As Pennsylvania begins a good faith discussion about issues surrounding adult use legalization of cannabis I am grateful for the opportunity to discuss DUI laws in other adult use states and how Pennsylvania can adopt/implement evidence based DUI laws that keep our streets and highways safe while also protecting the cannabis consumer from unwarranted arrest, prosecution, and conviction.

Cannabis reform advocates fully understand the concerns that adult use legalization will result in a torrent of cannabis impaired drivers menacing Pennsylvania's highways and byways. Law enforcement is right to express concern that legalization will cause an increase in cannabis related DUI accidents and cannabis related DUI fatalities. I am hopeful that the experiences of other states that have legalized will inform the General Assembly on a practical, safe and common sense approach to DUI enforcement.

I want to make clear at the outset that driving impaired, whether by legal cannabis, prescription or illegal narcotics or legal alcohol, is and should remain a serious criminal offense with offenders prosecuted under the law. No one is suggesting that a cannabis consumer should be entitled to operate a motor vehicle while impaired by the psychoactive effects of tetrahydrocannabinol (Delta 9 THC).

Under Pennsylvania's DUI law, codified at 75 Pa.C.S. §3801, *et seq.* operating a motor vehicle with any detectable amount of a Schedule I, II or III non-prescribed controlled substance *or its metabolites* constitutes the offense of DUI. *See* 75 Pa.C.S. §3802(d)(1)(i) - (iii). Pennsylvania is a "zero tolerance" state as no proof of actual impairment is required. Operating a motor vehicle with detectable amounts of THC, the psychoactive chemical that gets one "high" as well as detectable amounts of Hydroxy THC, its psychoactive metabolite, and Carboxy THC, its non-psychoactive metabolite are sufficient for an arrest, prosecution, and conviction.

I would submit that an understanding of how THC effects the user and how THC metabolizes in to its psychoactive and non-psychoactive metabolites is important to the crafting of a DUI law that protects the public and the cannabis consumer. On September 21, 2021, the Pennsylvania Senate Transportation Committee held a hearing on SB 167 who's prime sponsor is Senator Bartolotta (R – Washington). SB 167 would treat medical cannabis patients similarly to patients using prescription narcotics by requiring proof of actual impairment. The Committee received the testimony of Lauren Vrabel, PharmD, who is employed as a pharmacist with a Pennsylvania medical marijuana license holder.

Naturally the body breaks down drugs into smaller, inactive compounds before it is eliminated or excreted. This occurs predominantly in the liver, whether THC is inhaled or ingested. The resulting compounds are an active metabolite, 11-OH-THC (Hydroxy THC),

and an inactive metabolite THC-COOH (Carboxy THC). Active metabolites can still interact with receptors to elicit a response, whereas inactive metabolites cannot . . . .

[W]hen inhaled, THC is absorbed by the lungs and sent through blood circulation to the brain before it is metabolized to 11-OH-THC. The onset of action occurs more quickly than ingestibles, producing effects within minutes after inhaling. Approximately 30 minutes after inhalation, the levels of THC-COOH are much higher than THC because elimination is much quicker. The effects of inhaled THC generally last between 2-4 hours.

Either way the active metabolite, 11-OH-THC, is then broken down into THC-COOH. Interestingly, THC-COOH is excreted through urine and is the metabolite that is tested in drug screenings. This is a misleading representation of intoxication, as it cannot and will not interact with receptors to produce a “high.” What this actually represents is simply consumption. It is not an indicator of the time frame of consumption. Therefore, measuring THC-COOH to prove intoxication at the time of operating a motor vehicle is arbitrary.

Testimony of Dr. Lauren Vrabel, PharmD, before the Pennsylvania Senate Transportation Committee on September 21, 2001.<sup>1</sup>

Since 2014 when Washington and Colorado became the first states to fully legalize cannabis tens of millions of Americans now live in fully legal states. Eighteen states and the District of Columbia have legalized cannabis for adult use. Among the adult use states only Arizona and Michigan are “zero tolerance” for adult use consumers, though both require proof of actual impairment for medical patients. Three states, Illinois, Montana and Washington utilize a *per se* cutoff of 5 ng/ml of Delta 9 THC. Two states, Colorado and Nevada, employ a “hybrid” cutoff. In Colorado 5 ng/ml of Delta 9 THC creates a “permissible inference” of impairment. In Nevada the limits are 2 ng/ml of Delta 9 and 5 ng/ml of Hydroxy THC. Nevada, however, requires proof of actual impairment unless the motorist has two prior DUI offenses within 7 years. Then the levels become *per se* cutoffs. The remaining states and the District of Columbia require proof of actual impairment. All states and D.C. are “implied consent” states like Pennsylvania where a motorist can suffer civil consequences, such as a license suspension and a fine, for refusing to consent to a chemical test when requested by a law enforcement officer during a DUI investigation.

Despite the lack of a reliable roadside THC test,<sup>2</sup> law enforcement are well trained to detect drug impaired drivers. A typical DUI investigation begins with the officer’s observations – was the motorist driving carelessly or recklessly? Excessively speeding? Ignoring traffic control devices? Failing to notice when a red light turns to green? Once the officer observes the traffic violation the officer is legally entitled to make a traffic stop. Observations of the motorist herself are the next focus of the investigation. Are her eyes glassy or bloodshot? Does she appear confused or disoriented? Does she have difficulty understand the officer’s questions? Does she have difficulty producing her license, insurance and registration?

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<sup>1</sup> Dr. Vrabel’s powerpoint presentation is incorporated herein and has been attached for the Committee’s review.

<sup>2</sup> Roadside THC tests are in development, but can only test for presence of THC not levels thereof. “There’s an oral fluid test that tells if there is marijuana in the system, it just doesn’t tell what that active level of THC is . . . . There’s no way to know with this oral fluid. So you can’t do a breathalyzer or an oral fluid test on the side of the road to measure that THC,” says Elizabeth Carey, AAA Western and Central New York public relations director.

The next phase of the cannabis DUI investigation involves standard field sobriety tests which include balancing tests such as “walk and turn” and “one leg standing” test that all police are trained to administer in DUI investigations. Additionally, when cannabis or other drug impairment is suspected, officers are trained to observe the motorist’s eyes for a lack of convergence (eyes focusing on a single point like the tip of a pen) or lack of smooth pursuit when focusing on a single point moving across the motorist’s field of vision (horizontal gaze nystagmus). Failing these field sobriety tests will enable a trained officer to conclude that the motorist was incapable of safely operating a motor vehicle. Failing these field sobriety tests is sufficient, in and of themselves, for a DUI arrest and conviction.<sup>3</sup>

Many police receive Advanced Roadside Impairment Driving Enforcement (ARIDE) training which is provided by the National Transportation Highway Safety Administration (NHTSA). Upon successful completion officers are Drug Recognition Experts (DREs). Many State Police barracks have DREs available to assist troopers during traffic stops where drug impairment is suspected. DREs are trained to look for signs of impairment that include body tremors, monitoring the motorist’s pulse over a period of time as well as simply asking the motorist about his or her recent drug use.

Once an officer investigating a cannabis DUI has reason to suspect that the motorist has consumed cannabis or other drugs the officer may request a chemical test. As Pennsylvania is an implied consent state refusing a chemical test request will result in an automatic one year license suspension and may be admissible during a DUI trial. As referenced above, a motorist who has consumed cannabis within the past few days or even weeks will have Carboxy THC in their blood – the non-psychoactive metabolite of THC. The presence of Delta 9 THC – the psychoactive chemical compound – is indicative of recent use, but not necessarily impairment. According to the NHTSA peak effects occur within 10 – 30 minutes<sup>4</sup> while the effects of inhaled cannabis dissipate quickly after one hour.<sup>5</sup> According to the NHTSA “It is difficult to establish a relationship between a person's THC blood or plasma concentration and performance impairing effects. ... It is inadvisable to try and predict effects based on blood THC concentrations alone, and currently impossible to predict specific effects based on THC-COOH (metabolite) concentrations.”<sup>6</sup>

Numerous studies have assessed the impact of cannabis legalization in both medical marijuana states and full adult use legalization states. According to a 2019 study by Lane and Hall “In the year following implementation of recreational cannabis sales, traffic fatalities temporarily increased by an average of one additional traffic fatality per million residents in both legalizing US states of Colorado, Washington and Oregon and in their neighboring jurisdictions.” The study noted that this uptick was followed by a trend reduction thereafter. A 2021 Insurance Institute for Highway Safety found mixed results. “State-by-state data is inconsistent: fatal accidents down in

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<sup>3</sup> The results of field sobriety tests and the officer’s opinion as to whether they indicate impairment is admissible at trial.

<sup>4</sup> NHTSA. *Drugs and Human Performance Facts Sheets*

<sup>5</sup> NHTSA. *State of Knowledge of Drug-Impaired Driving: FINAL REPORT*

<sup>6</sup> NHTSA. *Drugs and Human Performance Facts Sheets*

3 states (CA, WA, NV) while up in 2 states assessed (CO, OR). Non-fatal injuries up in 4 states, down in 1 state (NV). Non-injury crashes up 18% in CO but down 7% in NV. Both states largely have the same laws. After legalization in Colorado and Washington motorists involved in accidents were routinely tested for cannabis resulting in an increase of cannabis involved DUI accidents, but these accidents also involved alcohol impairment resulting in difficulty detecting trends in cannabis only DUI accidents and fatalities.

As stated at the outset, no cannabis consumer should ever drive while impaired by cannabis. Under current Pennsylvania DUI laws a drug impaired driver is considered the highest tier relative to penalties similar to a motorist with a blood alcohol content of .16 or greater. Whether or not to maintain this highest tier classification when cannabis is no longer a Schedule I controlled substance for Pennsylvania Vehicle Code purposes is not at issue today. I am hopeful that the Committee understands that the mere presence of Delta 9 THC does not compel the conclusion that the motorist is under the influence of cannabis or unable to operate a motor vehicle safely. The presence of non-psychoactive metabolites cannot indicate impairment and should not be admissible in a cannabis DUI prosecution. The prevailing trend among adult use states are DUI laws that require proof of actual impairment as opposed to per se ng/ml Delta 9 THC levels. Finally, while some of the data may be inconsistent on whether adult use legalization increases the risk of DUI accidents or fatalities, no state has seen any significant increase in cannabis only DUI accidents and fatalities.

Thank you.

Patrick K. Nightingale, Esq.

## State by State survey of adult use cannabis DUI laws

Alaska - Alaska Stat. § 28.35.030(a)(1) (2010)

Proof of impairment required

Arizona - Ariz. Rev. Stat. Ann. §§ 28-1381(A)(1), (3) (West 2010)

Per se for any metabolites

Non-psychoactive metabolites inadmissible for medical patient DUI

California - Cal. Veh. Code §§ 23152(a)

Proof of Impairment

Colorado - Colo. Rev. Stat. Ann. § 42-4-1301(1)(a)-(c) (West 2010)

Proof of Impairment

Permissible inference at 5 ng/ml THC

Medical use is not a defense

Connecticut - Conn. Gen. Stat. Ann. § 14-227a(a) (West 2010)

Proof of Impairment

District of Columbia - D.C. Code § 50-2201.05(b)(1)(A)(i)(II) (2010)

Proof of Impairment

*Thomas v. District of Columbia*, 942 A.2d 645 (2008) – Impaired to the slightest degree

Illinois - 625 Ill. Comp. Stat. Ann. § 5/11-501(a) (West 2010)

Per se if over 5 ng/ml Delta 9 THC

Less than 5 ng/ml may still be admissible if other factors suggest impairment

Maine - 29-A Me. Rev. Stat. Ann. § 2411(1-A)(A)(1) (West 2010)

Proof of Impairment

Massachusetts - Mass. Gen. Laws Ann. ch. 90 § 24(1)(a)(1) (West 2010)

Proof of Impairment Required

Michigan - Mich. Comp. Laws Ann. §§ 257.625(1)(a), (8) (West 2010)

Zero tolerance for Delta 9 THC

Carboxy inadmissible - *People v. Feezel*, 783 N.W.2d 67(2010)

Proof of Impairment required for patients. *People v. Koon*, 2013.

Montana - Mont. Code Ann. §§61-8-401(1)(b)-(d) (West 2009)

Per se 5 ng/ml or greater

Nevada - Nev. Rev. Stat. § 484.397 (West 2010)

2 ng/ml Delta 9

5 ng/ml Hydroxy THC

Carboxy inadmissible

Proof of Impairment required unless third offense within 7 years – then per se cutoffs apply (July, 2021)

Legal use not a defense

New Jersey - N.J. Stat. Ann. § 39:4-50 (West 2010)

Proof of Impairment required

New Mexico - N.M. Stat. Ann. § 66-8-102 (West 2010)

Impaired and incapable of safely operating a motor vehicle

New York - McKinney's Vehicle and Traffic Law §§ 1192(4)(a)

Proof of Impairment required

Oregon - Or. Ref. Stat. Ann. 813.010(1)(b)-(c) (West 2009)

Proof of Impairment.

Medical use not a defense

Vermont - Vt. Stat. Ann. tit. 23, § 1201(a)(3)(a) (West 2010)

Lawful use is not a defense

Proof of Impairment required

Virginia - Va. Code Ann. § 18.2-266 (West 2010).

Proof of Impairment

Per se for other drugs

Washington - Wash. Rev. Code Ann. § 46.61.502(1)(a)-(b)(West 2010)

5 ng/ml per se cutoff Revised Code of Washington 46.61.502(1)(b)



**Working to Reform Marijuana Laws**

*Written Testimony of Paul Armentano,  
Deputy Director of the National Organization for the Reform  
of Marijuana Laws (NORML)*

My name is Paul Armentano and I am submitting written testimony in support of Pennsylvania Senate Bill 167, which would end the practice of "zero tolerance" enforcement for the mere presence of Tetrahydrocannabinol (THC) and its metabolites and require proof of actual impairment in a manner similar to a Schedule II or III prescription narcotic.

For over 25 years I have worked professionally in the field of marijuana policy, with a particular emphasis on the science specific to cannabis' effect on driving performance and traffic safety. My work on this issue has been highlighted in the peer-reviewed scientific literature and in various academic anthologies, and I have presented at numerous academic and legal symposiums on drugged driving.

I am a court certified expert on issues pertaining to cannabis and psychomotor performance, and I have attended many accredited educational forums on the topic, including those sponsored by the American Academy of Forensic Sciences (AAFS), the Society of Forensic Toxicologists (SOFT), the International Council on Alcohol, Drugs, and Traffic Safety (ICADTS), and the National Institute on Drug Abuse (NIDA). I have previously testified before numerous legislative bodies on the topic of cannabis, traffic accident risk, and traffic safety policy.

[pdf](#)



**Working to Reform Marijuana Laws**

I currently serve as the Deputy Director for the National Organization for the Reform of Marijuana Laws (NORML) – a public interest advocacy organization based in Washington, DC.

NORML’s official position on this issue is clear. We oppose the act of driving under the influence of any controlled substance, including cannabis<sup>2</sup>, and we support evidence-based laws, tools, and other legal efforts to discourage this behavior and to provide law enforcement with the ability to better target these drivers and remove them from our roads.<sup>3</sup> That said, **we adamantly oppose the imposition of *per se* limits for the presence of THC or its metabolite because such thresholds are not evidence-based and because they inadvertently prosecute non-impaired drivers as if they are a legitimate traffic safety threat.**

### **Leading Traffic Safety Experts Oppose *Per Se* Limits for Cannabis**

It is well-established by leading experts in the field that neither *per se* limits for THC or its metabolite are consistent or appropriate predictors of driving impairment. In fact, there is no legitimate debate on this issue.

Specifically, the premiere traffic safety agency in the United States, the National Highway Traffic Safety Administration (NHTSA), acknowledges: “It is difficult to establish a relationship between a person's THC blood or plasma concentration and performance impairing effects. ... **It is inadvisable to try and predict effects based on blood**

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<sup>2</sup> See NORML’s Principles of Responsible Use: II No Driving – “Responsible cannabis consumers never operate motor vehicles in an impaired condition. Public safety demands not only that impaired drivers be taken off the road, but that objective measures of impairment be developed and used, rather than chemical testing.”

<https://norml.org/principles/>

<sup>3</sup> Armentano. 2012. Cannabis and psychomotor performance: A rational review of the evidence and implications for public policy. *Drug Testing & Analysis* 5: 52-56.

<https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/abs/10.1002/dta.1404>





**Working to Reform Marijuana Laws**

**THC concentrations alone, and currently impossible to predict specific effects based on THC-COOH (metabolite) concentrations.”<sup>4</sup>**

On-road driving performance studies coordinated by NHTSA confirm this conclusion, finding, **“One of the program’s objectives was to determine whether it is possible to predict driving impairment by plasma concentrations of THC and/or its metabolite, THC-COOH, in a single sample. The answer is very clear: it is not.** Plasma of drivers showing substantial impairment in these studies contained both high and low THC concentrations; and, drivers with high-plasma concentrations showed substantial, but also no impairment, or even some improvement.”<sup>5</sup>

A 2016 study conducted by the American Automobile Association (AAA) also concludes, "There is no evidence from the data collected, particularly from the subjects assessed through the DRE exam, that any objective threshold exists that established impairment, based on THC concentrations.”<sup>6</sup>

A 2019 Congressional Research Service report, entitled *Marijuana Use and Highway Safety*, similarly determines: **“Research studies have been unable to consistently correlate levels of marijuana consumption, or THC in a person's body, and levels of impairment.** Thus, some researchers, and the National Highway Traffic Safety

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<sup>4</sup> NHTSA. Drugs and Human Performance Fact Sheet: Cannabis/Marijuana  
[https://www.wsp.wa.gov/breathtest/docs/webdms/DRE\\_Forms/Publications/drug/Human\\_Performance\\_Drug\\_Fact\\_Sheets-NHTSA.pdf](https://www.wsp.wa.gov/breathtest/docs/webdms/DRE_Forms/Publications/drug/Human_Performance_Drug_Fact_Sheets-NHTSA.pdf)

<sup>5</sup> US DOT, NHTSA Final Report: Marijuana and Actual Driving Performance, page 107.  
<https://rosap.ntl.bts.gov/view/dot/1558>

<sup>6</sup> AAA. *An Evaluation of Data from Drivers Arrested for Driving Under the Influence in Relation to Per Se Limits for Cannabis*. May 2016.  
<https://aaafoundation.org/wp-content/uploads/2017/12/EvaluationOfDriversInRelationToPerSeReport.pdf>



## Working to Reform Marijuana Laws

Administration, have observed that using a measure of THC as evidence of a driver's impairment is not supported by scientific evidence to date."<sup>7</sup>

Two recent state-appointed task forces on drugged driving – one in Michigan and another in California – have reaffirmed this position in recent months in their recommendations to lawmakers. In California, recommendations of a task force led by the California Highway Patrol concluded: **“Drugs affect people differently depending on many variables. A *per se* limit for drugs, other than ethanol, should not be enacted at this time as current scientific research does not support it.”**<sup>8</sup> In Michigan, a report from the state’s Impaired Driving Safety Commission similarly concluded: **“[B]ecause there is a poor correlation between  $\Delta$ 9-THC bodily content and driving impairment, the Commission recommends against the establishment of a threshold of delta-9-THC bodily content for determining driving impairment.”**<sup>9</sup>

This is not a matter of “we need more study.” This issue has been studied extensively and the results are clear and consistent. This reality is best summarized by Dr. Marilyn Huestis, who spent over 25 years studying this issue at the US National Institute on Drug Abuse and is one of the leading scholars in the world on the issue of cannabis and driving performance, who said: **“There is no one blood or oral fluid concentration that can differentiate impaired and not impaired. It’s**

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<sup>7</sup> Congressional Research Service. *Marijuana use and Highway Safety*. May 14, 2019. <https://crsreports.congress.gov/product/pdf/R/R45719>

<sup>8</sup> CHP Impaired Driving Task Force, Report to the Legislature. January 2021 <https://www.canorml.org/wp-content/uploads/2021/03/Senate-Bill-94-2017-CHP-Report-to-the-Legislature-Impaired-Driving-Task-Force-Report.pdf>

<sup>9</sup> Report from the Impaired Driving Safety Commission. March 2019 [https://www.michigan.gov/documents/msp/Impaired\\_Driving\\_Report\\_650288\\_7.pdf](https://www.michigan.gov/documents/msp/Impaired_Driving_Report_650288_7.pdf)



**Working to Reform Marijuana Laws**

**not like we need to say, ‘Oh, let’s do some more research and give you an answer.’ We already know. We’ve done the research.”<sup>10</sup>**

### **Why Are *Per Se* Limits Inadvisable for Cannabis?**

There are several reasons why neither the identification of THC nor its metabolite is not well correlated with either driving impairment or recency of cannabis exposure.

**First, THC possesses unique pharmacokinetics (absorption patterns).** For example, when inhaled, THC/blood levels rise to maximal levels almost instantly, well before the onset of acute impairment.<sup>11</sup> These levels then begin to decline precipitously during the acute impairment phase. This relationship is the exact opposite of that of alcohol, in which rising BAC levels are consistently correlated with both the level of consumption and the degree of intoxication.

By contrast, when THC is consumed orally, THC blood levels barely rise at all – despite associated (and longer lasting) intoxication.

**Second, because THC is lipid soluble, trace quantities of it may remain present in blood for days after past exposure – long after any intoxication has worn off.** Specifically, scientific studies have documented **the presence of residual quantities of THC in the blood of more frequent cannabis consumers at levels above Nevada’s existing standards for periods of time exceeding seven days<sup>12</sup> – long**

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<sup>10</sup> [https://www.eurekalert.org/pub\\_releases/2018-01/cp-dar011818.php](https://www.eurekalert.org/pub_releases/2018-01/cp-dar011818.php)

<sup>11</sup> Schwope et al. 2012. Psychomotor performance, subjective and physiological effects and whole blood delta-9- tetrahydrocannabinol concentrations in heavy, chronic cannabis smokers following acute smoked cannabis. *Journal of Analytical Toxicology*: 1-8.

<sup>12</sup> Odell et al. 2015. Residual cannabis levels in blood, urine and oral fluid following heavy cannabis use. *Forensic Science International*: 173-180.



**Working to Reform Marijuana Laws**

**after any psychomotor impairing effects have long subsided.**<sup>13</sup> At present, there exists no technology that can differentiate between cannabis exposure that occurred within the past several hours versus exposure that occurred within the past several days.

**Three, subjects' response to THC is much more variable than it is for alcohol.** For example, experienced cannabis consumers – such as those patients legally protected under Nevada's medical cannabis law who consume it daily, tend to display little to no change in psychomotor performance following cannabis administration,<sup>14</sup> while more naïve may display changes in reaction time, brake latency, and in standard deviation of lateral positioning. Several papers in the scientific literature affirm this phenomenon of cannabis tolerance.<sup>15</sup> One literature review finds, “Patients who take cannabinoids at a constant dosage over an extensive period of time often develop tolerance to the impairment of psychomotor performance, so that they can drive vehicles safely.”<sup>16</sup> Similarly, the US Food and Drug Administration acknowledges persons acclimated to the effects of oral THC “are able to tolerate the drug and to perform such tasks safely.”<sup>17</sup>

**Fourth, it should be acknowledged that Pennsylvania's arbitrary and unscientific THC *per se* DUI law was clearly enacted absent any scientific input.** By criminalizing the presence of non-psychoactive metabolites which can be detected days and even weeks after usage proves that not a single thought was given to how THC metabolizes

<sup>13</sup> Ronen et al., 2008. Effects of THC on driving performance, physiological state and subjective feelings relative to alcohol. *Accident, Analysis and Prevention*: 926-934.

<sup>14</sup> Sewell et al., 2009. The effect of cannabis compared with alcohol on driving. *American Journal of Addiction*: 185- 193.

<sup>15</sup> Colizzi and Bhattacharyya. 2018. Cannabis use and the development of tolerance: A systematic review of human evidence. *Neuroscience & Behavioral Reviews*: 1-25.

<sup>16</sup> Grotenhermen and Muller-Vahl. 2012. The therapeutic potential of cannabis and cannabinoids. *Duetsches Arzteblatt International*: 495-501.

<sup>17</sup> Online at: <http://www.fda.gov/ohrms/dockets/dockets/05n0479/05N-0479-emc0004-04.pdf>



**Working to Reform Marijuana Laws**

Pennsylvania passed 75 Pa.C.S.A. §3801 *et seq.*, in 2004.

**In Conclusion:**

**Zero tolerance DUI prosecutions and convictions without proof of actual impairment and reliance on non-psychoactive metabolites is unscientific and without any rational support.** Current Pennsylvania law makes criminals of over 350,000 Pennsylvanians who utilize medical cannabis pursuant to Pennsylvania's Medical Marijuana Act.

**Accordingly, I urge lawmakers to advance Senate Bill 167 to protect Pennsylvanians from arbitrary DUI prosecutions.**

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<sup>18</sup> <https://link.springer.com/article/10.1007/s10337-010-1869-2/tables/4>

# **Advanced Roadside Impaired Driving Enforcement (ARIDE)**

**R5/13 Edition**

**Participant Manual**



# **Advanced Roadside Impaired Driving Enforcement (ARIDE) School Participant Guide Table of Contents**

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Session III: Standardized Field Sobriety Testing Proficiency Examination

Session IV: Drugs in the Human Body

Session V: Observation of the Eyes and Additional Tests for Drug Impairment

Session VI: Seven Drug Categories

Session VII: The Effects of Drug Combinations

Session VIII: Pre and Post Arrest Procedures

## Acknowledgements

The International Association of Chiefs of Police (IACP) and the National Highway Traffic Safety Administration (NHTSA) would like to thank the following individuals for their contributions in updating and revising the 2013 ARIDE curricula.

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*Chuck Hayes*, International Association of Chiefs of Police

*Mike Iwai*, Oregon State Police

*Jim Maisano*, Norman, OK Police Department

*Evan Graham*, Royal Canadian Mounted Police

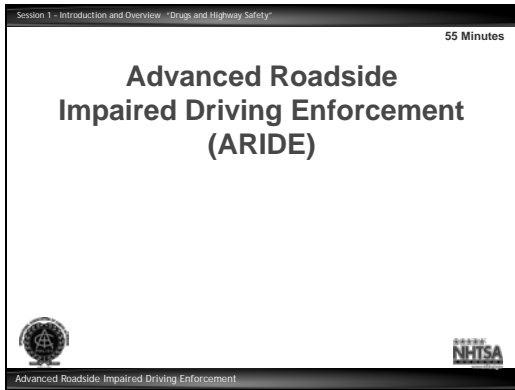
*Bill O'Leary*, National Highway Traffic Safety Administration

*Doug Paquette*, New York State Police



# ARIDE Participant Manual – Session 1

## Advanced Roadside Impaired Driving Enforcement (ARIDE)



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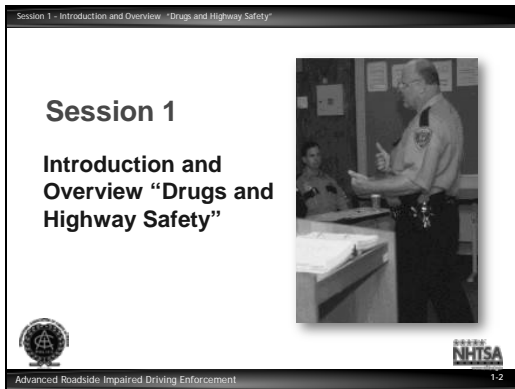
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*Welcoming Remarks*

*Introductions – Representatives of Host Agencies and Other Dignitaries*

*Faculty Introductions*

Session 1 - Introduction and Overview "Drugs and Highway Safety"

### Housekeeping

- Paperwork
- Mandatory attendance
- Breaks
- Facility
- Interruptions
  - All electronic devices off



Advanced Roadside Impaired Driving Enforcement 1-3

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*Paperwork*

*Attendance*

*Breaks*



*Facility*

*Interruptions*

Session 1 - Introduction and Overview "Drugs and Highway Safety"

### Participant Introductions

- Name
- Agency
- Affiliation
- Experience



Advanced Roadside Impaired Driving Enforcement 1-4

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Session 1 – Introduction and Overview: “Drug and Highway Safety”

### Learning Objectives

- Explain course goals and objectives
- Define the term “drug”
- Highlight US drug problem issues
- Describe impaired driving programs
- Underscore connection to DECP
- Emphasize roles of the DRE

Advanced Roadside Impaired Driving Enforcement 1-5

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Upon completion of this session, the participant will be able to:

- Explain the goals and objectives of this course.
- Identify the elements of the drug problem.
- Define and describe impaired driving enforcement programs.
- Understand the roles and responsibilities of the Drug Recognition Expert (DRE) and how this course supports the Drug Evaluation and Classification Program (DECP).
- Define the term drug in the context of traffic safety and impaired driving enforcement as referenced in the DECP.

### Content Segments

- Describe the course to the class  
Goal of the course
- What is a drug?
- Statistics and research
  - US and other countries
  - General alcohol and drug use
  - Prevalence of impaired driving
- Impaired driving enforcement programs
- Roles and responsibilities of the DRE


### Learning Activities

- Instructor-Led Presentation
- Instructor-Led Presentation
- Instructor-Led Presentation
- Instructor-Led Presentation
- Instructor-Led Presentation

Session 1 - Introduction and Overview - "Drugs and Highway Safety"

### Important Note

- This course is not intended to be a substitute for the Drug Evaluation and Classification Program
- This course will NOT qualify or certify the participant as a DRE



Advanced Roadside Impaired Driving Enforcement 1-6

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Many law enforcement officers are trained in Standardized Field Sobriety Testing (SFST) and use the skills gained in the course as part of their overall enforcement of **(Driving while Impaired DWI Laws)**

**This course is not developed to act as a substitute for the DEC program and will not qualify or certify an individual as a DRE.**


This course is intended to bridge the gap between the SFST and DRE course and to provide a level of awareness to the participants, both law enforcement and other criminal justice professionals, in the area of drug impairment in the context of traffic safety.

Based on that premise, the ARIDE course was developed with the following goals in mind.

Session 1 – Introduction and Overview: “Drugs and Highway Safety”

### Overall Course Goal

This course will train law enforcement officers to **observe, identify and articulate the signs of impairment** related to drugs, alcohol or a combination of both in order to reduce the number of impaired driving incidents, traffic fatalities and serious injuries.



Advanced Roadside Impaired Driving Enforcement 1-7

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### A. Course Goal

This course will train law enforcement officers to observe, identify, and articulate the signs of impairment related to drugs, alcohol or a combination of both in order to reduce the number of impaired driving incidents, serious injury, and fatal crashes.



This course will train other criminal justice professionals (prosecutors, toxicologists, etc.) to:

- Understand the signs of impairment related to drugs, alcohol, or a combination of both.
- Enable them to effectively work with law enforcement in order to reduce the number of impaired driving incidents, serious injury, and fatal crashes.

Session 1 – Introduction and Overview: “Drugs and Highway Safety”

### Background: High Visibility Enforcement Efforts

- Left prosecutors behind in technology advances and training
- Overloaded criminal court system
- Delivered poorly developed cases for prosecution
- Drove criminal justice professionals to understand impaired driving detection process



Advanced Roadside Impaired Driving Enforcement 1-8

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NHTSA has promoted high visibility enforcement efforts among law enforcement agencies. As a result of this effort, several things happened:

1. Prosecutors were left behind in technology advances and training
2. The criminal court system was overloaded
3. Delivered poorly developed cases for prosecution

Criminal justice professionals such as:


1. Prosecutors
2. Toxicologists
3. Probation and Parole Officers

They must also understand the impaired driving detection process in order to support enforcement efforts, which will increase the probability of successful prosecution and adjudication.

Session 1 - Introduction and Overview - "Drugs and Highway Safety"

### Overall Course Objectives

- Properly administer and articulate the SFSTs
- Describe the relationship of drugs to impaired driving incidents
- Observe, identify and articulate the observable signs of drug impairment



Advanced Roadside Impaired Driving Enforcement 1-9

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In order to meet these goals, this course will train participants to:

- Demonstrate, articulate, and properly administer the SFSTs proficiently.
- Define and describe the relationship of drugs to impaired driving incidents.
- Observe, identify, and articulate the observable signs of drug impairment with the established seven drug categories associated with the DEC Program.

Session 1 - Introduction and Overview - "Drugs and Highway Safety"

### Overall Course Objectives (Cont.)

- Identify, document and describe indicators observed and information obtained related to impairment which leads to the arrest/release decision
- Articulate through testimony impairment related to alcohol, drugs, or a combination of both based on a complete investigation



Advanced Roadside Impaired Driving Enforcement 1-10

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- Identify, document and describe indicators observed and information obtained related to impairment which leads to the arrest/release decision.
- Articulate, through testimony, impairment related to alcohol, drugs, or a combination of both based on a complete investigation.

This course is divided into sessions, which are designed to provide the participant with an overview of drug impaired driving.

Session 1 - Introduction and Overview - "Drugs and Highway Safety"

### Course Sessions

- Introduction and overview of drugs and highway safety
- SFST update and proficiency exam
- Drugs in the human body
- Observations of eyes and other sobriety tests
- Drug categories and combinations
- Legal issues in impaired driver



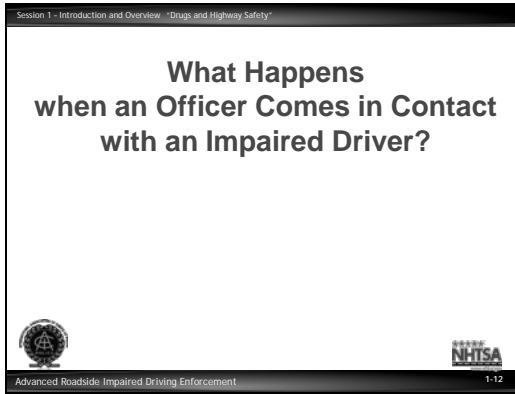
Advanced Roadside Impaired Driving Enforcement 1-11

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1. Introduction and Overview of Drugs and Highway Safety
2. SFST Update and Review
3. SFST Proficiency Exam
4. Drugs in the Human Body
5. Observation of the Eyes and Other Sobriety Tests for Impairment.
6. Seven Drug Categories
7. Effects of Drug Combinations
8. Pre and Post Arrest Procedures
9. Legal Issues Associated with Impaired Driving

The course is designed to serve as a bridge between SFST and DRE.





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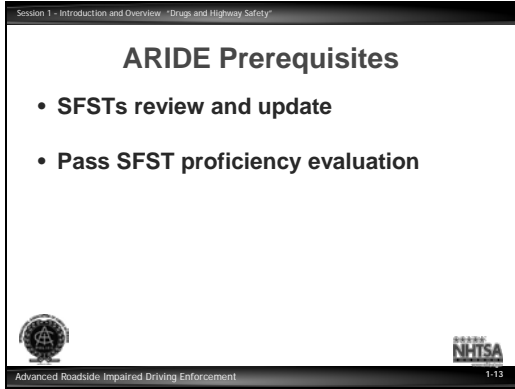
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Often times officers come in contact with the drug impaired driver. There are many things that could be happening.

The officer:

- Is unfamiliar with the indicators of drug impairment, therefore does nothing with the subject.
- Recognizes there is something wrong with the driver, but does not know how to address the issue.
- Allows subject to continue on their way.
- Drives the subject home or allows the subject to ride home with another individual.
- Is not familiar with the resources available to them.
- Officer recognizes indicators of impairment and arrests driver for DWI.



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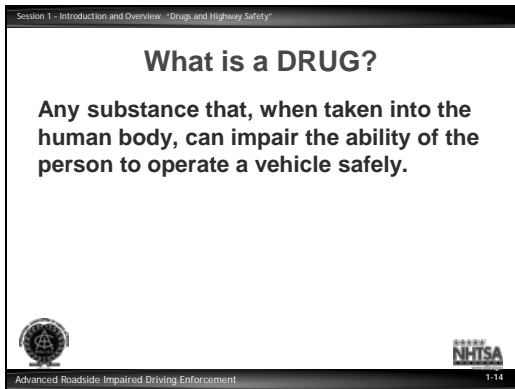
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In order for the participant to utilize the information presented in this course, NHTSA will require a prerequisite:

1. The participant will receive a short review and update for the SFSTs as part of Session II of this course.
- After completing that session, the participant will be required to pass a SFST proficiency evaluation.
  - Failure to successfully complete the SFST proficiency will result in dismissal from the course.



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**B. What Is a Drug?**

There are many definitions for the word drug:

Charles Leviathan's text, *Drugs, Behavior and Modern Society*, offers a general definition: "a chemical substance that, when taken into the body, alters the structures or functioning of the body in some way, excluding those nutrients considered to be related to normal functioning."

NHTSA's impaired driving training programs require a more specific definition since the ultimate goal is to decrease impaired driving incidents, serious injury, and fatal crashes.


For the purpose of this course and subsequent courses (DEC):

A drug is defined as any substance that, when taken into the human body, can impair the ability of the person to operate a vehicle safely.

Session 1 – Introduction and Overview – “Drug and Highway Safety”

### 2012 National Survey Drug Use and Health (NSDUH)

- 131 million (52%) people consider themselves drinkers
- 6.7% consider themselves heavy drinkers
- 22.6 million people (8.9%) have used illicit drugs in the past month



Advanced Roadside Impaired Driving Enforcement 1-15

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## **C. Statistics and Research**

### *Alcohol and Drug Use*

Social drinking is considered acceptable in many societies.

It is important to understand the use of alcohol in the context of society, since it is related to the enforcement and adjudication of DWI offenses.

The National Survey on Drug Use and Health (NSDUH) Survey reports that:

- 131 million (52%) people consider themselves drinkers
- 6.7% of this group describe themselves as heavy drinkers.
- 22.6 million people or 8.9% of the population have used illicit drugs in the past month.

### *2003 Research Survey*



- Although these statistics are significant, it is reasonable to assume that the problem is even larger when you consider legal or prescription drugs used in a manner other than for what they have been prescribed or produced.

When we look at drug use specifically, it is helpful to see the trends based on specific types of drugs.

Session 1 - Introduction and Overview "Drugs and Highway Safety"

### (NSDUH) Self-Reported Drug Use

- 17.4 million consider themselves current marijuana users
- 60% only use marijuana
- 17% use marijuana in combination with other drugs
- 77% of current illicit drug users also use marijuana

Advanced Roadside Impaired Driving Enforcement 1-16

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The following summarizes the usage information as reported by the NSDUH Survey 2012:



- 17.4 million people consider themselves current marijuana user
- 60% only use marijuana
- 17% use marijuana in combination with other drugs
- 77% of current illicit drug users also use marijuana.

NSDUH provides additional details on drugs used in a manner other than prescription:

Session 1 - Introduction and Overview "Drugs and Highway Safety"

### Types of Drugs Commonly Used

- Cocaine 2.3 M
- Hallucinogens 1.0 M
- Psychotherapeutics 6.3 M
- Pain Relievers 4.7 M
- Tranquilizers 1.8 M
- Stimulants 1.2 M
- Sedatives 0.3 M

Advanced Roadside Impaired Driving Enforcement 1-17

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<u>Type</u>	<u># of Users</u>
Cocaine	2.3 Million
Hallucinogens	1.0 Million
Psychotherapeutics	6.3 Million
Pain Relievers	4.7 Million
Tranquilizers	1.8 Million
Stimulants	1.2 Million
Sedatives	0.3 Million

Session 1 – Introduction and Overview: “Drugs and Highway Safety”

### Driving Under the Influence

- Males are twice as likely as females to drive under the influence of alcohol
- 13.6% (32M) of people reported that they had driven at least once in the last year under the influence of alcohol
- 5% (11M) of people reported that they drove under the influence of illicit drugs during the last year



Advanced Roadside Impaired Driving Enforcement 1-18

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Understand the magnitude of the problem of individuals driving while impaired by drugs and alcohol.

The surveys tell us:

1. Males are twice as likely as females to drive under the influence of alcohol.
2. Overall, 13.6% or more than 32 million people reported that they had driven at least once in the last year under the influence of alcohol.

That further translated into approximately 30% of minors (16-20 years of age) and 29% of those between the ages of 21 and 25 years.

5% (11m) of people reported that they drove under the influence of illicit drugs during the last year



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### **D. Impaired Driving Enforcement Programs**

IACP/NHTSA supports:

- Training
- Enforcement
- Prosecution
- Adjudication

One of the most critical support activities NHTSA provides is TRAINING.

Some examples of law enforcement and justice professional training that NHTSA provides and supports are:

- Standardized Field Sobriety Testing
- Advanced Roadside Impaired Driving Enforcement
- Drug Evaluation and Classification (DEC) Program
- Prosecuting the Drugged Driver
- Lethal Weapon
- Protecting Lives, Saving Futures



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The DWI Detection and Standardized Field Sobriety Testing (SFST) Practitioner course provides:

- The cornerstone for a system of impaired driving training and enforcement.
- Proficiency in the SFST skills provides a foundation for this course, as well as the Drug Evaluation and Classification Program (DECP).
- The SFST program should be part of all alcohol and drug impaired driving enforcement initiatives.

**DWI Detection and Standardized Field Sobriety Testing**

The SFST Battery is a set of tests that include the following:



- Horizontal Gaze Nystagmus
- Walk and Turn
- One Leg Stand

These tests are designed to be administered and evaluated in a standardized manner to obtain validated indicators of impairment based on NHTSA supported research.

Session 1 – Introduction and Overview: “Drugs and Highway Safety”

## Foundations of ARIDE

- **DWI Detection Process**
  - Phase One: Vehicle in Motion
  - Phase Two: Personnel Contact
  - Phase Three: Pre-arrest Screening
- **SFST Test Battery**
  - Horizontal Gaze Nystagmus
  - Walk and Turn
  - One Leg Stand



Advanced Roadside Impaired Driving Enforcement 1-21

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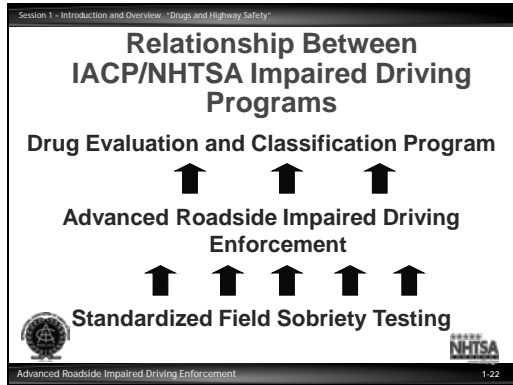
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The SFSTs are part of the overall DWI detection process which includes three phases:

- Vehicle in motion
- Personal contact
- Pre-arrest screening

The SFST test battery serves as the foundation for impaired driving enforcement. It is critical that these tests be performed and interpreted properly.





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*Drug Evaluation and Classification Program*

The ultimate goal of the DEC Program is:

- To help prevent crashes and avoid deaths and injuries by improving enforcement of drug impaired driving violations.

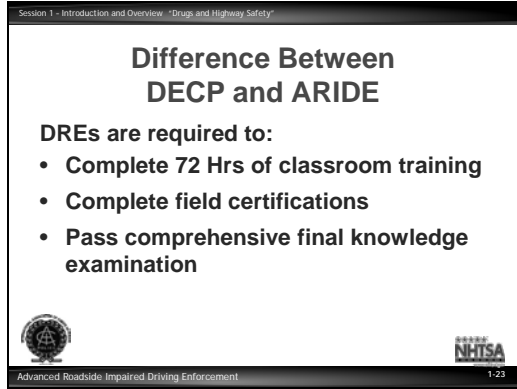
The DRE officer is trained to:

- Conduct a detailed evaluation, consisting of twelve steps (12), and obtain other evidence that can be articulated as an opinion.

A participant who successfully completes all phases of the DEC Program is known as a Drug Recognition Expert or Drug Recognition Evaluator (DRE).

They can reach reasonably accurate conclusions concerning the category or categories of drug(s), or medical conditions causing the impairment observed in the subject.

Based on these informed conclusions, the DRE officer can request the collection and analysis of an appropriate biological sample (blood, urine, or saliva) to obtain corroborative, scientific evidence of the subject's drug use.



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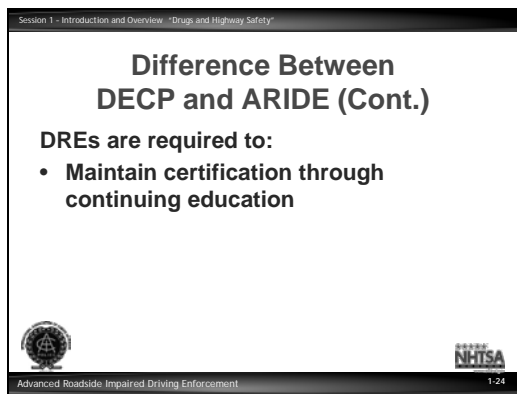
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*Roles and Responsibilities of a Drug Recognition Expert*

To obtain a DRE Certification the law enforcement officer must:

1. Complete 72 hours of classroom training.
2. Complete field certifications.
3. Pass comprehensive final knowledge examination.



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In order to retain their certification, the DRE must:



1. Participate in continuing education courses.
2. Complete a recertification training course every two years.
3. Maintain a log of all evaluations completed in training and as part of any enforcement activities.
4. Meet other administrative requirements as established in the International Association of Chiefs of Police (IACP) International Standards governing the DEC program.

The State DEC Program state coordinators may place other standards on each DRE that is specific to that state.

Session 1 - Introduction and Overview - "Drugs and Highway Safety"

### Bridging the Gap

- ARIDE training will allow the participant to build on SFST skills and knowledge
- ARIDE will provide the participant with information which will assist them to identify the drug impaired driver
- ARIDE is designed to support the DEC Program



Advanced Roadside Impaired Driving Enforcement 1-25

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### *The ARIDE Course*


The ARIDE program will allow the participant to build on the knowledge gained through their training and experience related to the SFSTs.

- Many law enforcement officers have encountered subjects who appear to be impaired by a substance other than alcohol, or seem to be displaying signs and symptoms which are inconsistent with their BAC test results.
- This course will provide additional information which can assist the officer in effective observation and interview techniques related to driving while impaired by alcohol, drugs, or a combination of both, and make an informed decision to arrest or not arrest a subject for impaired driving.

Session 1 - Introduction and Overview, "Drugs and Highway Safety"

### Bridging the Gap (Cont.)

- ARIDE training will allow the participant to build on SFST skills and knowledge
- ARIDE will provide the participant with information which will assist them to identify the drug impaired driver
- ARIDE is designed to support the DEC Program



Advanced Roadside Impaired Driving Enforcement 1-26

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This course will deliver knowledge and information that will help them better assess impaired drivers at roadside.


- This training and subsequent field experience will demonstrate the value of having a DRE on staff in an agency and may serve as motivation for the individual officers to attend a DRE course in the future.
- A subsequent result of this course will facilitate better utilization of DREs in the field.

The desired outcome of the training is:

- The participant will better understand the role of the DRE and will be able to use their expertise more effectively.
- For those communities with no DREs or limited access to their services, this course will help officers make informed decisions related to testing, documentation, and reporting drug-impaired driving cases.

Session 1 - Introduction and Overview, "Drugs and Highway Safety"

## QUESTIONS?



Advanced Roadside Impaired Driving Enforcement 1-27

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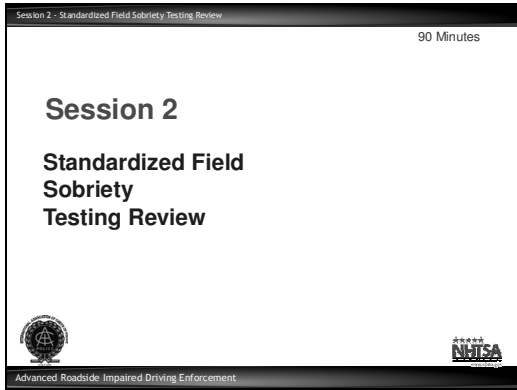
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# ARIDE Participant Manual – Session 2 Standardized Field Sobriety Testing Review



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Session 2 – Standardized Field Sobriety Testing Review

### Learning Objectives

- Describe how to apply results of selected SFST validation studies
- Describe administrative procedures for the eye examinations
- Define nystagmus and distinguish between the different types
- Describe and administer the SFSTs
- Document SFST indicators and clues
- Identify SFST limitations

Advanced Roadside Impaired Driving Enforcement 2-2

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Upon successfully completing this session, the participant will be able to:

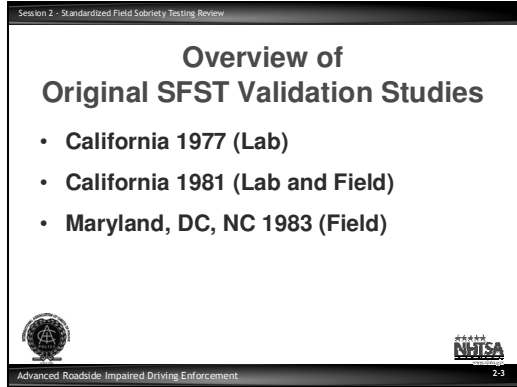
- Understand the results of selected SFST validation studies.
- Define and describe the Standardized Field Sobriety Tests (SFSTs).
- Define nystagmus and distinguish between the different types.
- Describe and properly administer the three SFSTs.
- Recognize, document and articulate the indicators and clues of the three SFSTs.
- Identify the limitations of the three SFSTs

**Content Segments**

- A. SFST Validation Studies
- B. Overview of Selected Types of Nystagmus Standardized Field Sobriety Tests
- C. Horizontal Gaze Nystagmus
  
- D. Practice HGN
- E. Walk-and-Turn
  
- F. Practice Walk-and-Turn
- G. One-Leg Stand
  
- H. Practice One-Leg Stand

**Learning Activities**

- Instructor-Led Presentation
- Instructor-Led Presentation
  
- Instructor-Led Presentation and Demonstration
- Participant Practice Session
- Instructor-Led Presentation and Demonstration
- Participant Practice Session
- Instructor-Led Presentation and Demonstration
- Participant Practice Session



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**A. Overview of the SFST Validation Studies**

For many years law enforcement officers have utilized field sobriety tests to determine a subject’s impairment due to alcohol.

The performance of the subject on those field sobriety tests was used by the officer to develop probable cause for arrest and as evidence in court.

NOTE: This may not seem important, but officers are seeing this in court as a defense strategy.

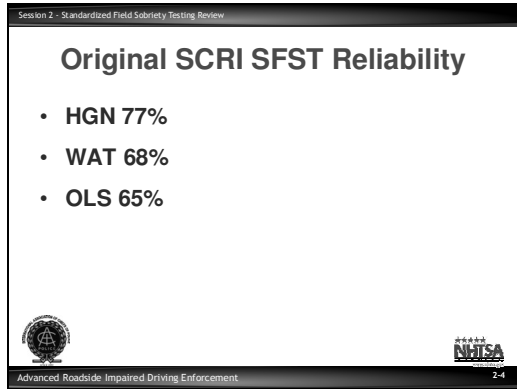
A wide variety of field sobriety tests were being used by officers throughout the country. There was a need to develop a battery of standardized, validated tests. NHTSA sponsored several research projects conducted through a contract with the Southern California Research Institute (SCRI). SCRI published the following three reports:

- California 1977 (Lab)
- California 1981 (Lab and Field)
- Maryland, DC, NC 1983 (Field)

Primary distinction (Validated at 0.10 BAC)

The recommended battery included the following SFSTs:

- Horizontal Gaze Nystagmus (HGN)
- Walk-and-Turn (WAT)
- One-Leg Stand (OLS)



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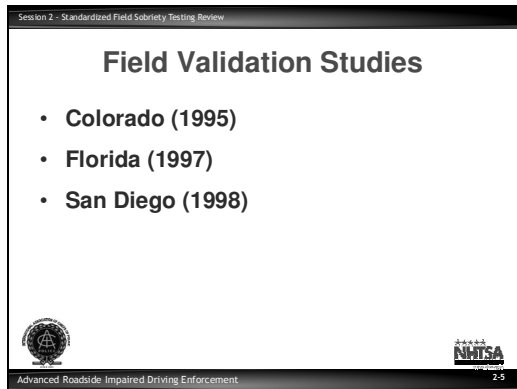
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Southern California Research Institute (SCRI) SCRI analyzed the laboratory test data and determined that:

- HGN, alone, was 77% accurate
- WAT, alone, was 68% accurate
- OLS, alone, was 65% accurate



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Additional research studies conducted to assess the performance of the 3-test battery by SFST-experienced personnel.

Three SFST field validation studies were:

- Colorado (1995)
- Florida (1997)
- San Diego (1998)


The Colorado SFST validation study was the first full field study that utilized law enforcement personnel experienced in the administration of SFSTs.



Session 2 - Standardized Field Sobriety Testing Review

### Difference in Results

- Conducted in the field with officers experienced in DWI detection and SFST
- Colorado - 93%
- Florida – 95% at 0.08% BAC
- San Diego – 91% at 0.08% BAC
  - HGN “Most Reliable” field sobriety test



Advanced Roadside Impaired Driving Enforcement 2-6

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The results of this study indicated that correct arrests decisions were made:

- 93% of the time based on the 3-test battery (HGN, WAT, OLS)
- The Florida SFST Field Validation study was the first study to evaluate the SFSTs in their ability to detect drivers at or above a 0.08 BAC.
- Correct decisions to arrest were made 95% of the time based on the 3-test battery (HGN, WAT, OLS).

The San Diego SFST validation field study was undertaken because of the nationwide trend towards lowering the BAC limits to 0.08.


The research was done to investigate how well the SFSTs discriminate at BACs below 0.10. Based on the revised arrest and release criteria the officers in the study made correct decisions 91% of the time based on the 3-test battery (HGN, WAT, OLS) at the 0.08 BAC level and above.

Session 2 - Standardized Field Sobriety Testing Review

### Correct Arrest Decision

Made when an officer, after completing the third phase of the detection process:

- Decides to arrest an individual and that individual tested above the illegal per se limit
- Decides to release an individual who is below the illegal per se limit



Advanced Roadside Impaired Driving Enforcement 2-7

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In order to understand the results of the research studies discussed in this course, it is important to define what is meant by a correct arrest decision.


A correct arrest decision is made when an officer, after completing the third phase of the detection process:

- Decides to arrest an individual and that individual tested above the illegal per se limit.
- Decides to release an individual who is below the illegal per se limit.

Session 2 - Standardized Field Sobriety Testing Review

### Correct Decision

	Arrested Subject	Did Not Arrest Subject
Above Illegal Per Se Limit	<b>I</b> Officer decided to arrest the subject <u>and</u> their BAC was <u>above</u> the illegal per se limit	<b>II</b> Officer decided <u>not</u> to arrest the subject and their BAC was <u>above</u> the illegal per se limit
Below Illegal Per Se Limit	<b>III</b> Officer decided to arrest the subject <u>but</u> their BAC was <u>below</u> the illegal per se limit	<b>IV</b> Officer decided <u>not</u> to arrest the subject and their BAC was <u>below</u> the illegal per se limit

Advanced Roadside Impaired Driving Enforcement  2-8

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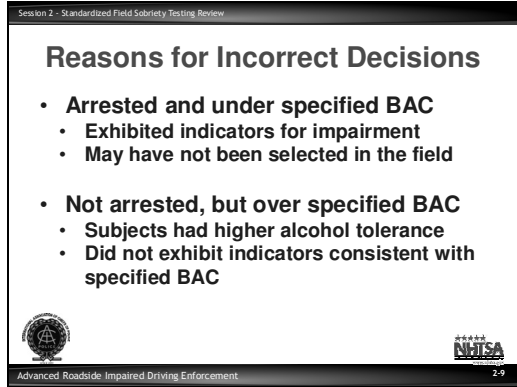
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- There are four quadrants, each representing a different decision.
- The quadrants (I and IV), shaded in gray, represent a correct arrest decision.
- The remaining individuals, incorrect arrest decisions, fall into two other categories.



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The first group was not arrested, but tested above the illegal per se limit, (quadrant II).

The reason for no arrest decision:

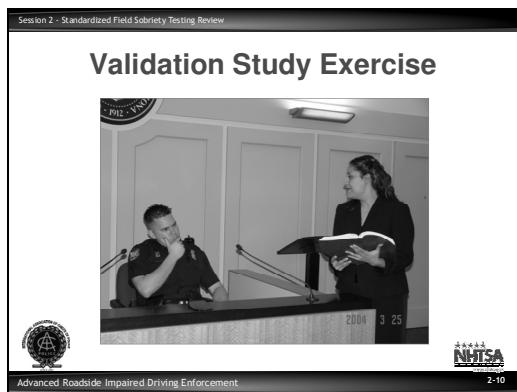
- (Approximately 33%) of these individuals were considered alcohol-tolerant and performed well on the SFSTs even though their BACs were above the illegal per se limit.

The members of second group were arrested, but their BAC was below the illegal per se limit. Many states stipulate in their statute that a driver is considered DWI if they are:

- Above the illegal per se limit.
- Lacking the normal use of their mental or physical faculties.

Even though the arrests in quadrant III may be legally justifiable according to an individual state's statute, these decisions are recorded as errors in the research based on the procedures outlined in the study.

It is important for the officer who is trained in SFST to prepare themselves to understand and explain these statistics in layman terms in order to effectively articulate them to a jury in a courtroom. Note: If you do not know the answer to a defense question you can say, "I DON'T KNOW." Do not testify to something you are not sure of.



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Session 2 - Standardized Field Sobriety Testing Review

## Nystagmus

**Nystagmus is defined as the involuntary jerking of the eyes.**



Advanced Roadside Impaired Driving Enforcement 2-11

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**Nystagmus** is the involuntary jerking of the eyes.

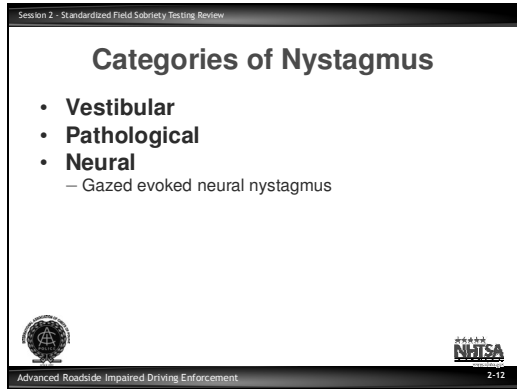
Horizontal Gaze Nystagmus is defined as the involuntary jerking of the eyes, as the eyes gaze to the side.

There are over 40 different types of nystagmus, but during this course we will focus on two types of nystagmus:

- Horizontal gaze nystagmus (HGN)
- Vertical gaze nystagmus (VGN)

The ability to recognize horizontal and vertical gaze nystagmus are important tools in impaired driving enforcement.

Alcohol and certain other drugs have been shown, through research, to cause horizontal and vertical gaze nystagmus, which is visible without the aid of specialized instrumentation.



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**B. Overview of Selected Types of Nystagmus**

Vestibular Nystagmus. Caused by movement or action to the vestibular system that can occur when an individual is spun around and the fluid in the inner ear is disturbed or there is a change in the fluid (temperature, foreign substance, etc.).

Pathological Nystagmus. Caused by the presence of specific pathological disorder, which include brain tumors, other brain damage, or some diseases of the inner ear.

Neural Nystagmus. Caused by some disturbance to the neural system.

There are over 40 different types of nystagmus.



This type of nystagmus occurs when the eye focuses on an object as they gaze towards the side.

Alcohol and/or specific types of drugs can cause these three types of nystagmus to be visible to the officer during the proper administration of the HGN and VGN tests.

Session 2 - Standardized Field Sobriety Testing Review

### Gaze Nystagmus

- **Resting Nystagmus**
  - Occurs as the eyes gaze straight ahead
- **Horizontal Gaze Nystagmus (HGN)**
  - Occurs as the eyes move to the side
  - Useful in determining alcohol influence as well as some drug categories
- **Vertical Gaze Nystagmus (VGN)**
  - Occurs as the eyes move upward (vertical plane) to an elevated position as far as they can go
  - Associated with a high doses of alcohol and some drug categories for that individual
  - Drug categories which cause VGN also cause HGN



Advanced Roadside Impaired Driving Enforcement 2-13

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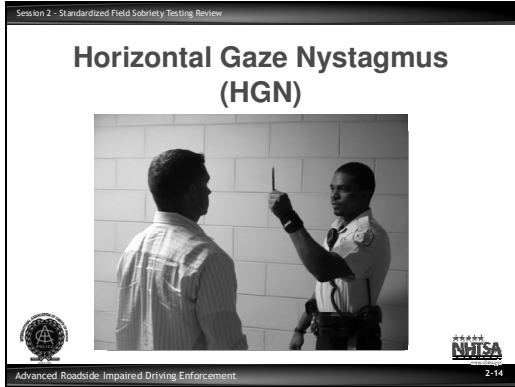
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### Gaze Nystagmus

Resting Nystagmus is defined as the involuntary jerking of the eyes as they gaze straight ahead. This condition is not frequently observed. Its presence usually indicates a medical problem, or may indicate a high level of Dissociative Anesthetic usage. If detected, take precautions. As always, exercise sound officer safety techniques and consider calling for medical aid.

During this course we will focus on two types of nystagmus:

- Horizontal gaze nystagmus (HGN)
- Vertical gaze nystagmus (VGN)



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**C. Horizontal Gaze Nystagmus**

Horizontal Gaze Nystagmus is defined as the involuntary jerking of the eyes as they gaze toward the side.

Although this type of nystagmus is useful in determining alcohol influence, its presence may also indicate use of Dissociative Anesthetics, Inhalants, and other CNS Depressants (DID drugs).

HGN becomes observable:


- When a subject is impaired by alcohol
- As the subject's BAC increases the jerking will appear sooner.
- When an individual is impaired by DID drugs.

In administering the HGN test the subject must focus on a stimulus. This stimulus can be the tip of a pen or similar object that contrasts with the background.

Session 2 - Standardized Field Sobriety Testing Review

### Administrative Procedures:

- **Eyeglasses/Contacts**
  - Have the subject remove glasses.
  - It is recommended to note if contacts are worn, especially colored contacts
- **Verbal Instructions**
  - Stand with feet together
  - Hands to the sides
  - Keep head still
  - Follow with eyes only



Advanced Roadside Impaired Driving Enforcement

NHTSA

2-15

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**Initiating the HGN Test.** Begin the test by positioning the subject in a manner that is deemed safe by the officer and safe for the subject being tested. The subject should be turned away from emergency lights. Take care as to not interfere with subject's ability to fixate on stimulus.

Ask the subject to:

- Remove glasses. (Note if subject wears contacts, especially colored contacts);
- Place feet together;
- Put hands at their side;
- Look straight ahead;
- Keep head still; and
- Follow stimulus with eyes only.

It is suggested to give the subject the following verbal instructions:

"I am going to check your eyes."

"Keep your head still and follow the stimulus with your eyes only."

"Keep your eyes on the stimulus until I tell you to stop."



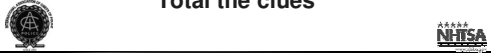
Session 2 - Standardized Field Sobriety Testing Review

### Administrative Procedures (Cont.)

Beginning with subject's left eye check:

- Equal pupil size, resting nystagmus, equal tracking.
- Lack of smooth pursuit
- Distinct and Sustained nystagmus at maximum deviation.
- Onset of nystagmus prior to 45 degrees.

Total the clues



Advanced Roadside Impaired Driving Enforcement 2-16

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Position the stimulus approximately 12 to 15 inches from the face in front of the suspect's nose and hold it slightly above eye level.

- Check both eyes for equal pupil size and resting nystagmus. Both pupils should be of equal size and there should not be any noticeable nystagmus.
- Take notice if the pupils are noticeably unequal in size or there is noticeable nystagmus at rest. This could be indicative of a medical condition or a head injury.

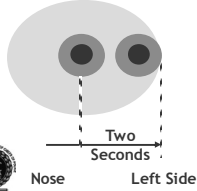
Check both eyes for equal tracking by making a rapid horizontal pass across both eyes.

- The speed of the stimulus should be approximately the same speed as checking for lack of smooth pursuit.
- Both eyes should track the stimulus together.
- If the eyes fail to track together, this could be the indication of a possible medical disorder, injury or blindness.

Session 2 - Standardized Field Sobriety Testing Review

## Three Clues of Horizontal Gaze Nystagmus

### 1. Lack of Smooth Pursuit



- Move the stimulus to the person's left
- It should take **approximately 2 seconds** to bring it to the side
- Check the other eye at the same speed
- Repeat

Advanced Roadside Impaired Driving Enforcement

NHTSA

2-17

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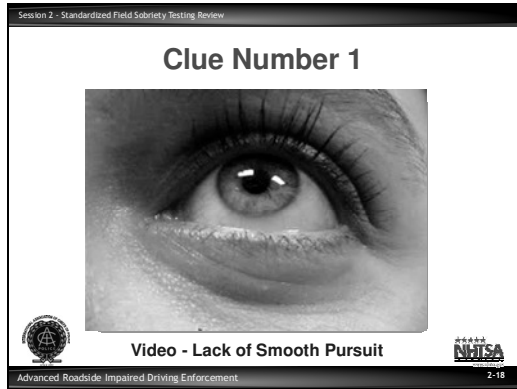
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### *Lack of Smooth Pursuit (LSP)*

- LOSP occurs when the eyes jerk or bounce as they follow a smoothly moving stimulus.
- Check the subject's left eye first.
- Move the stimulus smoothly, at a speed that requires approximately two seconds to bring the subject's eye as far to the side as it can go.
- Carefully watch the subject's left eye and determine if it is able to pursue smoothly.
- Move the stimulus all the way to the left, back across the subject's face and check the right eye at the same speed.
- Movement of the stimulus should take approximately two seconds to move from the center of the subject's face to the shoulder on the left side.
- Approximately two seconds to get back to the center then.
- Approximately two seconds to move from the center of the subject's face to the shoulder on the right side.
- Then approximately two seconds to return to the center of the subject's face to end the first pass.
- Repeat the procedure until each eye has been checked twice.

The stimulus should be moved in a smooth manner to best observe the eyes in motion.

The two-second timing is provided based on how the eye should follow the stimulus if the individual is not impaired by alcohol and/or other drugs.



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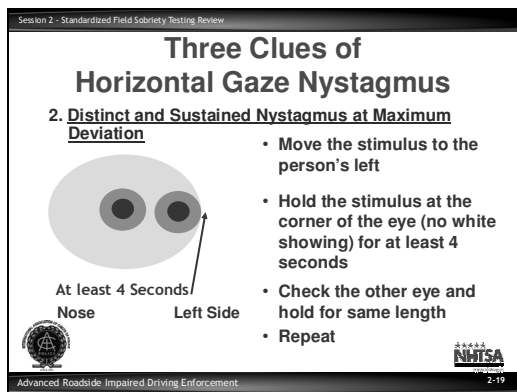
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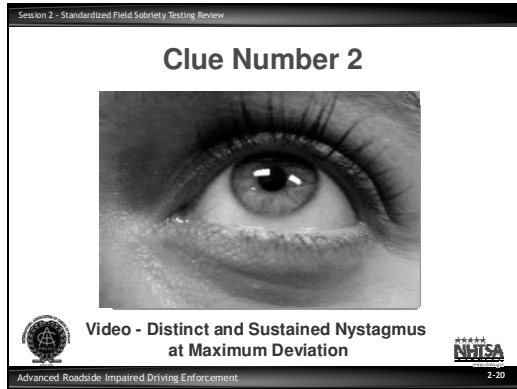
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*Distinct and Sustained Nystagmus at Maximum Deviation*

- At extreme lateral gaze, also known as the endpoint or maximum deviation, the nystagmus is distinct and sustained when the stimulus is held for a minimum of 4 seconds.
- Start again with the individual's left eye.
- Move the stimulus to the individual's left side until there is no more white of the eye visible.
- The eye should not be able to move any further on the horizontal plane.
- Hold the left eye in that position for a minimum of four (4) seconds and not more than 30 seconds.
- Observe the eye for distinct and sustained nystagmus while being held in this position.
- Move the stimulus all the way to the left, back across the individual's face and check the right eye.
- Repeat the procedure until each eye has been checked twice.



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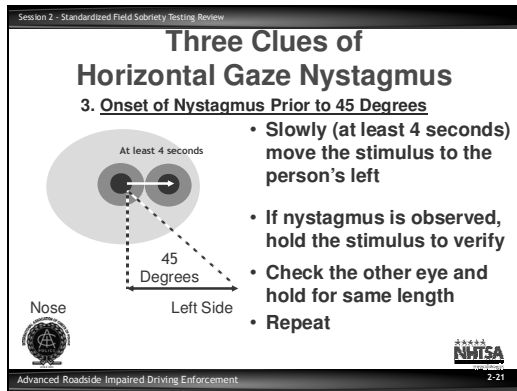
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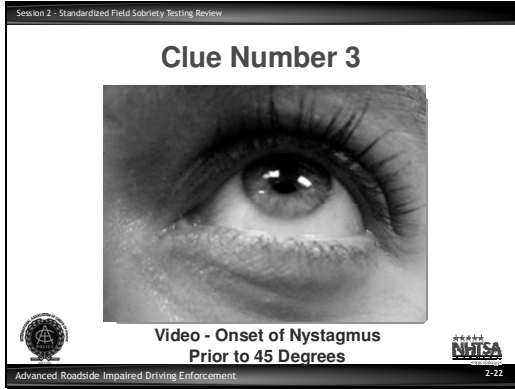
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*Onset of Nystagmus Prior to 45 degrees*

- Start again with the individual's left eye
- Move the stimulus at a speed that would take approximately four seconds to reach the 45 degree angle.
- Watch the eye carefully for any sign of jerking.
- If jerking is observed, hold the stimulus at that position and verify the nystagmus is distinct and sustained (i.e. continuous).
- Move the stimulus all the way to the left, back across the individual's face and check the right eye.
- Repeat the procedure until each eye has been checked twice.



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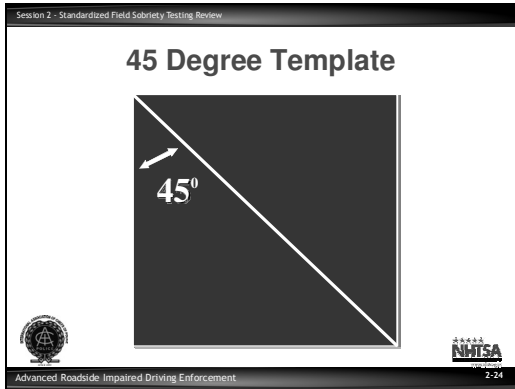
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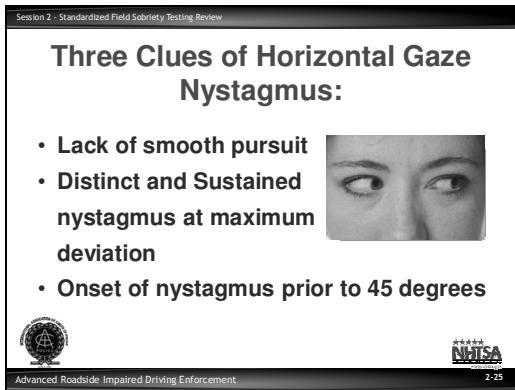
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*Three Clues of Horizontal Gaze Nystagmus*

- Lack of smooth pursuit
- Distinct and Sustained nystagmus at maximum deviation
- Onset of nystagmus prior to 45 degrees

Session 2 - Standardized Field Sobriety Testing Review

### Horizontal Gaze Nystagmus Indications

- Six maximum clues
- Maximum three clues per eye
- 77% accurate detecting subjects  $\geq 0.10$  BAC



Advanced Roadside Impaired Driving Enforcement 2-26

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HGN Test Criterion. 4 or more clues indicates BAC at or above 0.10 - 77% reliable (1977 original SCRI study) sponsored by NHTSA.

Session 2 - Standardized Field Sobriety Testing Review

### Vertical Nystagmus

- Move the stimulus vertically
- Raise the stimulus until the individual's eyes are elevated as far as possible and hold for at least four seconds
- Repeat



Advanced Roadside Impaired Driving Enforcement 2-27

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### Vertical Nystagmus

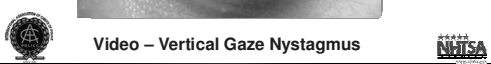
- Start with the stimulus approximately 12-15 inches from the face in front of the nose.
- Elevate the stimulus up until the eyes cannot elevate further.
- Hold the stimulus in that position for a minimum 4 seconds.
- If vertical nystagmus is present it must be distinct and sustained (i.e. continuous).

Session 2 - Standardized Field Sobriety Testing Review

### Vertical Gaze Nystagmus



Video - Vertical Gaze Nystagmus



Advanced Roadside Impaired Driving Enforcement 2-28

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Session 2 - Standardized Field Sobriety Testing Review

### Test Interpretation

Three clues in each eye:

- 1) Lack of Smooth Pursuit
- 2) Distinct and Sustained Nystagmus at Maximum Deviation
- 3) Onset of Nystagmus Prior to 45 Degrees



Advanced Roadside Impaired Driving Enforcement

NHTSA

2-29

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## D. Practice HGN

### *Test Interpretation*

There are three clues in each eye. Six total clues.

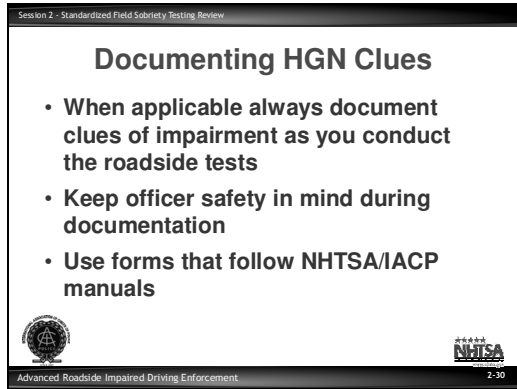
- Lack of Smooth Pursuit
- Present
- Not present
- If present, it accounts for 2 clues, one in each eye
- Distinct and sustained nystagmus at maximum deviation
- Present
- Not present
- If present, it accounts for 2 clues, one in each eye

### 3) Onset of nystagmus prior to 45 degrees

The more impaired a person becomes the sooner the onset of nystagmus is observed.

This jerking must be distinct and sustained.

- Present
- Not present
- If present, it accounts for 2 clues, one in each eye



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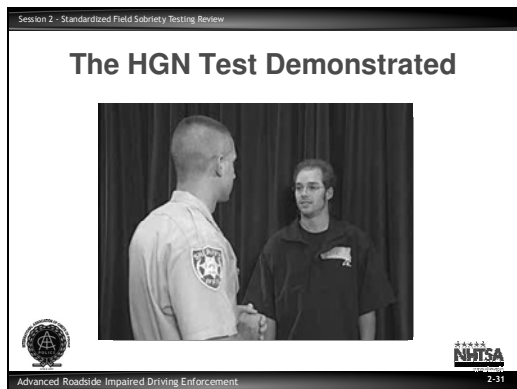
*Documenting the HGN Clues*

The HGN test has been researched and found to be a reliable indicator of impairment with subjects at or above 0.08 BAC.

Based on the 1998 San Diego field validation study, if four or more clues are observed, it is likely that the subject's BAC is at or above 0.08. If two or three clues are observed, it is likely that the subject's BAC is at or above 0.04 but under 0.08.

When applicable you should always document the clues of impairment as you are conducting the roadside tests. Make sure that you keep officer safety in mind when documenting these clues.

Each jurisdiction has come up with techniques and forms to record the results. As long as these forms follow the NHTSA/IACP manuals, they may be used. Listed in your manual is only one example that could be used.



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*Horizontal Gaze Nystagmus (HGN)*

Clue #1 – Lack of smooth pursuit.

Clue #2 – Distinct and sustained Nystagmus at maximum deviation.

Clue #3 – Angle of Onset.





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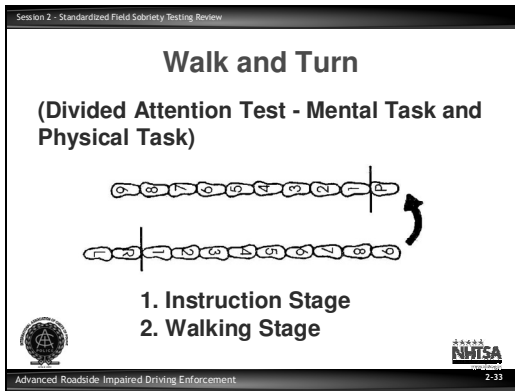
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### E. Walk and Turn Test

The Walk-and-Turn (WAT) test is divided into two stages:

- Instruction Stage
- Walking Stage

#### *Instruction Stage*

- Stand heel-to-toe with arms at their sides.
- Divided attention, listening to and remembering instructions.

#### *Walking Stage*

- Balancing, walking heel-to-toe, and turning.
- Small muscle control, counting out loud, and short-term memory, recalling the number of steps required, turning as instructed, and counting correctly.

Session 2 – Standardized Field Sobriety Testing Review

### Safety Precautions

- Keep subject to your left during demonstrations
- Never turn back on suspect
- Be aware of surroundings
- Left-handed officers should demonstrate the test in this manner. Officers may opt to demonstrate the test from a distance greater than arm's length away

Advanced Roadside Impaired Driving Enforcement 2-34

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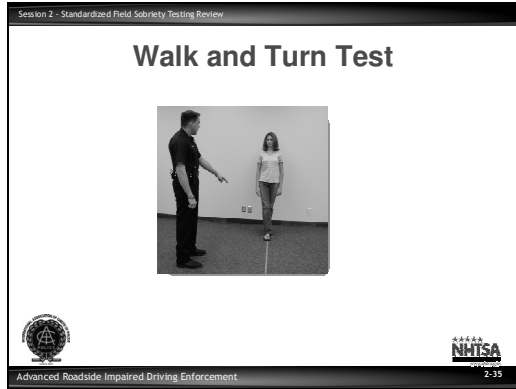
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*Officer safety precautions*

- Keep subject on your left during demonstration
- Never turn your back on a suspect
- Be aware of surroundings
- Left-handed officers should demonstrate the test in this manner. Officers may opt to demonstrate the test from a distance greater than arm's length away.



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Walk and Turn is the second divided attention test administered during the drug influence evaluation.

The test is administered the same way that we have used it for Standardized Field Sobriety Testing purposes.

- Monitor the practice and offer coaching and constructive criticism, as appropriate.
- Review of Walk and Turn administrative procedures.

The test has two stages: the instructions stage and the walking stage.

- During the instructions stage the subject must stand heel-to-toe, with the right foot ahead of the left foot with the heel of the right foot against the toe of the left foot, and keeping the arms at the sides.
- Demonstrate the stance that the subject must maintain during the instructions stage. If the subject fails to maintain the starting position during your instructions, discontinue the instructions and direct the subject back to the starting position before continuing.
- The subject is told to not start walking until told to do so.
- The subject must be told to take nine heel-to-toe steps on the line, to turn around keeping the front or lead foot on the line and to turn by taking a series of small steps with the other foot, and to return nine heel-to-toe steps down the line.

Session 2 - Standardized Field Sobriety Testing Review

### Walk and Turn Test Diagram

Walk And Turn Test

Describe Turn

Cannot keep balance \_\_\_\_\_

Starts too soon \_\_\_\_\_

	1st Nine	2nd Nine
Stops Walking		
Misses Heel-Toe		
Steps Off Line		
Raises Arms		
Actual Steps Taken		

Cannot Do Test (explain)

Advanced Roadside Impaired Driving Enforcement 2-36

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- The subject must be told to watch his or her feet while walking, and to count the steps out loud.
- The subject must be told to keep their arms at the sides at all times.
- The subject must be told not to stop walking until the test is completed.
- The subject should be asked if he/she understands the instructions.
- Once the subject acknowledges his/her understanding of the instructions, instruct the subject to begin the test.
- If the subject stops or fails to count out loud or watch his/her feet, remind him/her to perform these tasks. This interruption will not affect the validity of the test and is essential for evaluating divided attention.

Session 2 - Standardized Field Sobriety Testing Review

### Walk and Turn Test Clues

1. Can't balance during instructions (breaks heel/toe)
2. Starts too soon
3. Stops while walking
4. Doesn't touch heel to toe



Advanced Roadside Impaired Driving Enforcement 2-37

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Look for the following clues each time the Walk-and-Turn test is administered. Cannot keep balance while listening to the instructions.

- Record this clue if the individual does not maintain the heel-to-toe position throughout the instructions.
- Do not record this clue if the suspect sways or uses the arms to balance but maintains the heel-to-toe position.

**Note: Feet must actually break apart.**


2. Starts too soon, before the instructions are finished.
  - Since you specifically instructed the suspect not to start walking "until I tell you to begin," record this clue if the individual starts walking before told to do so.
3. Stops while walking.
  - a. The individual pauses for several seconds. Do not record this clue if the individual is merely walking slowly.
4. Does not touch heel-to-toe. The individual leaves a space of more than one-half inch between the heel and toe on any step.

Session 2 - Standardized Field Sobriety Testing Review

### Walk and Turn Test Clues (Cont.)

- 5. Steps off the line
- 6. Uses arms for balance
- 7. Improper turn (or loses balance on turn)
- 8. Wrong number of steps

**Note:** If subject can't complete the test, record clues that were observed, and note why test was not completed



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- 5. Steps off the line. The individual steps so that one foot is entirely off the line.
- 6. Uses arms to balance. The individual raises one or both arms more than 6 inches from the sides in order to maintain balance.
- 7. Improper turn. The individual removes the front foot from the line while turning. Also record this clue if the individual has not followed directions as instructed, i.e., spins or pivots around.
- 8. Incorrect number of steps. Record if the individual takes more or fewer than nine steps in either direction.

Session 2 - Standardized Field Sobriety Testing Review

### Documenting the Walk and Turn Test Clues

- Note clue by placing a slash on assessment form
- Considerations:
  - Straight line
  - Dry, hard, level, non-slippery surface
  - Room for nine heel-to-toe steps



Advanced Roadside Impaired Driving Enforcement 2-39

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### *Documenting the Walk and Turn Clues*

Each clue is noted by placing a slash in the appropriate place on the assessment form.

For example: If the individual raised their arms twice and stepped off the line three times, they would be considered to have demonstrated “two” clues.

It is a good practice to use an assessment form that documents the administrative procedures.

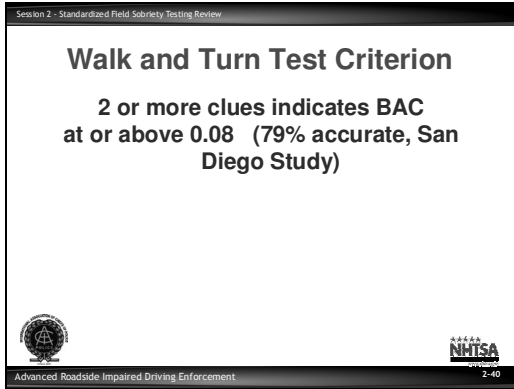
### *Considerations*

Walk-and-Turn test requires a real or imaginary straight line, and should be conducted on a reasonably dry, hard, level, non-slippery surface. There should be sufficient room for individuals to complete nine heel-to-toe steps.

Notes:

- However, recent field validation studies have indicated that varying environmental conditions have not affected a subject’s ability to perform this test.
- The original research indicated that subject’s over 65 years of age may have difficulty performing this test.
- Individuals wearing heels more than 2 inches high should be given the opportunity to remove their shoes.

**\*\*PRACTICAL EXERCISE\*\***



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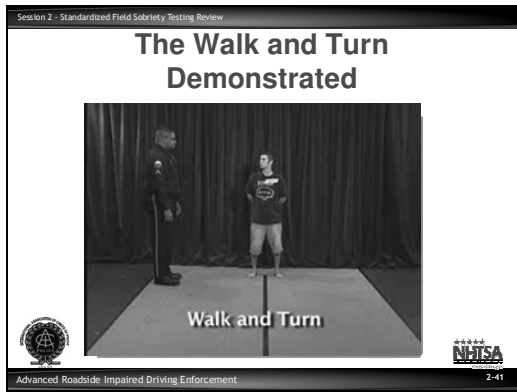
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Based on recent research, if the subject exhibits two or more clues on this test or fails to complete it, classify the subject's BAC as at or above 0.08. Using this criterion, you will be able to accurately classify 79% (San Diego Study) of your subjects.



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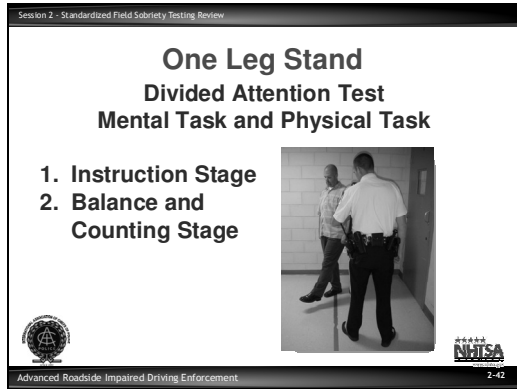
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### F. One Leg Stand

The One-Leg Stand (OLS) test is divided into two stages:

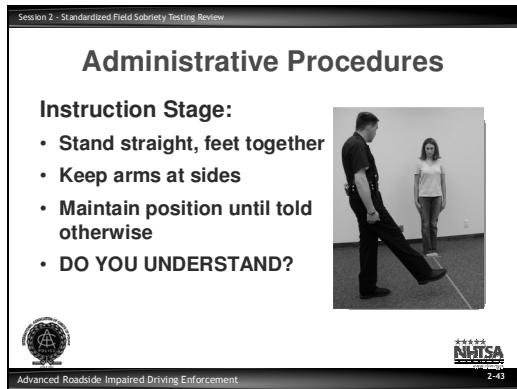
- Instructional stage
- Balancing and counting

*Instructional Stage:*

- Balancing and Counting
- Listening to instructions

*The Balancing Stage:*

- Balancing
- Short-term memory



Notes: \_\_\_\_\_

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### *Administrative Procedures*

- Initial positioning and verbal instructions
- “Stand with your feet together and your arms down at your sides.”
- “Remain in this position and do not begin until I tell you to do so.”
- “Do you understand the instructions so far?”



Session 2 – Standardized Field Sobriety Testing Review

### Administrative Procedures (Cont.)

**Balance and Counting Stage:**

- Raise one leg, either leg
- Keep raised foot approximately six inches off the ground, foot parallel to the ground
- Keep both legs straight
- Keep eyes on elevated foot
- Count out loud in the following manner: 1001, 1002, 1003, and so on, until told to stop.

**Note:** It is important for the officer to time 30 seconds for the test

Advanced Roadside Impaired Driving Enforcement 2-41

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### *Instructions for the Balancing and Counting Stage*

Two instructors should be used for this demonstration, one as the “subject” and the other as the examiner.


- The test has two stages, the instructions stage and the balance and counting stage.
- During the instructions stage, the subject must stand with the feet together, arms at the side, facing the examiner.
- Demonstrate the stance that the “subject” is required to maintain.
- The subject must be told that they will have to raise either leg approximately 6 inches off the ground, with the right leg held straight and the raised foot parallel to the ground.
- The examiner must demonstrate the one-leg stance.
- Emphasize that the subject must maintain the foot elevation throughout the test.
- If the subject lowers his/her foot, he/she should be instructed to raise it.
- The subject must be told that they must look at the elevated foot during the test.
- Emphasize that the examiner should not look at his or her own foot while giving the instructions; for safety reasons, the examiner must keep the eyes on the subject at all times.
- The subject must be told that they will have to count out loud in the following manner: “one thousand one, one thousand two, one thousand three” and so on until told to stop.
- After giving the instructions, the examiner should ask the “subject” if they understand.
- Note: If the subject puts the foot down, remind the subject to pick the foot up again and continue counting from the point at which the foot touched.

Session 2 - Standardized Field Sobriety Testing Review

### One Leg Stand Test Evaluation

1. Puts foot down
2. Uses arms to balance
3. Sways while balancing
4. Hopping

**Note:** If suspect can't do the test, record clues that were observed, and note why test was not completed.



Advanced Roadside Impaired Driving Enforcement 2-45

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### Test Evaluation


Look for the following clues each time the One-Leg Stand test is administered:

- Puts foot down
- Uses arms to balance
- Sways while balancing
- Hopping

Session 2 - Standardized Field Sobriety Testing Review

### One Leg Stand Test Documentation and Considerations

- Note clues with slash on assessment form
- Consider subjects may have injuries
- Have subject remove shoes with heels over two inches



Advanced Roadside Impaired Driving Enforcement 2-46

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### Documentation

Each clue is noted by placing a slash in the appropriate place on the assessment form.

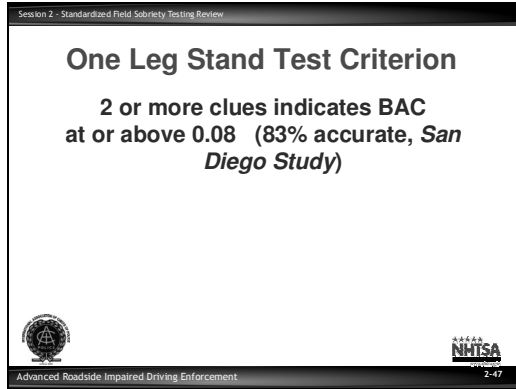
For example, if the individual used their arms twice and swayed three times, they would be considered to have demonstrated “two” clues. It is a good practice to use an assessment form that documents the administrative procedures.

### Considerations

Some people may have difficulty with the One Leg Stand test even when not impaired.

Persons with injuries to their legs and/or hips or inner ear disorders may have difficulty with this test.

Individuals wearing shoes more than 2 inches high should be given the opportunity to remove them.



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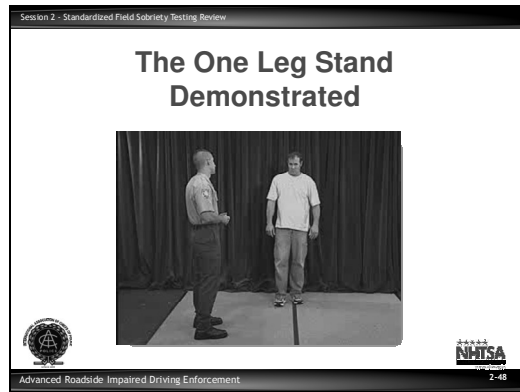
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*One-Leg-Stand Test Criterion*

Based on recent research, if an individual shows two or more clues or fails to complete the One Leg Stand, there is a good chance the BAC is at or above 0.08. Using that criterion, you will accurately classify 83% (*San Diego Study*) of the people you test as to whether their BAC's are at or above 0.08.



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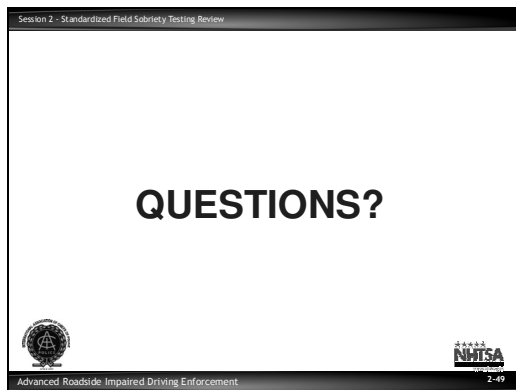
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**\*\*PRACTICAL EXERCISES\*\***

**G. Practice One Leg Stand**



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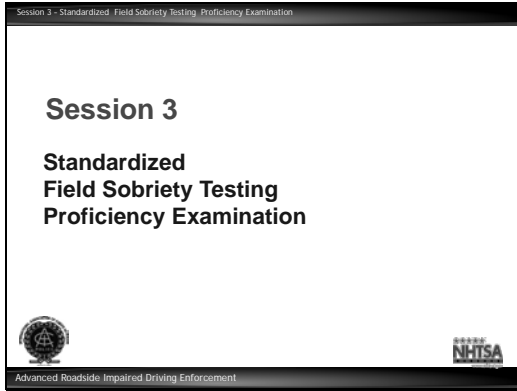
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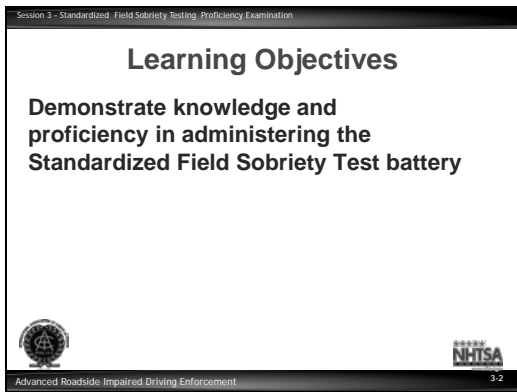
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# ARIDE Participant Manual – Session 3 Standardized Field Sobriety Testing Proficiency Examination



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Upon Successful completion of this session the participant will be better able to:

- Demonstrate knowledge and proficiency in administering the SFST battery.

Session 3 - Standardized Field Sobriety Testing - Proficiency Examination

### SFST Proficiency

- The student will be given two chances to successfully complete the proficiency examination
- If the student does not pass the proficiency on their second attempt they will not be allowed to continue with the training



Advanced Roadside Impaired Driving Enforcement 3-3

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*Explanation for Proficiency*

SFST is the foundation of every impaired driving training program that has been developed, researched, and supported for over two decades.

This makes it very important for the participants to be proficient in administering these tests.

NHTSA, IACP, and the courts have recognized the importance of proficiency as it relates to the detection, arrest, and prosecution of impaired drivers.

By recognizing this, NHTSA and the IACP committed to bridging the information gaps between the governing bodies and the agencies applying these techniques in the field.

There are several factors that can affect a law enforcement officer’s SFST proficiency. They include the following:



- Adult learning limitations
- Officer assignment
- Time to practice proficiency
- Opportunity to use in the field
- Limitations of instructors
- Gaps in communication
- Program administration

Session 3 - Standardized Field Sobriety Testing Proficiency Examination

### SFST Proficiency (Cont.)

**Remember!!!!**

- The participant will be given only two opportunities to do the SFST battery
- The instructor will not assist or coach the participant in any manner during the proficiency examination

Advanced Roadside Impaired Driving Enforcement 3-4

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### SFST Proficiency Examination

- The participant will be given only two opportunities to do the SFST battery.
- If the participant fails their first attempt, they will be given the opportunity to practice on their own or with another participant within a reasonable amount of time not to exceed the end of the first day.
- The instructor will not assist or coach the participant in any manner during the proficiency examination.
- The instructor will correct the participant after the completion of all three tests, but will not correct the participant during the tests.
- Utilize proficiency examination form located in the participant manual and the administrator’s guide.
- A **“check”** will be placed in the space provided for each step completed according to the SFST manual.
- An **“X”** will be placed in the space if the participant does not perform the step according to the SFST manual.

Session 3 - Standardized Field Sobriety Testing Proficiency Examination

### SFST Proficiency (Cont.)

- The instructors are here to assist you with the proficiency
- If you are having trouble with the process you will be given ample time to practice

Advanced Roadside Impaired Driving Enforcement 3-5

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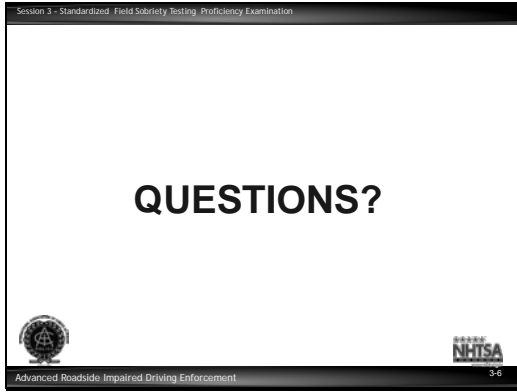
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Remember the Instructors are here to assist you with the proficiency.

If the participant is having trouble passing the proficiency examination the participant shall be responsible for seeking out instructors to assist them.



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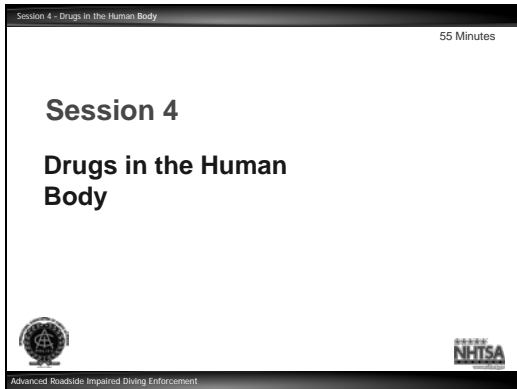
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## ARIDE Participant Manual – Session 4 Drugs in the Human Body



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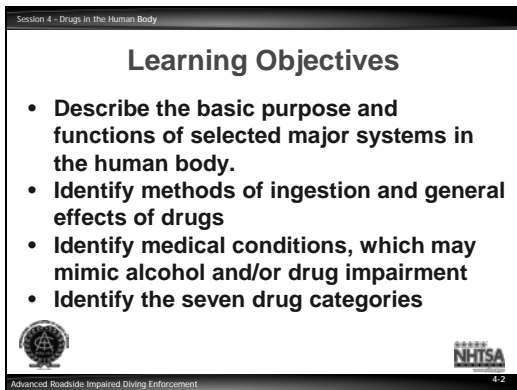
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Upon successfully completing this session, the participant will be able to:

- Describe, in general terms, the basic purpose and functions of selected major systems in the human body as they relate to observable signs.
- Identify methods of ingestion and general effects of drugs.
- Identify medical conditions which may mimic alcohol and drug impairment.
- Identify the seven drug categories as referenced in the DECP and the basis for dividing drugs into these specific groups.

### Content Segments

- A. Drugs in the Human Body
- B. Overview of selected major systems of the human body:
  - Basic purpose and function,
  - Muscular, Urinary, Respiratory, Digestive, Nervous, Circulatory Systems
- C. Homeostasis
- D. Identify methods of ingestion and general effects of drugs
- E. Medical conditions which may mimic alcohol and drug impairment
- F. Seven drug categories and the basis for dividing drugs into these specific groups
- G. Blank Drug Indicator Matrix


### Learning Activities

- Instructor-Led Presentation
- Instructor-Led Presentation
- Instructor-Led Presentation
- Instructor-Led Presentation
- Instructor-Led Presentation

Session 4 - Drugs in the Human Body

**Identifying the Effects of Drugs on the Human Body is Dependent in part on:**

- Recognizing changes in behavior
- Recognizing observable signs and symptoms related to an impaired individual



Advanced Roadside Impaired Driving Enforcement 4-3

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**A. Drugs in the Human Body**

This process is dependent, in part, on:


- Recognizing changes in behavior
- Recognizing observable signs and symptoms related to an impaired individual

In order to gain a better understanding of how alcohol and/or drugs affect bodily functions, it is helpful to be familiar with some of the processes of the human body.

Session 4 - Drugs in the Human Body

**This Session Will...**

- Provide a general overview related to how drugs affect the body in basic terms
- Highlight those systems involved with distribution, absorption, metabolism, and elimination of alcohol and/or other drugs in the body



Advanced Roadside Impaired Driving Enforcement 4-4

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This session is designed to provide the participant with:


- General overview related to how drugs affect the body in basic terms.
- Highlight those systems involved with distribution, absorption, metabolism, and elimination of alcohol and/or other drugs in the body.

Session 4 - Drugs in the Human Body

### Pharmacokinetics

*How a chemical substance is transported through the body in terms of absorption, distribution, metabolism, and elimination.*

- A number of different body systems can have impact on, or be affected by, the introduction of drugs



Advanced Roadside Impaired Driving Enforcement 4-5

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### Pharmacokinetics

Pharmacokinetics accounts for how a chemical substance is transported through the body in terms of absorption, distribution, metabolism, and elimination.


As stated in the objectives, this session will also:

- Explain the different types of drug ingestion.
- Describe medical conditions, which may mimic the signs and symptoms of alcohol and/or drug use.
- Identify the seven drug categories used by the DEC program.
- Introduction of a drug indicator matrix.

Session 4 - Drugs in the Human Body

### What is a Drug?

**A drug is any substance that, when taken into the human body, can impair the ability of the person to operate a vehicle safely.**



Advanced Roadside Impaired Driving Enforcement 4-6

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As we progress through this course, it is important to understand how drugs are defined.

The following provides operational definitions for drug and psychoactive which describe the majority of the drugs we will discuss as part of this course.

### Drug


A drug is: Any substance that, when taken into the human body, can impair the ability of the person to operate a vehicle safely.

Session 4 - Drugs in the Human Body

### Psychoactive

A chemical that alters brain/body function resulting in temporary changes in:

- Perception
- Mood
- Consciousness
- Behavior



Advanced Roadside Impaired Driving Enforcement 4-7

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### Psychoactive

A psychoactive drug or substance:

Is a chemical that alters brain/body function, resulting in temporary changes in perception, mood, consciousness, or behavior.

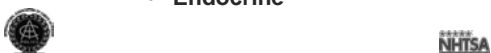
Such drugs are often used for:

- Recreational purposes
- Spiritual purposes
- Medical purposes, especially for treating neurological problems
- Psychological illnesses and deficiencies

Session 4 - Drugs in the Human Body

### Major Systems of the Human Body

- Muscular
- Urinary
- Respiratory
- Digestive
- Endocrine



Advanced Roadside Impaired Driving Enforcement 4-8

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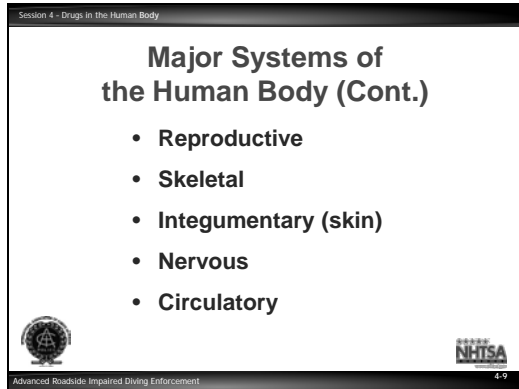
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### **B. Introduction of Selected Systems of the Human Body**

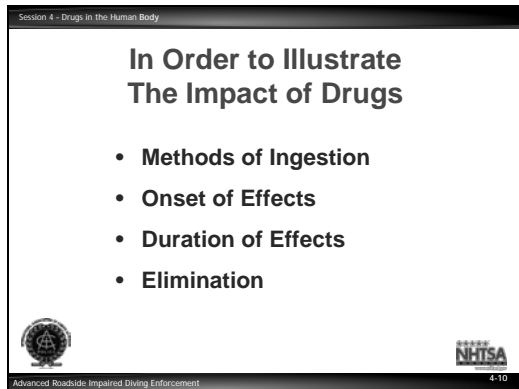
There are ten systems in the human body:

- Muscular
- Urinary
- Respiratory
- Digestive
- Endocrine



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- Reproductive
- Skeletal
- Integumentary (skin)
- Nervous
- Circulatory

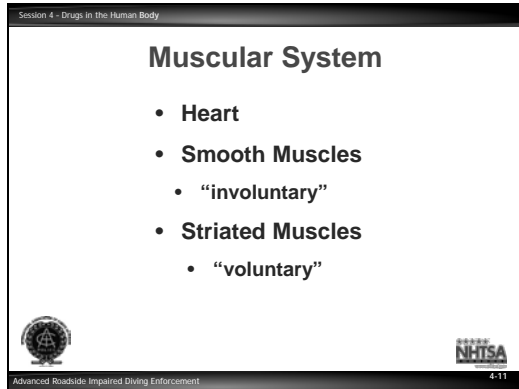


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In order to illustrate the impact of drugs, alcohol or a combination of substances, it is helpful to think of it in terms of:

- Ingestion
- Onset
- Duration of effects
- Elimination

The systems we previously discussed provide the most predominant observable signs and symptoms related to influence of alcohol and/or other drugs on the human body.



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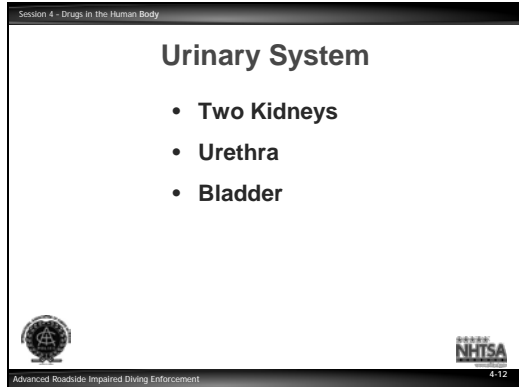
## Muscular System

The body has three types of muscles:

- Heart
- Smooth muscles (which control involuntary movements)
- Striated muscles (which control voluntary movements).

The brain controls the operation of all these muscles through the nervous system.

The impact of drugs and alcohol on the muscular system can often be observed during the walk and turn, one-leg stand test, as well as during general observations.



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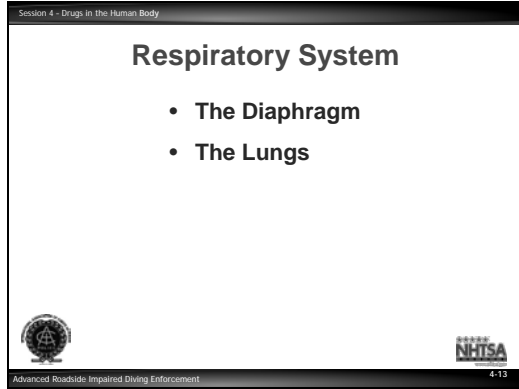
## Urinary System

The urinary system is responsible for the elimination of waste from the body.

It consists of:

- Two kidneys connected by long tubes (urethras) to the bladder, which stores urine.
- A third tube, the urethra, carries the urine from the bladder out of the body.
- Kidneys - filters waste products out of the system as blood passes through them.

Since drugs are removed from the blood in the kidneys and passed out of the body in the urine, the urinary system plays a key role in producing evidence of drug use.



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### Respiratory System

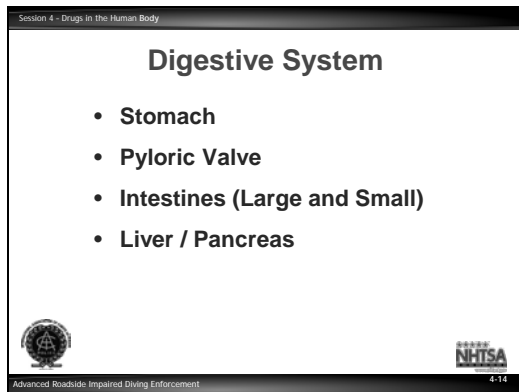
The primary organs of the respiratory system are:

- Diaphragm
- Lungs

The diaphragm is a muscular sheet that separates the thoracic (upper) cavity from the abdominal (lower) cavity, and draws fresh air into the lungs and forces used air out.

The transfer of oxygen from the air to the blood, and carbon dioxide from the blood to the atmosphere, occurs in the lungs.

Oxygen must be supplied to all the body cells, and carbon dioxide must be removed from them in order for life to exist.

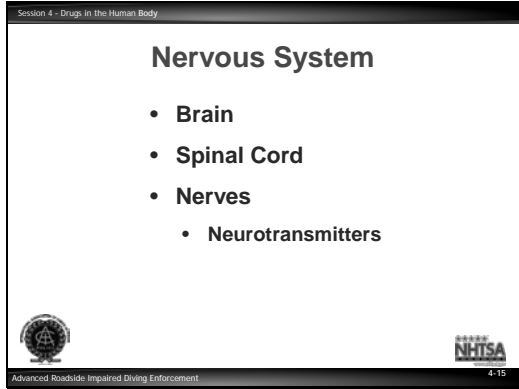


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### Digestive System

- Stomach
- Pyloric Valve
- Intestines (Large and Small)
- Liver / Pancreas

This system breaks down food and/or chemicals, metabolizes and eliminates waste products.



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### **Nervous System**

The nervous system serves as the control center for the human body.

It consists of:

- Brain
- Spinal cord
- Nerves

Each of these components is made up of nerve cells (neurons) and supporting tissues.

The nervous system keeps the body apprised of changes in the environment by enabling

- Sight
- Hearing
- Smell
- Taste
- Touch


Through sensations of temperature, pressure, pleasure and pain.



Session 4 - Drugs in the Human Body

## Nervous System

- Brain
- Spinal Cord
- Nerves
  - Neurotransmitters



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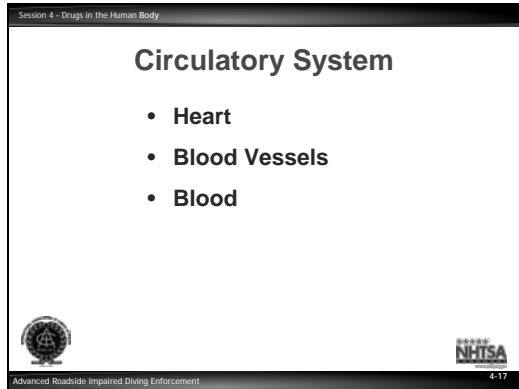
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The nervous system also enables reasoning, memory and emotions.

The central nervous system sends impulses that cause muscles to contract and glands to secrete, and it works with all body systems to integrate all physiological processes so that normal functions can be maintained.

Much of the activity of the nervous system is involuntary and therefore it is carried out below the level of consciousness.

The Central Nervous System (CNS) is one of the body's major control systems and the brain is the center of that system.



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## Circulatory System

The circulatory system consists of

- Heart
- Blood vessels
- Blood

The heart pumps blood throughout the body transporting:

- Food
- Water
- Hormones
- Antibodies
- Oxygen
- Carbon dioxide
- Other substances to and from the body cells as required

Body temperature regulation is a partial responsibility of the circulatory system, since warm blood is constantly moved throughout the body.



The circulatory system plays a key role in transporting drugs to the brain, where most of the drugs' effects are exerted.

The circulatory system also transports the drugs to the liver and other organs, where the drugs are metabolized.

Session 4 - Drugs in the Human Body

### Brain

- **Made up of nerve cells - Neurons**
- **Neurotransmitters send messages to receptors**
- **Drugs have influence on how neurons function**



Advanced Roadside Impaired Driving Enforcement 4-18

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The brain is made up of billions of nerve cells, also known as neurons. Nerve cells communicate by transferring chemical substances between each other.

When a message is sent from one neuron (transmitter), it triggers the release of neurotransmitters and sends the message to another nerve cell which is called the receptor.

This is the way nerve cells share information.

There are many different types of neurotransmitters and each one has a specific role to play in how the brain and the CNS functions.

Some drugs affect the brain because their chemical makeup is similar to the neurotransmitters which occur in the body naturally.


In the appropriate dose amount, drugs have a positive influence on how the neurons function.

However in some cases, drugs can cause the release of large amounts of a similar neurotransmitter while others can block the receptors.

Session 4 - Drugs in the Human Body

### Limbic System of the Brain

- Our feelings
- Emotions
- Motivations
- Supports memory and learning



Advanced Roadside Impaired Driving Enforcement 4-19

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All drugs of abuse, such as nicotine, cocaine, and marijuana, impacts the limbic system of the brain.

The limbic system generates:

- Our feelings
- Emotions
- Motivations
- Supports memory and learning

It responds to pleasurable experiences by releasing the neurotransmitter dopamine.

The effect which a subject experiences when dopamine is 'dumped' in the CNS, creates a euphoric sensation which makes some drugs of abuse so appealing to the user.


The actions associated with the communication between neurons affects the other systems of the human body.

Session 4 - Drugs in the Human Body

### Homeostasis

Homeostasis is any self-regulating process by which a biological or mechanical system maintains stability while adjusting to changing conditions.

*The body's systems are said to be in "dynamic equilibrium"*



Advanced Roadside Impaired Driving Enforcement 4-20

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### C. Homeostasis

Homeostasis is any self-regulating process by which a biological or mechanical system maintains stability while adjusting to changing conditions.

As we have discussed earlier in this session, the human body is made up of systems.


They are in a dynamic equilibrium.

Under normal circumstances, systems seek a balance in which internal change continuously compensates for external change in a feedback control process to keep conditions relatively level.

Session 4 - Drugs in the Human Body

### Examples of Homeostasis

- Temperature Regulation
- Maintaining supplies of bodily fluids
- Bringing in Oxygen and eliminating Carbon Dioxide
- Eliminating waste
- Integrating the functions of the various body systems



Advanced Roadside Impaired Driving Enforcement 4-21

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### Examples of Homeostasis

- Temperature regulation
  - Mechanically in a room by a thermostat
  - Biologically in the body by a complex system controlled by the hypothalamus in the brain.

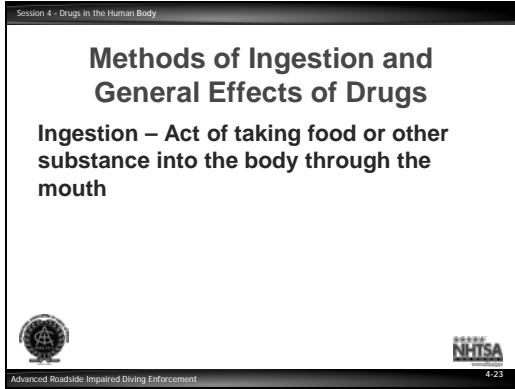
Every organ system plays some role in the maintenance of homeostasis.

- The circulatory system keeps the body sufficiently supplied with fluids.
- The respiratory system constantly brings in oxygen and eliminates carbon dioxide.
- The digestive and urinary systems take in food and water and eliminate waste.
- The nervous system integrates the functioning of the other systems; and so on.

When alcohol and/or other drugs are introduced into the body, the resulting interactions can cause the body to:

- Speed up
- Slow down
- Become confused

The observation and examination of selected bodily functions help to indicate whether a subject is impaired by alcohol and/or other drugs.

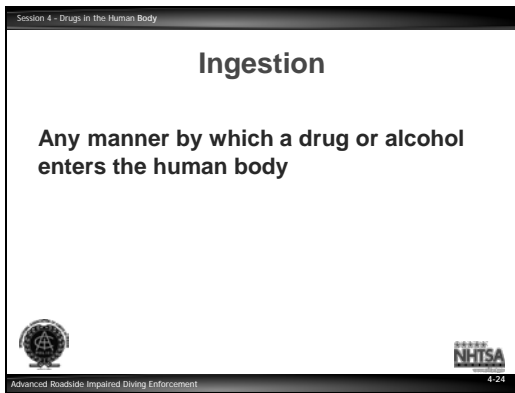


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**D. Methods of Ingestion and General Effects of Drugs**

In general terms, ingestion is:

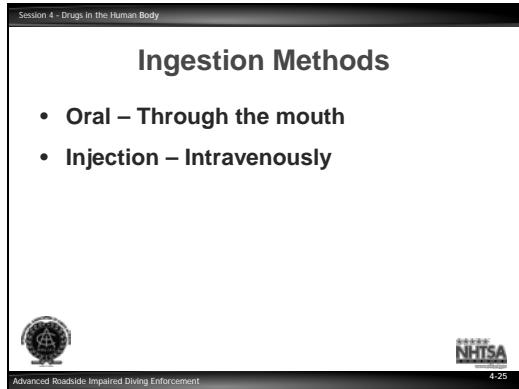
The act of taking food or another substance into the body through the mouth.



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For the purpose of this course:

We will use the term ingestion to describe any manner by which a drug or alcohol enters the human body whether it be orally or otherwise administered.



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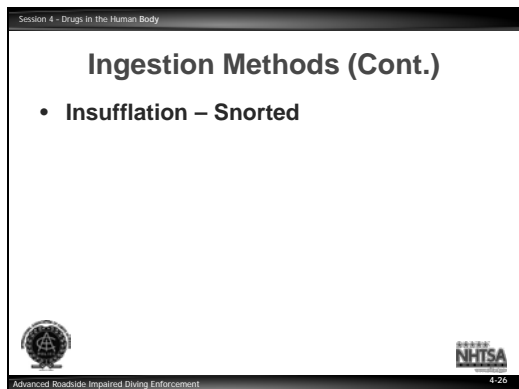
*Oral*

Oral ingestion is administered through the mouth.

*Injection*

- Is a common method of administering heroin (narcotic analgesic),
- Is also used to introduce stimulants, hallucinogens, dissociative anesthetics, and other narcotic analgesics into the body.
- CNS depressants can also be injected but this is not common due to the size of the needle required to deliver the substance.

In addition to injecting drugs into the veins in the arms, users will find more creative and less conspicuous areas on the body to administer a substance since needles typically leave marks which can be difficult to disguise.



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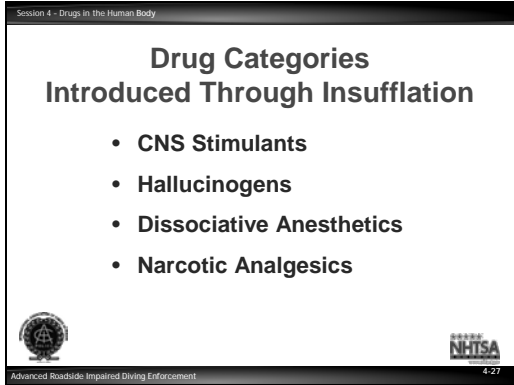
*Insufflation*

The act of introducing a substance by inhaling through the nose for the purpose of intranasal absorption through the mucous membrane.

For a substance to be effective when insufflated it must be in a water soluble powder so it can be readily absorbed through the mucous membranes.

This method is commonly referred to as "snorting".





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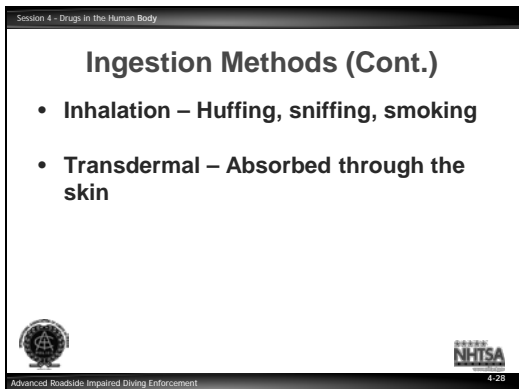
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Drug categories which are commonly introduced into the body through insufflations are:

- Stimulants
- Hallucinogens
- Dissociative Anesthetics
- Narcotic Analgesics



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*Inhalation*

The act of introducing a substance directly into the respiratory system through the nose and mouth for the purpose of absorbing the substance through the alveoli in the lungs.

This is a very rapid method of absorption and is often referred to as huffing, sniffing, or smoking.



Drug categories which are commonly introduced into the body through inhalation are:

- Cannabis – Smoking
- Narcotic Analgesics – Smoking
- Dissociative Anesthetics – Smoking
- Hallucinogens – Smoking
- Stimulants – Smoking
- Inhalants - Inhaling

Session 4 - Drugs in the Human Body

### Transdermal Administration

- Transdermal means that the chemical or drug is absorbed into an individual's system through the skin
- Less common administration
- USE EXTREME CAUTION !!!

Advanced Roadside Impaired Driving Enforcement 4-29

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### *Transdermal*

A less common method of administering drugs. Transdermal means that the chemical or drug is absorbed into an individual's system through the skin.


Drugs which are able to be administered transdermally can be administered accidentally through contact.

Some selected Hallucinogens, Dissociative Anesthetics, and Narcotic Analgesics can be administered transdermally.

Session 4 - Drugs in the Human Body

### Medical Conditions Which May Mimic Drug Impairment

- Head Trauma
- Stroke
- Diabetes
- Conjunctivitis
- Shock
- Multiple Sclerosis
- Other Conditions




Advanced Roadside Impaired Driving Enforcement 4-30

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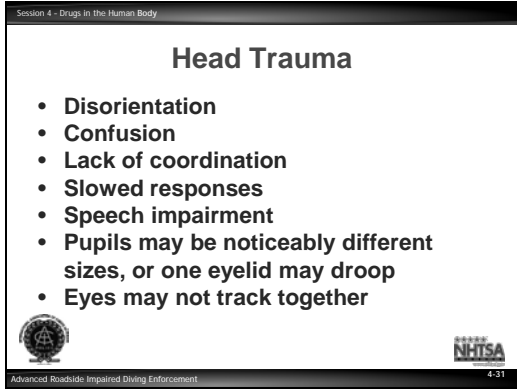
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### **E. Medical Conditions Which May Mimic Drug Impairment**

There are various medical conditions and injuries that may cause individuals to appear to be impaired by alcohol and/or other drugs.

Some of the more common medical conditions that may mimic drug impairment include:

- Head Trauma
- Stroke
- Diabetes
- Conjunctivitis
- Shock
- Multiple Sclerosis
- Other Conditions



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*Head Trauma*

A severe blow or bump to the head may injure the brain and create:

- Disorientation
- Confusion
- Lack of coordination
- Slowed responses
- Speech impairment
- Other gross indicators of alcohol or drug influence

Because the injury usually affects one side of the brain more than the other, disparities usually will be evident in the subject's eyes.



Sometimes the pupils will be noticeably different in size or one eyelid may droop while the other appears normal.

Additionally, the eyes may not be able to track equally while focusing on a stimulus.

Session 4 - Drugs in the Human Body

### Stroke

- **Markedly unequal pupil sizes**
- **Paralysis or weakness on one side of the body**
- **Slurred speech, facial droop**
- **Confused, frightened**



Advanced Roadside Impaired Driving Enforcement 4-32

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*Stroke*

A stroke will usually produce many of the same effects and indicators associated with head trauma.

Stroke victims often will have:

Pupils that are noticeably different in size. One pupil may remain fixed and exhibit no visible reaction to light, while the other reacts normally.



Paralysis, physical weakness and other observable signs are often more predominant on one side of the body than the other.

Additionally, individuals suffering from a stroke will often have a dazed appearance and be confused and/or scared.

Session 4 - Drugs in the Human Body

### Diabetes

- Confused or non-responsive
- Sweat profusely
- Cold, clammy skin
- Rapid, weak pulse
- May require immediate medical attention



Advanced Roadside Impaired Driving Enforcement 4-33

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### *Diabetes*

A diabetic is most likely to be mistaken for a person impaired by alcohol and/or drugs when they have too much insulin, causing the blood sugar level to become dangerously low.

This condition is referred to as insulin shock.



A diabetic in insulin shock may:

- Appear very confused
- Be non-responsive
- Sweat profusely
- Exhibit elevated pulse rate
- Elevated blood pressure

Session 4 - Drugs in the Human Body

### Conjunctivitis

An inflammation of the mucous membrane that lines the inner surface of the eyelids giving a red, bloodshot appearance of the conjunctiva of the eyes



Advanced Roadside Impaired Driving Enforcement 4-34

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### *Conjunctivitis*

This is an inflammation of the mucous membrane that lines the inner surface of the eyelids giving a red bloodshot appearance to the conjunctiva of the eyes.


At first glance, this may appear similar to the bloodshot conditions associated with impairment by alcohol or cannabis.

This condition may occur in one or both eye and is often referred to as 'pink eye'.

Session 4 - Drugs in the Human Body

### Shock

- Occurs when the body is not getting enough blood flow
- Immediate medical attention
  - Cold clammy skin
  - Weak, lethargic
  - Rapid, weak pulse



Advanced Roadside Impaired Driving Enforcement 4-35

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### *Shock*

Shock is a life-threatening condition that occurs when the body is not getting enough blood flow.

This can damage multiple organs and lead to death.


Shock requires IMMEDIATE medical treatment and can get worse very rapidly.

Individuals in shock often will appear dazed, uncoordinated, and non-responsive.

Session 4 - Drugs in the Human Body

### Multiple Sclerosis

- May lack coordination
- Exhibit gait ataxia
- Tremors
- Slurred or garbled speech
- May appear alert and responsive to questions



Advanced Roadside Impaired Driving Enforcement 4-36

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### *Multiple Sclerosis*


Victims of Multiple Sclerosis (MS) and other degenerative muscular disorders may lack coordination or exhibit gait ataxia, tremors, slurred or garbled speech, and many of the other gross motor indicators of intoxication.

Unlike subjects impaired by alcohol and/or drugs, MS sufferers usually appear alert.

Session 4 - Drugs in the Human Body

### Other Medical Conditions

- Carbon Monoxide Poisoning
- Seizures
- Endocrine disorders
- Neurological disorders
- Psychiatric disorders
- Infections



Advanced Roadside Impaired Driving Enforcement 4-37

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### *Other Medical Conditions*


Some other medical conditions that may cause signs and symptoms similar to drug impairment include:

- Carbon monoxide poisoning
- Seizures
- Endocrine disorders
- Neurological conditions
- Psychiatric conditions
- Infections

Session 4 - Drugs in the Human Body

### Behavioral Conditions

- Exercise
- Excitement
- Fear
- Anxiety
- Depression



Advanced Roadside Impaired Driving Enforcement 4-38

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### *Behavioral Conditions*


There are some behavioral conditions that may affect vital signs:

- Exercise
- Excitement
- Fear
- Anxiety
- Depression

Session 4 - Drugs in the Human Body

### Seven Drug Categories - Review

1. Central Nervous System Depressants
2. Central Nervous System Stimulants
3. Hallucinogens



Advanced Roadside Impaired Driving Enforcement 4-39

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### F. Introduction to the Seven Drug Categories

As a review, the definition of a drug, adopted by the DEC program and this course:

Based on this definition of “drug”, the DEC program divided drugs into seven categories. These drug categories are based on the observable signs and symptoms they produce. The following is a brief description of each category:


- Central Nervous System Depressants. Includes a large number of different drugs. The common drug in this category is alcohol. CNS depressants slow down the operation of the brain and other parts of the central nervous system.
- Central Nervous System Stimulants. Influence the human body by speeding up, or over stimulating the brain. Cocaine is an example of a CNS stimulant.
- Hallucinogens. Includes some natural, organic substances as well as some synthetic chemicals. All hallucinogens impair the subject’s ability to perceive reality. LSD is an example of a hallucinogen.



Session 4 – Drugs in the Human Body

### Seven Drug Categories – Review (Cont.)

- 4. Dissociative Anesthetics
- 5. Narcotic Analgesics
- 6. Inhalants
- 7. Cannabis



Advanced Roadside Impaired Driving Enforcement 4-40

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- Dissociative Anesthetics. Consists of the drug Dextromethorphan (DXM), PCP and its various analogs. DA's are powerful drugs that act like a depressant in some ways, but also cause the body to respond similar to a stimulant as well as a hallucinogen.
- Narcotic Analgesics. Relieves pain, produces addiction, and withdrawal symptoms. Heroin is an example of a narcotic analgesic.
- Inhalants. Breathable chemicals, which are contained in familiar household items that can be easily purchased. Gold spray paint is an example of an inhalant.
- Cannabis. The most popular widely used and abused illegal drug and is most commonly referred to as marijuana.

Session 4 - Drugs in the Human Body

### Drug Indicator Matrix

	CNS Dep.	CNS Stim.	Hall.	Dissoc. Anest.	Narc. Analg.	Inhalant	Cannabis
HGN							
VGN							
LOC							
Pupil Size							

Advanced Roadside Impaired Driving Enforcement  4-1


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**G. Blank Drug Indicator Matrix**

	<b>CNS Dep.</b>	<b>CNS Stim.</b>	<b>Hall.</b>	<b>Dissoc. Anest.</b>	<b>Narc. Analg.</b>	<b>Inhalant</b>	<b>Cannabis</b>
<b>HGN</b>							
<b>VGN</b>							
<b>LOC</b>							
<b>Pupil Size</b>							

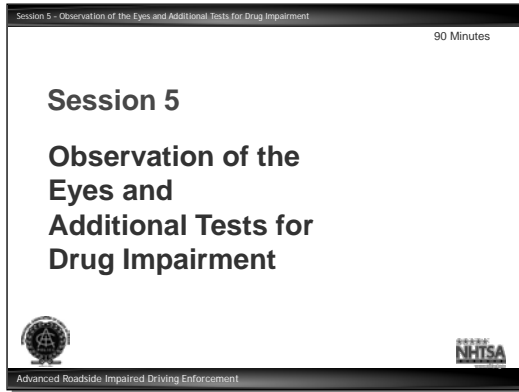
Session 4 - Drugs in the Human Body

## QUESTIONS?

Advanced Roadside Impaired Driving Enforcement  4-1

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## Participant Manual ARIDE - Session 5 – Observation of the Eyes and Additional Tests for Drug Impairment



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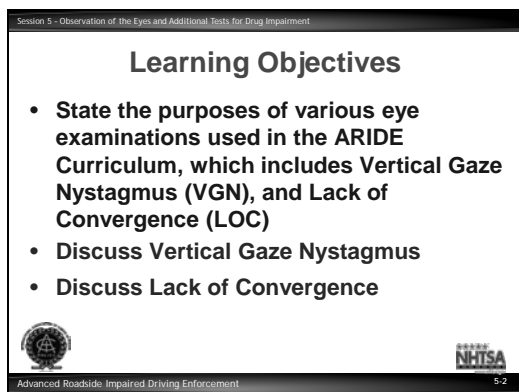
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Upon successfully completing this session, the participant will be able to:

- State the purposes of various eye examinations used in the ARIDE Curriculum, which includes Vertical Gaze Nystagmus (VGN), and Lack of Convergence (LOC)
- Discuss Vertical Gaze Nystagmus: How to administer properly and describe what the results indicate.
- Discuss Lack of Convergence: How to administer properly and describe what the results indicate.

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Learning Objectives (Cont.)

- Describe the difference in pupil size
- Discuss Modified Romberg Balance test: How to administer properly and describe what the results indicate
- Explain the relationship between eye examinations and the seven drug categories

Advanced Roadside Impaired Driving Enforcement 5-3

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- Describe the difference in pupil size.
- Discuss Modified Romberg Balance test: How to administer properly and describe what the results indicate.
- Explain the relationship between eye examinations and the seven drug categories.

### Content Segments

- Discuss Vertical Gaze Nystagmus  
How to administer properly  
Describe what the results indicate  
Practice VGN
- Describe the difference in pupil size
- Discuss Lack of Convergence  
How to administer properly  
Describe what the results indicate  
Practice LOC
- Modified Romberg Balance test  
How to administer properly  
Describe what the results indicate  
Practice Modified Romberg Balance test
- Relationship between eye examinations and the seven categories
- Frame the discussion for the seven drug categories
- Blank Drug Indicator Matrix


### Learning Activities

- Instructor-Led Presentation
- Participant Practice Session
- Instructor-Led Presentation
- Instructor-Led Presentation
- Participant Practice Session
- Instructor-Led Presentation
- Participant Practice Session
- Instructor-Led Presentation

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Vertical Gaze Nystagmus (VGN)

- How to administer properly
- Describe what the results indicate
- Practice VGN



Advanced Roadside Impaired Driving Enforcement 5-4

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**A. Discuss Vertical Gaze Nystagmus**

*Discuss Vertical Gaze Nystagmus*


- How to administer properly
- Describe what the results indicate
- Practice VGN

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Documenting Observations

- HGN / VGN
- Walk and Turn
- One Leg Stand

The information collected at roadside is critical to the entire impaired driving enforcement process



Advanced Roadside Impaired Driving Enforcement 5-5

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*Documenting Observations*


- HGN / VGN
- Walk and Turn
- One Leg Stand

The information collected at roadside is critical to the entire impaired driving enforcement process.

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Administration and Interpretation of Additional Roadside Sobriety Tests

- Pupil size observations
- Lack of Convergence (LOC)
- Modified Romberg Balance test



Advanced Roadside Impaired Driving Enforcement 5-6

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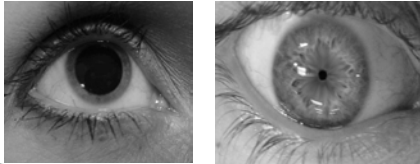

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Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Pupil Size Observation

The eyes are often referred to as “The windows to the soul”

Advanced Roadside Impaired Driving Enforcement 5-7

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**B. Describe the Difference in Pupil Size**



*Pupil Size Observation*

- The pupil is basically a circular hole in the middle of the iris, which regulates the amount of light that passes through into the retina.
- The pupils of the eyes continually adjust in size to accommodate different lighting conditions and refocus according to focal length.
- When placed in a darkened environment, the pupils will normally expand in size, or dilate, to allow the eyes to capture as much light as possible.
- When the lighting conditions are very bright, the pupils will normally shrink or constrict, to limit the amount of light that passes through and to keep the eyes from being over stimulated.

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Limits on Constriction and Dilation

- Recognize noticeable differences in the pupils
- Each of the seven drug categories has a predictable effect on the pupils



Advanced Roadside Impaired Driving Enforcement 5-8

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- This process of constriction and dilation normally occurs within certain limits.
- This course trains officers to recognize the noticeable differences in the pupils.
- When ingested, each of the seven drug categories has a predictable effect on the eyes, which will be discussed in the subsequent sections.



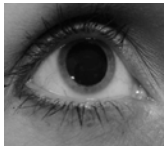
Example: If a stop is made during the day, you should expect to see the pupils somewhat smaller, because of the bright lighting conditions

Note: If you make a stop at night and the pupils are somewhat constricted, then there may be a drug causing the pupil reaction.

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Dilated Pupils

Observed when the pupils are larger than expected for the given lighting condition, resulting in a very large opening (circle) in the center of the eye



Advanced Roadside Impaired Driving Enforcement 5-9

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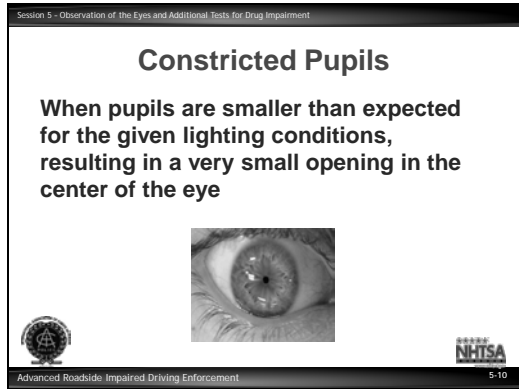
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### *Dilated Pupils*

The pupils appear larger than expected for the given lighting condition, resulting in a noticeably larger opening (circle) in the center of the eye.



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### *Constricted Pupils*

When pupils appear smaller than expected for the given lighting conditions, resulting in a noticeably smaller opening in the center of the eye.

The effects that drugs have on the eyes are involuntary reactions, which mean they cannot be controlled by the individual.



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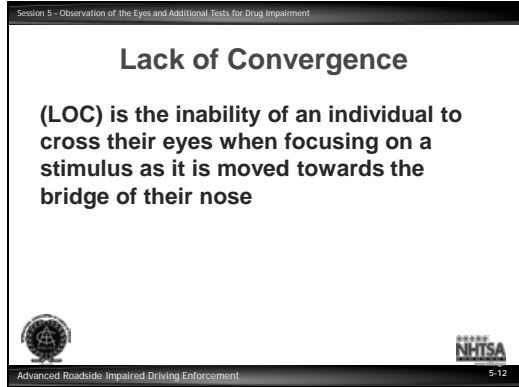
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### **C. Discuss Lack of Convergence**

*Lack of Convergence (LOC)*





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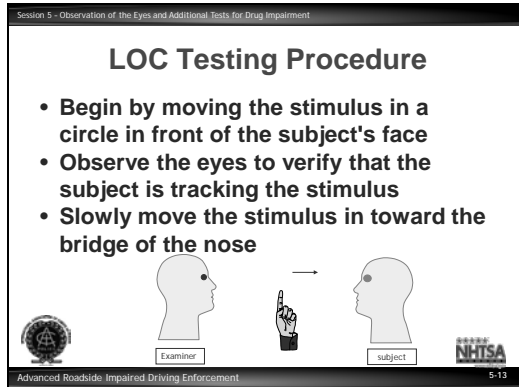
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*Definition of LOC*

The inability of a subject to cross their eyes when focusing on a stimulus as it is moved towards the bridge of their nose.



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*Administration of LOC*

*Instructional Stage*

- Inform the subject that you will be moving the stimulus around in a circle, and will be moving it toward the bridge of their nose. In addition, inform the subject that you will not actually touch the nose with the stimulus. This notice is important so the individual will not move their head away.
- Instruct the subject to keep their head steady and to follow the stimulus with their eyes only.
- Position the stimulus approximately 12-15 inches in front of the subject's nose in the same position as used in the HGN test.
- Law enforcement officers should not touch the bridge of the nose with the stimulus.

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Normal Convergence

- A distance approximately two inches (2") from the bridge of the nose
- If the eyes converge (cross) when the stimulus is approximately two inches from the bridge of the nose, the Lack of Convergence is "not present"

Advanced Roadside Impaired Driving Enforcement 5-14

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*Test Interpretation*

- The subject's eyes should come together and cross (converge) as they track and remained aligned with the stimulus.
- If the eyes are able to cross (converge), i.e., if they both come together when the stimulus is stopped approximately 2" from the bridge of the subject's nose, lack of convergence is "not present."

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

Examiner      2"      Subject

**Lack of convergence is present if the subject's eyes do not come together and cross as they track and stay aligned on the stimulus**

Advanced Roadside Impaired Driving Enforcement 5-15

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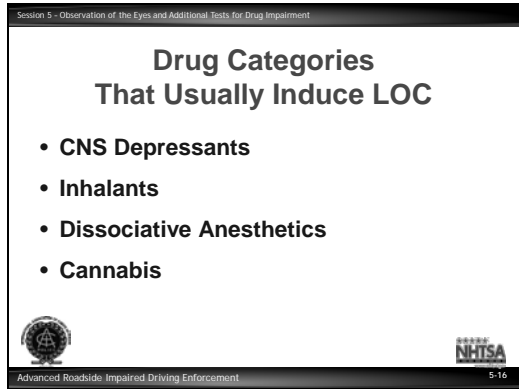
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LOC is "present" if one eye, or both eyes drift away or outward toward the side instead of converging toward the bridge of the nose.



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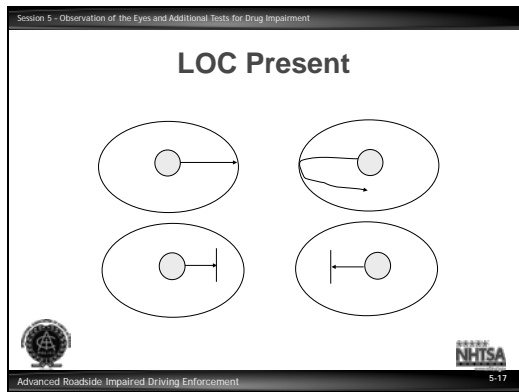
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The following drug categories usually will induce Lack of Convergence:

**CNS Depressants**

- Inhalants
- Dissociative Anesthetics
- Cannabis



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*Left Eye Unable to Converge*

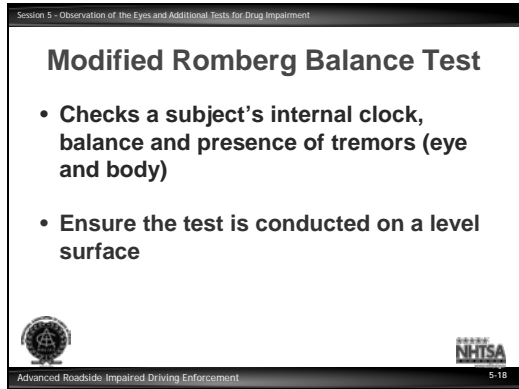
- Both eyes began to converge, however the left eye bounced down and back out

*Both Eyes Unable to Converge*

- Both eyes began to converge, however they both stopped before the convergence was completed.

There are no validated clues associated with the LOC test, the officer should note all observations associated with this test.

- The law enforcement officer should note whether or not convergence is present and document their observations as to the movement of the eyes during this test.

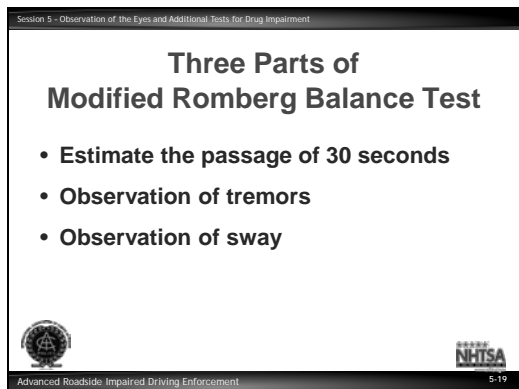


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### D. Modified Romberg Balance Test

The Modified Romberg Balance test is adapted and modified from its original use as a neurological assessment tool in order to check a subject's internal clock, balance and presence of tremors (eye and body).

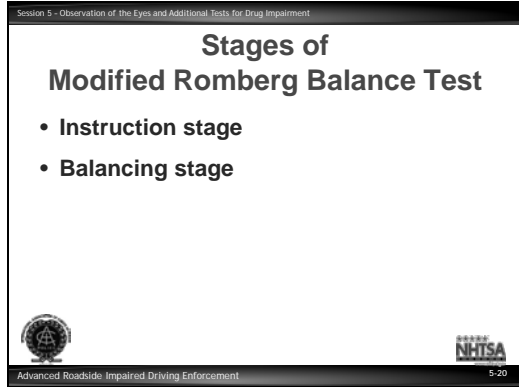
Since part of the Modified Romberg Balance test checks for balance, care should be taken to ensure the test is conducted on a level surface and in an environment, which is appropriate for this type of test when conducted at roadside.



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The Modified Romberg Balance test is divided into three parts which are conducted simultaneously.

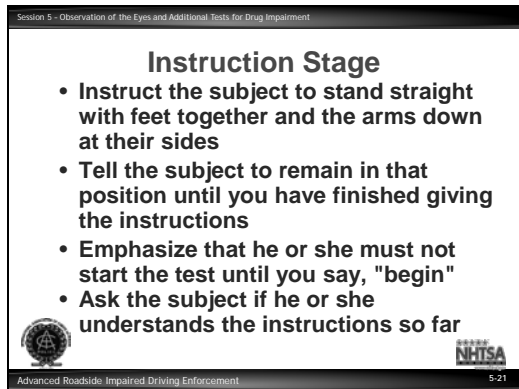
- Estimation the passage of 30 seconds
- Observation of tremors
- Observation of sway



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There are two stages to the Modified Romberg Balance test:

- Instruction stage
- Balancing stage



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*Administrative Procedures*

*Instruction Stage*

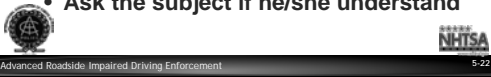
- Instruct the subject to stand straight with their feet together and their arms down at their sides.
- Tell the subject to remain in that position until you have finished giving the instructions. Emphasize that they must not start the test until you say, "begin".
- Ask the subject if they understand the instructions so far.

Note: Make sure to obtain a verbal response from the subject.

Section 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Instruction Stage (Cont.)

- Tell the subject, "When I tell you to tilt your head back slightly and close your eyes"
- Estimate the passage of 30 seconds
- Tell the subject, "When you think 30 seconds has gone by, bring your head forward, open your eyes, and say "Stop""
- Ask the subject if he/she understand



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*Instruction Stage (Cont.)*

4. Tell the subject, "When I tell you to tilt your head back slightly and close your eyes."

Note: Demonstrate this without closing your eyes.

5. Emphasis that they will estimate the passage of 30 seconds.

6. Tell the subject, "When you think 30 seconds has gone by, bring your head forward, open your eyes, and say "Stop"."

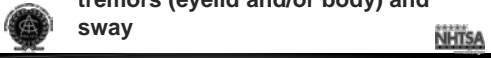
7. Ask the subject if they understand the instructions.

Note: Make sure to obtain a verbal response from the subject.

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Balancing Stage

1. Instruct the subject to tilt his or her head back and close their eyes
2. Use a timing device, and pick a convenient time to start the test
3. Tell the subject to begin
4. Keep track of time while the subject performs the test
5. Check subject for presence of tremors (eyelid and/or body) and sway



Advanced Roadside Impaired Driving Enforcement 5-23

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*Balancing Stage*

- Instruct the subject to tilt his or her head back and close their eyes.
- Use a timing device, and pick a convenient time to start the test.
- Tell the subject to begin.
- Keep track of the time while the subject performs the test.
- Check subject for presence of tremors (eyelid and/or body) and sway.

Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Balancing Stage (Cont.)

6. When the subject opens his/her eyes ask, "How much time was that?"
7. Record how much time actually elapsed from the start of the test until the subject opened the eyes or was told to stop.



Advanced Roadside Impaired Driving Enforcement 5-24

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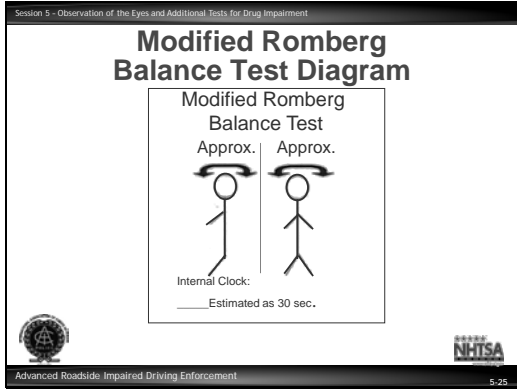
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*Balancing Stage (Cont.)*

6. When the subject opens his/her eyes ask, "How much time was that?"  
Note: Make sure to document their "exact" verbal response.
7. Record how much time actually elapsed from the start of the test until the subject opened the eyes or was told to stop.



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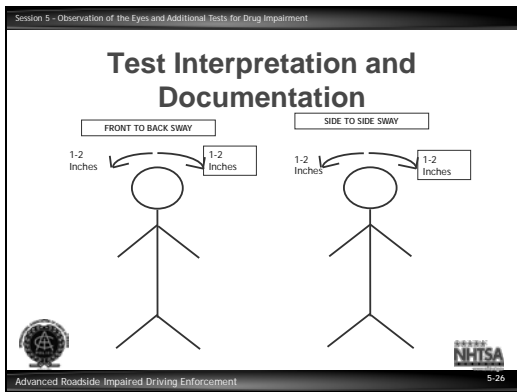
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*Instructor-Lead Demonstrations*



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*Recording Results of the Modified Romberg Balance Test*

The major items that need to be recorded for the Modified Romberg Balance test are:

- The amount that the subject sways.
- The actual amount of time that the subject keeps the eyes closed.
- To record swaying, the officer must estimate how many inches the subject sways, either front-to-back or left-to-right, or both.

Example: If the subject sways approximately two inches toward the left and approximately two inches toward the right, the officer should write the number “2” on each side of the “stick figure” that shows left-to-right movement. To record the subject’s time estimate, simply write the number of seconds that the subject kept his or her eyes closed.





Session 5 - Observation of the Eyes and Additional Tests for Drug Impairment

### Relationships to the Categories

	CNS Dep.	CNS Stim.	Hall.	Dissoc. Anest.	Narc. Analg.	Inhalant	Cannabis
HGN	Present	None	None	Present	None	Present	None
VGN	Present (1)*	None	None	Present	None	Present	None
LOC	Present	None	None	Present	None	Present	Present
Pupil Size	Normal (2)*	Dilated (4)*	Dilated (4)*	Normal	Constricted	Normal (3)*	Dilated (4)*

1. \*High dose for that individual  
 2. \*Pupil size may be dilated for Soma, Quaaludes, and some anti-depressants  
 3. \*Normal (average ranges) but may be dilated  
 4. \*Dilated, but may be normal (average ranges)

Advanced Roadside Impaired Driving Enforcement 5-27

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## **E. Relationship Between the Eye Observations and the Drug Categories**

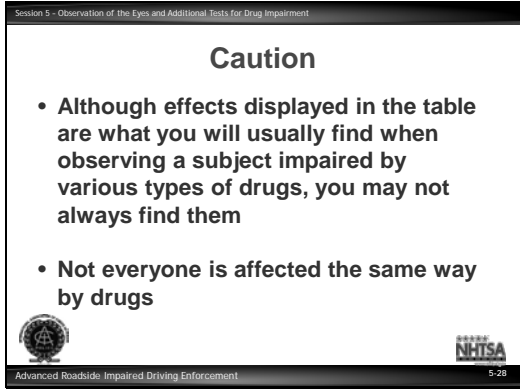
### *Eye Observations*

- Eye observations can provide valuable information, which can help determine impairment.
- Additionally, we discussed in Session 2 that HGN is a critical part of assessing subjects suspected of being under the impairment of alcohol.
- HGN also plays a significant part in the evaluation of individuals who might be impaired by drugs alone or in combination with alcohol.

In addition to HGN, VGN, and LOC, pupil size can also provide information, which contributes to the overall process in determining whether or not an individual is impaired by alcohol and/or drugs.

We have included a chart to assist the law enforcement officer in recognizing signs of alcohol, drug, or a combination of both alcohol and drug impairment relative to eye observations.

This chart or any of the other information presented in this course relative to a specific drug category is not meant to encourage the officer to connect their observations to a specific drug category.



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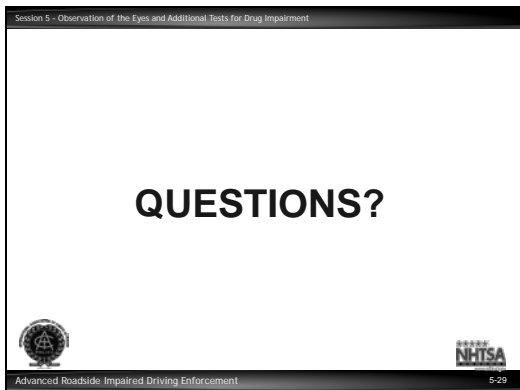
The law enforcement officer who successfully completes this course shall use only their roadside observations to make a decision as to whether the subject is impaired or not impaired according to their specific state’s statutes and support an arrest or no arrest decision.

*Important Note: (Caution)*

*Although effects displayed in the table are what you will **usually** find when observing a subject impaired by various types of drugs, you **may not always** find them.*

*Not everyone is affected the same way by drugs. You need to remember this when describing drug effects. It is best “never to say never” and “always avoid saying always.”*

**The officer who completes this course is NOT certified as a DRE and does not have the training required to support the selection of a specific drug category, which may be the source of the subject’s impairment.**



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## Participant Manual ARIDE – Session 6 – Seven Drug Categories



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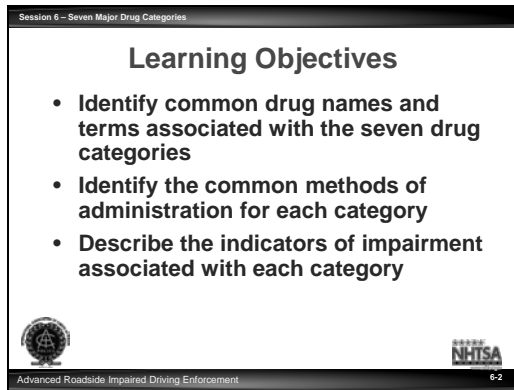
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Upon successfully completing this session, the participant will be able to:

- Identify common drug names and terms associated with the seven drug categories.
- Identify the common methods of ingestion for each category.
- Describe the indicators of impairment associated with each category.

### Content Segments

- A. Overview of the Drug Categories
- B. For each Drug Category, identification of:
  - Drugs
  - Indicators
  - Eye indicators
  - Other conditions which mimic indicators
  - Expected results from the detection process


### Learning Activities

- Instructor-Led Presentation
- Instructor-Led Presentation

Session 6 – Seven Major Drug Categories

### Learning Objectives (Cont.)

- Describe conditions which may mimic the signs and symptoms associated with each drug category
- List the indicators which may emerge during the three phases of the DWI detection process which may indicate the subject is under the influence of a drug(s)



Advanced Roadside Impaired Driving Enforcement 6-3

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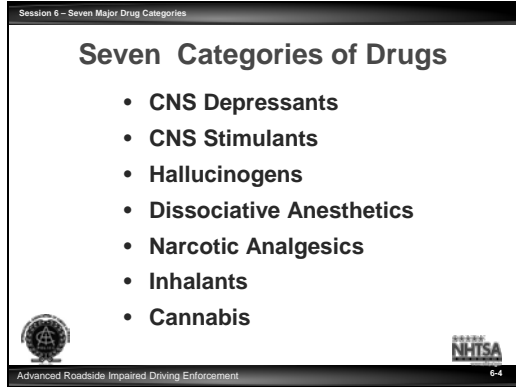
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- Describe conditions which may mimic the signs and symptoms associated with each drug category.
- List the indicators which may emerge during the three phases of the DWI detection process (vehicle in motion, personal contact and pre-arrest screening) which may indicate the subject is under the influence of a drug(s).

Historically, alcohol has been the most used and abused psychoactive depressant.

The majority of the general public is familiar with the effects of alcohol either through personal experience and/or observing others impaired by alcohol.



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**A. Overview of the Drug Categories**

This familiarity with the indicators of impairment associated with alcohol makes the depressant category relatively straightforward.

*Seven Categories of Drugs:*

- CNS Depressants
- CNS Stimulants
- Hallucinogens
- Dissociative Anesthetics
- Narcotic Analgesics
- Inhalants
- Cannabis



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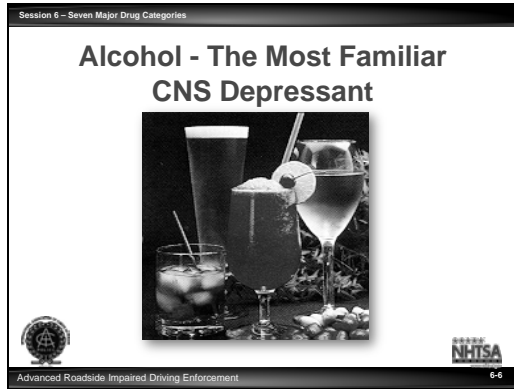
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*Identification of CNS Depressants*

In order for a drug to be classified as a depressant according to the DEC program, it must:

- Depress the activity of a subject's brain and CNS.



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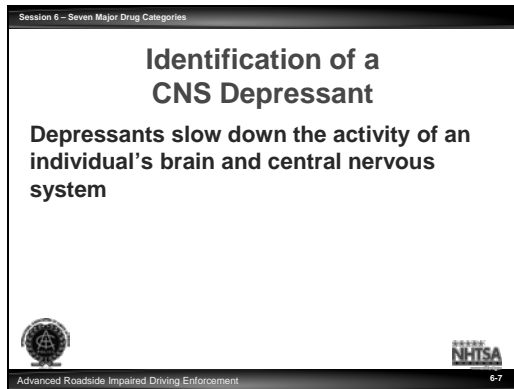
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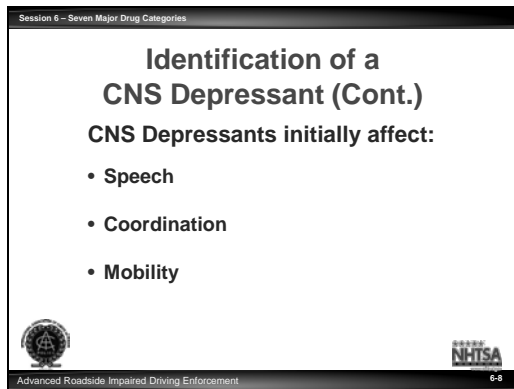
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At doses greater than therapeutic levels, impairment of the body's autonomic nervous system is affected.



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The depressant category initially affects a person's functions:

- Speech
- Coordination
- Mobility



At doses greater than therapeutic levels, impairment of the body's autonomic nervous system is affected.

Session 6 – Seven Major Drug Categories

### Doses greater than Therapeutic levels

CNS Depressants may cause impairment to the body's autonomic nervous system.

- Heartbeat
- Blood Pressure
- Breathing



Advanced Roadside Impaired Driving Enforcement 6-9

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At doses greater than therapeutic levels, impairment of the body's autonomic nervous system is affected.

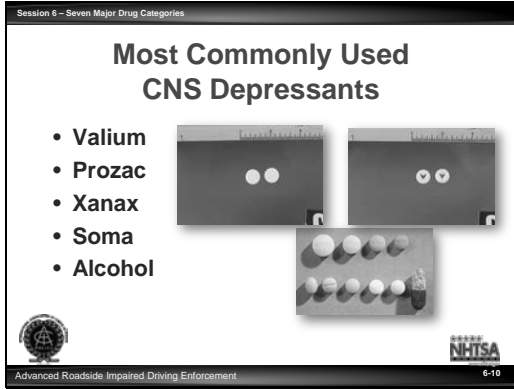
The systems affected are:

- Heartbeat
- Body temperature
- Breathing

In addition to alcohol, the depressant category also includes:

- Antianxiety drugs
- Antipsychotics
- Antidepressants
- Barbiturates
- Non-barbiturate or combination drugs

Subjects impaired by depressants may look very much like subjects impaired by alcohol, but without the odor of alcohol on their breath.



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Most familiar and abused depressants are:

- Valium
- Prozac
- Xanax
- Soma
- Alcohol

These are examples of just a few anti-anxiety tranquilizers, anti-depressants, and anti-psychotics legally prescribed for a variety of disorders.



Session 6 – Seven Major Drug Categories

### Illicit CNS Depressants

- Rohypnol (Flunitrazepam)
- Gamma Hydroxy Butyrate (GHB)



Advanced Roadside Impaired Driving Enforcement

NHTSA

6-11

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There are also several illicit CNS depressants that have gained national attention in the past several years.

- Rohypnol (Roofies)(Flunitrazepam)
- Gamma Hydroxy Butyrate (GHB)

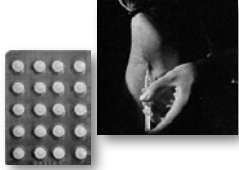
These drugs have been implicated in an alarming number of sexual assaults and overdose deaths.

Rohypnol is most commonly found in pill form (1 or 2 mg) and is still smuggled across the US/Mexico border.

Session 6 – Seven Major Drug Categories

## Methods and Signs of Ingestion

- Oral
- Insufflation
- Injection



Advanced Roadside Impaired Driving Enforcement

NHTSA

6-12

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### *Methods and Signs of Ingestion*

Generally, CNS depressants will be found in pill or liquid form.

The most common method for using depressants is to take them orally.

Pills may be crushed and insufflated (snorted).

Some CNS depressants, on very rare occasions, may be injected.



When CNS depressants (other than alcohol) are taken orally, signs of ingestion may be difficult to detect.

- There are occasions when a subject may chew the tablets to create a quicker onset of effect. When this happens traces of the tablet may be lodged in the teeth.
- Injection sites are easily identifiable by swelling of the area and ulcerations of the skin.
- The injection sites differ from those of other injectable drugs because liquid depressants are generally thicker and take a larger gauge needle to inject the drug.

Session 6 – Seven Major Drug Categories

### Effects of CNS Depressants

A person under the influence of a CNS depressant will look like a drunk, talk like a drunk, walk like a drunk, but they may not smell like a drunk



Advanced Roadside Impaired Driving Enforcement 6-13

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### *Effects of CNS Depressants*

A person impaired by a CNS depressant will look like a drunk, talk like a drunk, walk like a drunk, but they may not smell like a drunk.

Therapeutic doses (amounts typically prescribed by a physician) may not exhibit observable effects if they are ingested as prescribed.



Combinations of Depressants can be risky; they are commonly combined with Alcohol.

This increases the effects of the depressant and could magnify the effects and observable signs and symptoms.

Session 6 – Seven Major Drug Categories

### General Indicators

- Wide variety of emotional behavior
- Reduced ability to divide attention
- Disoriented
- Sluggish
- Thick, slurred speech
- Drunk-like behavior
- Droopy eyes
- Fumbling



Advanced Roadside Impaired Driving Enforcement 6-14

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Indicators include:

- A wide variety of emotional effects:
  - Euphoria
  - Depression
  - Laughing or crying for no apparent reason
- Reduced ability to divide attention
- Disoriented
- Sluggish
- Thick, slurred speech
- Drunk-like behavior
- Droopy eyes
- Fumbling

Session 6 – Seven Major Drug Categories

### General Indicators (Cont.)

- Relaxed inhibitions
- Slowed reflexes
- Uncoordinated
- Drowsiness
- Gait ataxia



Advanced Roadside Impaired Driving Enforcement 6-15

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- Relaxed inhibitions
- Slowed reflexes
- Uncoordinated
- Drowsiness
- Gait ataxia (impaired walking)

Session 6 – Seven Major Drug Categories

### Eye Indicators

HGN	Present
VGN	May be Present (high dose)
LOC	Present
Pupil Size	Normal



Advanced Roadside Impaired Driving Enforcement 6-16

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*Eye Indicators*

- HGN – Present
- VGN – May be Present – especially at high dose levels for that individual
- LOC – Present
- Pupil Size – Normal

Session 6 – Seven Major Drug Categories

### Onset and Duration of Effects

Type	Onset	Duration
Ultra Short	Seconds	Few Minutes
Short	10 to 15 min.	4 hours
Intermediate	30 minutes	4 to 6 hours
Long Acting	One hour	6 or more hours

Advanced Roadside Impaired Driving Enforcement

NHTSA

6-17

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### *Duration of Effects*

There are four different categories of depressants which are classified based on their onset properties:

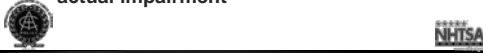
<u>Type</u>	<u>Action</u>
Ultra Short	Very rapid
Short	4 hours or less
Intermediate	4 to 6 hours
Long Acting	6 or more hours

Session 6 – Seven Major Drug Categories

### Duration of Effects

The duration of effects of CNS Depressants can vary depending on:

- Dosage amounts
- Age
- Weight
- Tolerance level
- Other variables may dictate the length of actual impairment



Advanced Roadside Impaired Driving Enforcement 6-18

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*Duration of Effects*


The duration of effects of CNS depressants can vary depending upon:

- Dosage amounts
- Age
- Weight
- Tolerance level
- Other variables may dictate the length of actual impairment

Session 6 – Seven Major Drug Categories

### Duration of Effects

Type	Duration
Barbiturate	1 to 16 hours
Tranquilizers	4 – 8 hours
GHB	3 – 5 hours
Rohypnol	Peak 1-2 hours Duration 8-12 hours



Advanced Roadside Impaired Driving Enforcement 6-19

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<u>Type</u>	<u>Duration</u>
Barbiturate	1 – 16 hours
Tranquilizers	4 – 8 hours
GHB	3 – 5 hours
Rohypnol	Peak 1-2 Duration 8-12 hours

Session 6 – Seven Major Drug Categories

### Overdose Signs and Symptoms

- Shallow breathing
- Cold/clammy skin
- Dilated pupils
- Rapid / weak pulse



Advanced Roadside Impaired Driving Enforcement 6-20

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*Overdose Signs and Symptoms*

- Shallow breathing
- Cold/clammy skin
- Dilated pupils
- Rapid/weak pulse

Session 6 – Seven Major Drug Categories

### Medical Conditions That May Mimic Drug Impairment

- Extreme fatigue
- Very recent head injuries
- Diabetic reactions
- Hypotension (low blood pressure)
- Inner ear disorders
- Severe depression



Advanced Roadside Impaired Driving Enforcement 6-21

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*Medical Conditions That May Mimic Drug Impairment*



- Extreme fatigue
- Very recent head injuries
- Diabetic reactions
- Hypotension (low blood pressure)
- Inner ear disorders
- Severe depression



Session 6 – Seven Major Drug Categories

### Drug Matrix

	CNS Dep.	CNS Stim.	Hall.	D.A.	N.A.A	Inhalant	Cannabis
HGN	Present						
VGN	Present						
Pupil Size	Normal *						
LOC	Present						

 \*Soma, Quaaludes, and possibly some Anti-Depressants usually dilate pupils 

Advanced Roadside Impaired Driving Enforcement 6-22

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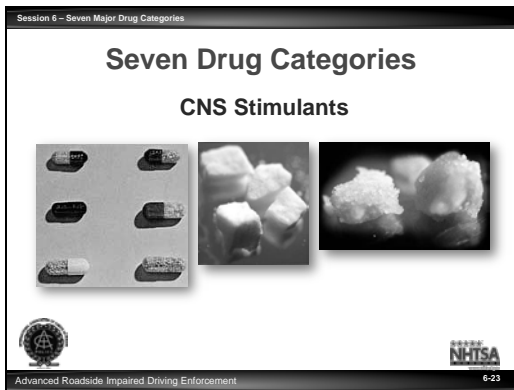
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### Drug Matrix: CNS Depressants



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### CNS Stimulants

Session 6 – Seven Major Drug Categories

### Central Nervous System Stimulants

- Relieve fatigue
- Aid in weight reduction
- Reduce the need for sleep
- Increase energy and confidence levels



Advanced Roadside Impaired Driving Enforcement 6-24

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Central nervous system stimulants:

- Relieve fatigue
- Aid in weight reduction
- Reduce the need for sleep
- Increase energy and confidence levels

In general, it brings about both a psychological and physical exhilaration.

CNS stimulants are commonly known as “*uppers*” and their effects are similar to the body’s flight or fight responses.

As stimulants “wear off”, the individual can exhibit signs and symptoms similar to those associated with depressants since the some of the body’s systems may experience a “crash.”



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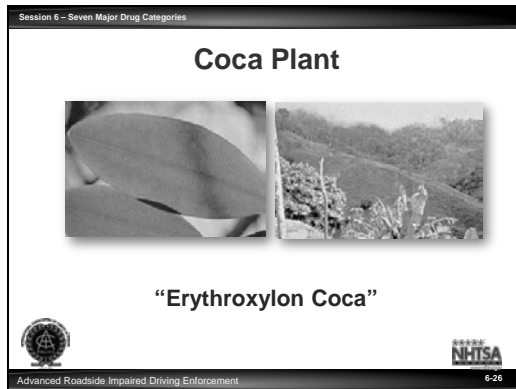
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The most widely abused CNS stimulants are:

- Cocaine
- Amphetamines
- Methamphetamines



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Cocaine is made from the leaves of the coca plant and is generally found as a white or off-white power.

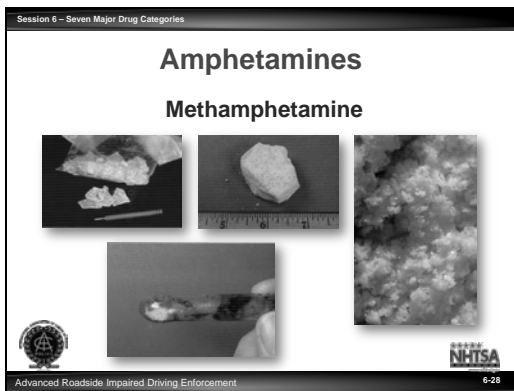


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Crack cocaine is made by mixing

- Baking soda,
- Cocaine
- Water
- Then heating

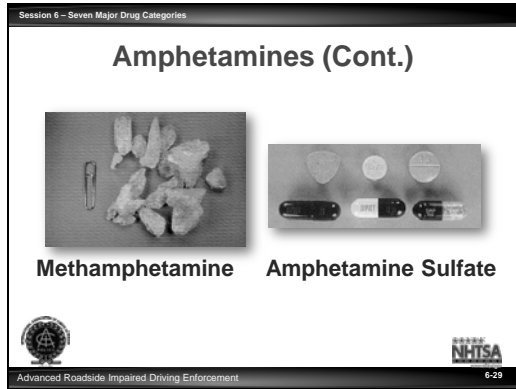
It appears as small white or off-white chunks.



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Amphetamines are usually found in pill form and are legally manufactured for medical use.

Methamphetamine usually has the consistency of brown sugar, can be a variety of different colors, and is primarily produced illegally.



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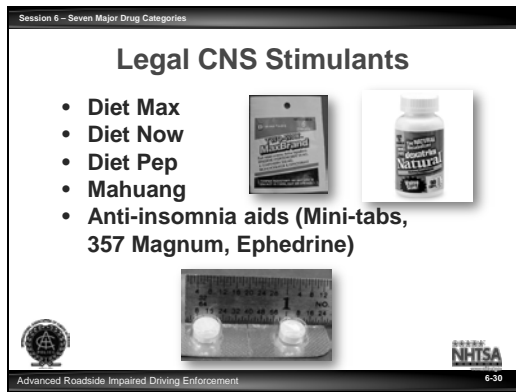
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Ephedrine and pseudoephedrine are also classified as CNS stimulants



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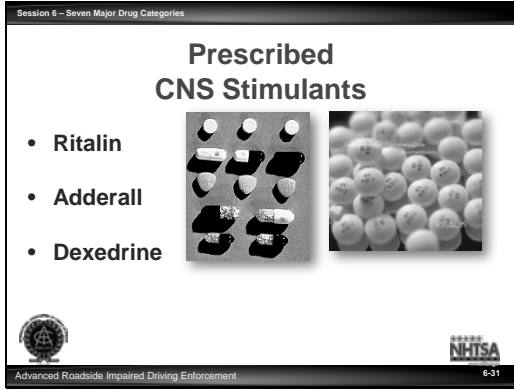
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Ephedrine is often advertised as diet supplements

- Diet Max
- Diet Now
- Diet Pep
- Mahuang
- Anti-insomnia aids (Mini-tabs, 357 Magnum, Efedrin)
- “Natural versions of illegal drugs” (Herbal Ecstasy and Herbal Bliss).  
Pseudoephedrine can be found in a variety of over-the-counter antihistamines, decongestants and cold products, thus making it more accessible
  - Both are usually found in pill form and can be used in the production of methamphetamine.
  - When taken in excess, they have the ability to impair.



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Ritalin, Adderall, and Dexedrine are also classified as CNS stimulants.

These medications allow an individual with attention deficit disorder (ADD) and attention deficit hyperactivity disorder (ADHD) to focus their attention.

These medications have recently become common targets for abuse for participants and professionals who want to obtain a temporary increase in their ability to focus and process information.

Session 6 – Seven Major Drug Categories

### Methods and Signs of Ingestion

- Insufflated
- Injected
- Smoked
- Oral

Advanced Roadside Impaired Driving Enforcement

NHTSA

6-32

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### *Methods and Signs of Ingestion*

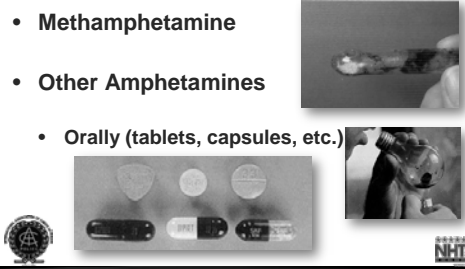
There are many types of stimulants and their form will dictate the method of ingestion.

- Powder cocaine is typically insufflated, but can be injected or smoked.
- To be injected it must be converted to a liquid form. Users will heat the powder in distilled water. The chemicals will combine to form the injectable liquid.
- Crack cocaine is smoked. Crack Cocaine burns very hot, there may be signs of ingestion in the mouth

Session 6 – Seven Major Drug Categories

### Ingesting Stimulants

- Methamphetamine
- Other Amphetamines
- Orally (tablets, capsules, etc.)



Advanced Roadside Impaired Driving Enforcement

NHTSA

6-33

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- Methamphetamines can be snorted, smoked, injected, or taken orally.
- Ephedrine, Pseudoephedrine, Ritalin (pill), Adderall (pill), and Dexedrine (pill and capsule) are primarily taken orally.
- Some schools have reported Ritalin to have been crushed and inhaled by some abusers.



Session 6 – Seven Major Drug Categories

## Ingestion Signs

- Perforated septum
- Powder residue in nasal cavity
- Blisters on lips and tongue
- Raised taste buds
- Injection track marks

Advanced Roadside Impaired Driving Enforcement 6-34

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When a CNS stimulant is taken orally, signs of ingestion may be very limited.

When they are inhaled (as a powder) the septum may be perforated.

When they are inhaled (as a powder) the nasal tissue may be irritated or inflamed.



When they are smoked, the intense heat of the smoke may cause the taste buds to rise, burn marks on the fingers (where the pipe was held), and burn marks on the lips (where the pipe touched the mouth).

Injection marks may be observed as a fresh puncture mark with blood oozing, bruising of the vein (caused by damage to the vein itself), or older marks, which may have dried blood covering the mark.

Session 6 – Seven Major Drug Categories

## Effects of CNS Stimulants

- Euphoria – an extremely pleasurable sensation (while the drug is psychoactive)
- Opposite effect as the drug wears off

Advanced Roadside Impaired Driving Enforcement 6-35

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The main effect of most CNS stimulants is Euphoria – an extremely pleasurable sensation.


This is only true while the high is felt. The user may find an opposite effect as the drug wears off.

While the drug is psychoactive, the user may seem like their system is sped up or in fast forward, (But!), as the drug leaves the system (crashing), this person may appear as though they are under the influence of a CNS depressant or Narcotic Analgesic.

Session 6 – Seven Major Drug Categories

### General Indicators of Impairment

- Restlessness
- Body tremors
- Excited
- Euphoric
- Talkative
- Exaggerated reflexes
- Anxiety



Advanced Roadside Impaired Driving Enforcement 6-36

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*General Indicators*

- Restlessness
- Body tremors
- Excited
- Euphoric
- Talkative
- Exaggerated reflexes
- Anxiety

Session 6 – Seven Major Drug Categories

### General Indicators of Impairment (Cont.)

- Grinding teeth (bruxism)
- Redness to nasal area
- Runny nose
- Loss of appetite
- Increased alertness
- Dry mouth
- Irritability



Advanced Roadside Impaired Driving Enforcement 6-37

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- Grinding teeth (bruxism)
- Redness to nasal area
- Runny nose
- Loss of appetite
- Increased alertness
- Dry mouth
- Irritability

Session 6 – Seven Major Drug Categories

### Eye Indicators

- HGN – Not Present
- VGN – Not Present
- LOC – Not Present
- Pupil Size – Dilated



Advanced Roadside Impaired Driving Enforcement 6-38

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*Eye Indicators / Matrix*

- HGN – Not Present
- VGN – Not Present
- LOC – Not Present
- Pupil Size – Dilated

Session 6 – Seven Major Drug Categories

### Duration of Effects

- Cocaine                    5 – 10 minutes (smoked)  
                                  10 – 15 (injected)  
                                  30 – 90 (snorted)
- Amphetamines        4 – 8 Hours
- Methamphetamines 12 hours
- Ritalin                    Varies
- Adderall                Varies
- Dexedrine              Varies



Advanced Roadside Impaired Driving Enforcement 6-39

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*Duration of Effects*

Cocaine	5 – 10 minutes (smoked) 10 – 15 (injected) 30 – 90 (snorted)
Amphetamines	4 – 8 Hours
Methamphetamines	12 hours
Ritalin, Adderall, Dexedrine	Varies

Session 6 – Seven Major Drug Categories

### Overdose Signs and Symptoms

- Increase in heart rate and blood pressure
- Convulsions
- Increased body temperature
- Hallucinations



Advanced Roadside Impaired Driving Enforcement 6-40

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*Overdose Signs and Symptoms*


Overdose signs and symptoms of a CNS stimulant may include, but are not limited to:

- Possible increase in heart rate or intensity
- Convulsions
- Increased body temperature
- Hallucinations

Session 6 – Seven Major Drug Categories

### Medical Conditions That Mimic CNS Stimulants

- Hyperactivity
- Nervousness
- Stress
- Fear
- Hypertension (high blood pressure)



Advanced Roadside Impaired Driving Enforcement 6-41

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*Conditions that may mimic CNS Stimulant impairment*

There are several conditions that may mimic impairment by a CNS stimulant.

These may be, but are not limited to:

- Hyperactivity
- Nervousness
- Stress
- Fear
- Hypertension (high blood pressure)

Session 6 – Seven Major Drug Categories

### Drug Matrix

	CNS Dep.	CNS Stim.	Hall.	D.A.	NA.A	Inhalant	Cannabis
HGN	Present	None					
VGN	Present	None					
LOC	Present	None					
Pupil Size	Normal *	Dilated					

*\* Soma, Quaaludes, and possibly some Anti-Depressants usually dilate pupils*

Advanced Roadside Impaired Driving Enforcement NHISA 6-42

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## Hallucinogens

Session 6 – Seven Major Drug Categories

### Hallucinogens

- This category causes hallucinations
- Hallucinations are sensory experiences of something that does not exist outside the mind

Advanced Roadside Impaired Driving Enforcement NHISA 6-44

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Hallucination is a sensory experience of something that does not exist outside the mind.

Session 6 – Seven Major Drug Categories

### Hallucinogens (Cont.)

Hallucinations affect a person's:

- Perceptions
- Sensations
- Thinking
- Self-awareness
- Emotional state



Advanced Roadside Impaired Driving Enforcement 6-45

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Hallucinogens affect a person's:

- Perceptions
- Sensations
- Thinking
- Self-awareness
- Emotional state

Session 6 – Seven Major Drug Categories

### Hallucinogens (Cont.)

- An example of a hallucination would be seeing sounds and hearing colors
- This is called Synesthesia: or the transposition of senses



Advanced Roadside Impaired Driving Enforcement 6-46

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The category is classified in this manner because one of the significant effects of these drugs is hallucinations.

An example would be seeing something that does not exist or hearing a color.


This is called Synesthesia – or a transposition of senses.

Session 6 – Seven Major Drug Categories

### Identification of Hallucinogens

Some hallucinogens occur naturally:

- Peyote is a species of cactus containing *mescaline*
- There are numerous mushrooms (psilocybin) capable of inducing hallucinations
- Jimson weed and morning glory seeds
- Toad (*Bufo Alvarius*) releases a hallucinogenic secretion when threatened



Advanced Roadside Impaired Driving Enforcement 6-47

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### Identification of Hallucinogens

Some hallucinogenic drugs occur naturally.

- Peyote - is a species of cactus containing mescaline.
- There are numerous mushrooms (psilocybin) capable of inducing hallucinations.
- Jimson Weed and Morning Glory seeds can also be abused, often with tragic consequences.
- There is also a toad (*Bufo Alvarius*), which releases a hallucinogenic secretion when threatened.

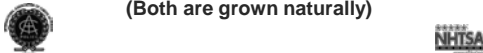
Session 6 – Seven Major Drug Categories

### Common Hallucinogens



Peyote (Mescaline)

Psilocybin  
(Both are grown naturally)



Advanced Roadside Impaired Driving Enforcement 6-48

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### Common Hallucinogens

- Peyote (Mescaline)
- Psilocybin


Note: Both are grown naturally

Session 6 – Seven Major Drug Categories

### Identification of Hallucinogens

Some hallucinogens are synthetically manufactured:

- Lysergic acid Diethylamide (LSD)
- Methylenedioxymethamphetamine (MDMA) or Ecstasy



Advanced Roadside Impaired Driving Enforcement 6-49

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Hallucinogenic drugs are also synthetically manufactured.

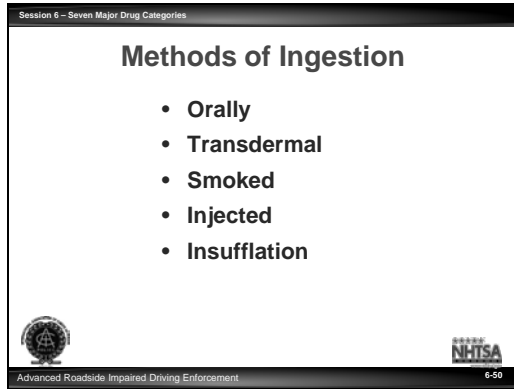
Examples include:

- Lysergic Acid Diethylamide (LSD) liquid can be placed on blotter paper and sold as tabs, or it can be absorbed by sugar cubes or other pills.
- Methylenedioxymethamphetamine (MDMA) or Ecstasy is an example of a synthetically produced hallucinogen.
  - MDMA can be found as a pill or as a powder

A pill press can be used to compress the powder into a pill, which may contain a variety of different shapes or figures.

The use and abuse of Ecstasy has received wide spread attention because of its popularity in the “rave scene” and overdose deaths.





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Many hallucinogens are taken orally.

LSD is absorbed directly either by placing it on the:

- Tongue
- Skin
  - When a substance is absorbed through the skin it is called transdermal absorption.

**Note: Extreme care should be taken when handling suspected LSD blotter paper. LSD can be absorbed through the skin causing unintentional intoxication.**

**Gloves should be worn!**

Substances that are dried and then eaten or brewed as a tea:

- Peyote
- Psilocybin Mushrooms
- Jimson Weed
- Morning Glory seeds

Ecstasy is usually taken orally.

Additionally, users can consume hallucinogens by:



- Smoking
- Injecting
- Insufflation

Since most hallucinogens are taken orally, detecting any signs of ingestion may be difficult.

Session 6 – Seven Major Drug Categories

### Effects of Hallucinogens

- The drug generally intensifies the mood of the user at the time of ingestion.
- If the user is depressed – you could observe a deeper depression
- If the user is feeling pleasant – you could see a heightened pleasure

Advanced Roadside Impaired Driving Enforcement 6-51

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### Effects of Hallucinogens

The user can feel a wide variety of effects when using hallucinogens.

The effects depend on the personality and expectations of the individual as well as the surroundings in which the drug is taken.

The drug generally intensifies the mood of the user at the time of ingestion.

If the user is depressed:

- You could observe a deeper depression



If the user is feeling pleasant

- You could see a heightened pleasure.

Session 6 – Seven Major Drug Categories

### Effects of Hallucinogens (Cont.)

- Hallucinogens can uncover emotional flaws in the user
- Therefore, the user may expect a pleasurable “trip,” but end up instead with a bad “trip”

Advanced Roadside Impaired Driving Enforcement 6-52

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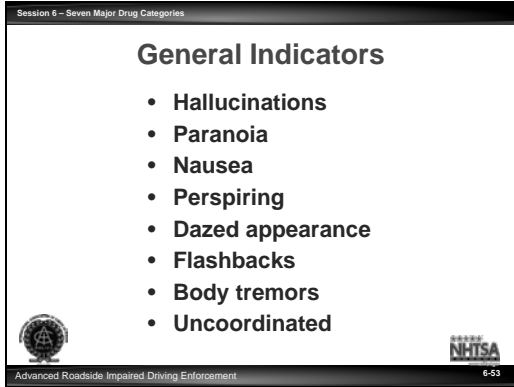
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Hallucinogens can uncover emotional flaws in the user.

Therefore, the user may expect a pleasurable “trip,” but end up instead with a bad “trip.”



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*General Indicators*

Some of the physical, mental, and medical behaviors associated with Hallucinogens are:

- Hallucinations
- Paranoia
- Nausea
- Perspiring
- Dazed appearance
- Flashbacks
- Body tremors
- Uncoordinated


Note: Flashbacks are not believed to be caused by a residual quantity of drug in the user's body, but rather are vivid recollections of a previous hallucinogenic experience.

This can be similar to flashbacks associated with traumatic events.

Session 6 – Seven Major Drug Categories

### General Indicators (Cont.)

- Disoriented
- Memory loss
- Synesthesia (transposing of the senses)
- Difficulty in speech



Advanced Roadside Impaired Driving Enforcement 6-54

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- Disoriented
- Memory Loss
- Synesthesia (mixing of the senses)
- Difficulty in speech

Session 6 – Seven Major Drug Categories

### Eye Indicators

• HGN	Not Present
• VGN	Not Present
• LOC	Not Present
• Pupil Size	Dilated



Advanced Roadside Impaired Driving Enforcement 6-55

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### *Eye Indicators*

- HGN – Not Present
- VGN – Not Present
- LOC – Not Present
- Pupil Size – Dilated

Session 6 – Seven Major Drug Categories

### Duration of Effects

- **LSD**                    **10 to 12 hours**  
                                      Peaks between 4-6 hours
- **Ecstasy**                **1 to 3 hours**
- **Psilocybin**            **2 to 3 hours**
- **Peyote**                 **up to 12 hours**  
                                      Peaks between 3-4 hours



Advanced Roadside Impaired Driving Enforcement      6-56

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- LSD – 10 to 12 hours (Peaks between 4-6 hours)
- Ecstasy – 1 to 3 hours
- Psilocybin – 2 to 3 hours
- Peyote – up to 12 hours (Peaks between 3-4 hours)

Session 6 – Seven Major Drug Categories

### Overdose Signs and Symptoms

The primary overdose symptom for the hallucinogen category is a long and intense “bad trip”



Advanced Roadside Impaired Driving Enforcement      6-57

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The primary overdose symptom for the hallucinogen category is a long and intense “bad trip.”

Session 6 – Seven Major Drug Categories

## Medical Conditions That Mimic Hallucinogen Impairment

- High fever
- Mental illnesses



Advanced Roadside Impaired Driving Enforcement 6-58

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There are two conditions that may mimic impairment by a hallucinogen. These may be, but are not limited to:

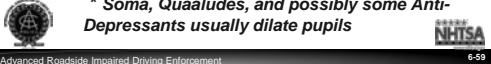
- High fever
- Mental illnesses

Session 6 – Seven Major Drug Categories

## Drug Matrix

	CNS Dep.	CNS Stim.	Hall.	Dissoc Anest.	Narc. Analg	Inhalant	Cannabis
HGN	Present	None	None				
VGN	Present	None	None				
LOC	Present	None	None				
Pupil Size	Normal *	Dilated	Dilated				

*\* Soma, Quaaludes, and possibly some Anti-Depressants usually dilate pupils*



Advanced Roadside Impaired Driving Enforcement 6-59

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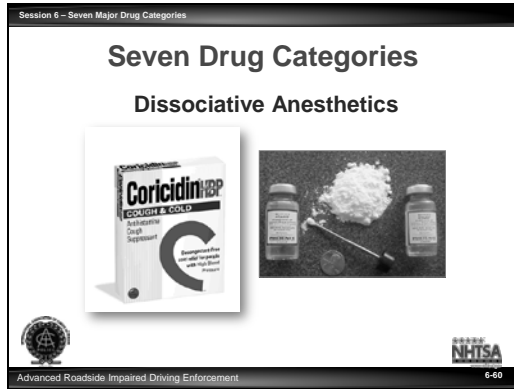
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## Dissociative Anesthetics



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Phencyclidine, along with its analogs, forms a distinct category all by themselves.

The chemical name for PCP is Phenyl Cyclohexyl Piperidine.

An analog of a drug is one with a similar chemical composition.

Analogs have slightly different chemical structures but produce the same effects.

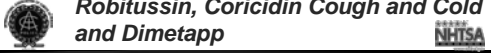
Dissociative Anesthetics symptoms may be confused with individuals under the influence of hallucinogens, stimulants and depressants.

If a thorough assessment is not performed, the examiner may jump to an incorrect conclusion.

Session 6 – Seven Major Drug Categories

### Identification of Dissociative Anesthetics

- PCP was originally manufactured as an intravenous anesthetic - trade name *Sernyl*
- Ketamine (*Ketalar*) is an analog of PCP and is still used in pediatric and animal surgery
- DXM is found in over-the-counter anti-tussive medicines like *Robitussin, Coricidin Cough and Cold and Dimetapp*



Advanced Roadside Impaired Driving Enforcement 6-62

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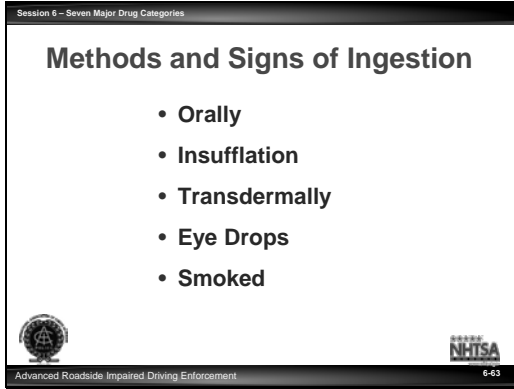
*Identification of Dissociative Anesthetics*

PCP was originally manufactured as an intravenous anesthetic. It was marketed under the trade name of Sernyl.

Although the drug proved to be a very effective anesthetic, it was discontinued for human use in 1967 because of very undesirable side effects.

Ketamine (Ketalar) is an analog of Dissociative Anesthetics and is still used in pediatric and animal surgery.





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*Methods and Signs of Ingestion*

Dissociative Anesthetics ingestion:

- Orally
- Insufflation
- Transdermally
- Eye Drops
- Smoked



Most Common form of ingestion is smoking in cigars, cigarettes, and marijuana

Note: Officer Safety is important. Numerous incidents have been documented where officers have been exposed to the side effects of the drug.

Session 6 – Seven Major Drug Categories

### Effects of Dissociative Anesthetic

- Cut off or distort the brain's perception of the rest of the body's senses (Dissociate)
- Increase the user's pain threshold (Anesthetic)



Advanced Roadside Impaired Driving Enforcement 6-64

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### Effects of Dissociative Anesthetic

The predominant effect of Dissociative Anesthetics is as a dissociative anesthetic. This means Dissociative Anesthetics has the ability to cut off the brain's perception of the rest of the body's senses.

This sense is so strong that many users feel their head is actually separated from their body.

Another, more dangerous, effect of PCP is the user's increased pain threshold.



The user is impervious to the same pain sensations that would typically render an impaired person incapacitated.

One should be extremely cautious when dealing with an individual impaired by PCP.

Session 6 – Seven Major Drug Categories

### General indicators

- Perspiring
- Blank stare
- Cyclic behavior
- Chemical odor
- Increased pain threshold
- Incomplete verbal responses



Advanced Roadside Impaired Driving Enforcement 6-65

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*General Indicators*

- Perspiring
- Blank stare
- Cyclic behavior
- Chemical odor
- Increased pain threshold
- Incomplete verbal responses

Session 6 – Seven Major Drug Categories

### General indicators (Cont.)

- Warm to the touch
- Repetitive speech
- Hallucinations
- Confused
- Possibly violent and combative
- “Moon walking”

Advanced Roadside Impaired Driving Enforcement 6-66

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- Warm to the touch
- Repetitive speech
- Hallucinations
- Confused
- Possibly violent and combative
- “Moon walking”

Session 6 – Seven Major Drug Categories

### Eye Indicators

• HGN	Present
• VGN	Present
• Pupil Size	Normal
• LOC	Present

Advanced Roadside Impaired Driving Enforcement 6-67

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*Eye Indicators*

HGN	Present
VGN	Present
Pupil Size	Normal
LOC	Present

Session 6 – Seven Major Drug Categories

### Duration of Effects

- **PCP**            4 to 6 hours
- **Ketamine**    30-45 minutes (injected)  
                         45-60 minutes (snorted)  
                         1-2 hours (orally)
- **DXM**            3-6 hours



Advanced Roadside Impaired Driving Enforcement      6-68

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*Duration of Effects*

PCP	4 to 6 hours
Ketamine	30 – 45 minutes (injected) 45 – 60 minutes (snorted) 1– 2 hours (orally)
DXM	3-6 hours


The duration of general effects may vary according to dose and whether the drug is injected, snorted, smoked or taken orally.

There is often a prolonged recovery period following the dissipation of the general effects.

Session 6 – Seven Major Drug Categories

### Overdose Signs and Symptom

- **Deep coma lasting up to 12 hours**
- **Seizures and convulsions**
- **Respiratory depression**
- **Magnification of pre-existing cardiac conditions**
- **Possible psychosis**



Advanced Roadside Impaired Driving Enforcement      6-69

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One of the primary overdose symptoms for the Dissociative Anesthetic drug category is a long and intense “trip.”



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### Conditions That May Mimic Drug Impairment

Mental illnesses may mimic impairment by Dissociative Anesthetics.

Session 6 – Seven Major Drug Categories

## Drug Matrix

	CNS Dep.	CNS Stim.	Hall.	Dissoc. Anest.	Narc. Analg.	Inhalant	Cannabis
HGN	Present	None	None	Present			
VGN	Present	None	None	Present			
Pupil Size	Normal*	Dilated	Dilated	Normal			
LOC	Present	None	None	Present			

\* Soma, Quaaludes, and possibly some Anti-Depressants usually dilate pupils

Advanced Roadside Impaired Driving Enforcement

NHTSA

6-71

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### Narcotic Analgesics

Session 6 – Seven Major Drug Categories

## Narcotic Analgesics

**Narcotic Analgesics:**

- Relieve pain
- Induce euphoria, alter moods, and produce sedation
- Known for physically addicting properties and severe withdrawal symptoms



Advanced Roadside Impaired Driving Enforcement 6-73

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### *Narcotic Analgesics*

Drugs in the narcotic analgesics category relieve pain.

They induce euphoria, alter moods, and produce sedation.


Narcotic Analgesics are also included in the opiate family and are legal prescription medications as well as illegal drugs.

This category is known for its physically addicting properties and severe withdrawal symptoms.

Session 6 – Seven Major Drug Categories

## Identification of Narcotic Analgesics

- The most familiar narcotic analgesic is heroin
- Heroin is normally found in powder form
- Heroin's color ranges from white to dark brown (tar colored)



Advanced Roadside Impaired Driving Enforcement 6-74

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### *Identification of Narcotic Analgesics*

The most familiar narcotic analgesic is heroin.

Depending on the purity, heroin may be a white powder to a dark brown powder/tar color.



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Session 6 – Seven Major Drug Categories

### Identification of Narcotic Analgesics

Other narcotic analgesics include:

- Hydrocodone
- Vicodin
- Lortab
- Tylenol 3 (with codeine)
- Buprenorphine
- Morphine
- Oxycontin



Advanced Roadside Impaired Driving Enforcement 6-77

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Other narcotic analgesics include:

- Hydrocodone
- Vicodin
- Lortab
- Tylenol 3 (with codeine)
- Buprenorphine
- Morphine
- Oxycontin

Typically, these are prescription drugs and found in pill form.

The shape, size, or scoring can depend on the manufacturer or milligram strength.

In most cases, narcotic analgesics are obtained in local pharmacies and sold locally

These drugs are inexpensive and frequently prescribed, but nevertheless remain a controlled substance.

Session 6 – Seven Major Drug Categories

## Methods, Signs, and Symptoms

Methods of ingestion vary, depending on the drug used

- Orally in pill form
- Inhaled as a powder
- Injected as a liquid



Advanced Roadside Impaired Driving Enforcement 6-78

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Methods of ingestion vary, depending on the drug used.

They may be taken:

- Orally in pill form
- Inhaled as a powder
- Injected as a liquid



Most of the prescribed pain relievers are found in the pill form, which will be taken orally. If taken orally, signs of ingestion may be limited.

Heroin that is more pure may be inhaled, while heroin that is less pure is typically injected.

Session 6 – Seven Major Drug Categories

### Effects of Narcotic Analgesics

- Usually very addictive
- Addicts who stop using may suffer physical withdrawal symptoms
- Users may develop a tolerance to the drug (Each time the drug is taken, a larger dose is required to achieve the same feeling)



Advanced Roadside Impaired Driving Enforcement 6-79

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### *Effects of Narcotic Analgesics*

- Narcotic analgesics are usually very addictive.
- This means the person must receive a dose of the drug at regular intervals or physical withdrawal may result.
- Narcotic analgesics also enable the person to develop a tolerance to the drug.
- Each time the drug is taken, a larger dose is required to achieve the same feeling.

Session 6 – Seven Major Drug Categories

### General Indicators

- Droopy eyelids
- “On the nod”
- Drowsiness
- Depressed reflexes
- Dry mouth
- Low, raspy, slow speech



Advanced Roadside Impaired Driving Enforcement 6-80

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### General Indicators

- Droopy eyelids
- “On the nod”
- Drowsiness
- Depressed reflexes
- Dry mouth
- Low, raspy, slow speech

Session 6 – Seven Major Drug Categories

### General Indicators (Cont.)

- Euphoria
- Fresh puncture marks
- Itching
- Nausea
- Track marks



Advanced Roadside Impaired Driving Enforcement 6-81

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- Euphoria
- Fresh puncture marks
- Itching
- Nausea
- Track marks

Session 6 – Seven Major Drug Categories

### Eye Indicators

- HGN                      Not Present
- VGN                      Not Present
- Pupil Size              Constricted
- LOC                        Not Present



Advanced Roadside Impaired Driving Enforcement      6-82

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*Eye Indicators*

HGN                      Not Present

VGN                      Not Present


Pupil Size              Constricted

LOC                        Not Present

Session 6 – Seven Major Drug Categories

### Duration of Effects

- Heroin                    4-6 hours
- Hydrocodone            6-8 hours
- Dilaudid                 5 hours
- Percodan                4-6 hours
- Methadone              12-18 hours



Advanced Roadside Impaired Driving Enforcement      6-83

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*Duration of Effects*

The duration of narcotic analgesics can vary from one type to another.

Dosage amounts, age, weight, tolerance, and other variables may dictate the length of actual impairment.

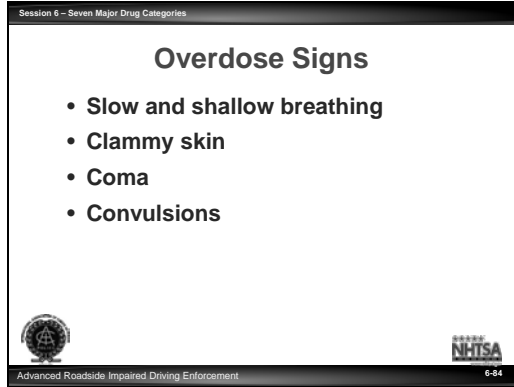
Heroin                              4-6 hours

Hydrocodone                      6-8 hours

Dilaudid                            5 hours

Percodan                            4-6 hours

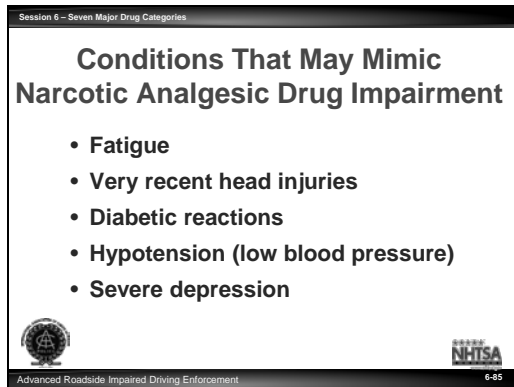
Methadone                        12-18 hours



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Overdose signs and symptoms of a narcotic analgesic may include, but are not limited to:

- Slow and shallow breathing
- Clammy skin
- Coma
- Convulsions



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There are several conditions that may mimic impairment by a narcotic analgesic. These may be, but are not limited to:



- Fatigue
- Very recent head injuries
- Diabetic reactions
- Hypotension (low blood pressure)
- Severe depression

Session 6 – Seven Major Drug Categories

### Drug Matrix

	CNS Dep.	CNS Stim.	Hall.	Dissoc. Anest.	Narc. Analg.	Inhalant	Cannabis
HGN	Present	None	None	Present	None		
VGN	Present	None	None	Present	None		
LOC	Present	None	None	Present	None		
Pupil Size	Normal (1)*	Dilated	Dilated	Normal	Constricted		

*1\*. Soma, Quaaludes and some Anti-Depressants usually dilate pupils*

Advanced Roadside Impaired Driving Enforcement 6-86

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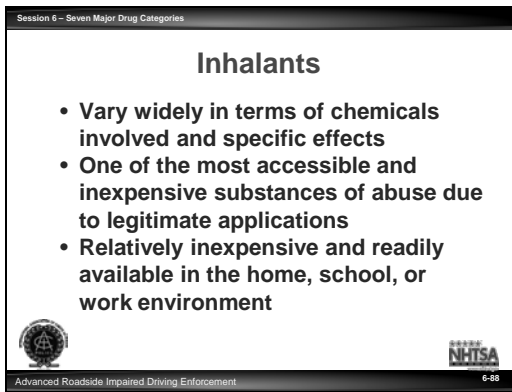
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### Inhalants



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Inhalants vary widely in terms of the chemicals involved and the specific effects they produce.

Inhalants are one of the most accessible and inexpensive substances of abuse due to their legitimate applications.

They are relatively inexpensive as well as readily available in the home, school, or work environment.




Session 6 – Seven Major Drug Categories

### Identification of Inhalants

The three sub-categories of inhalants are:

- Volatile solvents
- Aerosols
- Anesthetic gases



Advanced Roadside Impaired Driving Enforcement 6-89

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There are three major categories of inhalant abuse:


- Volatile solvents
- Aerosols
- Anesthetic gases

Session 6 – Seven Major Drug Categories

### Volatile Solvents

These chemicals are usually inhaled directly from their source:

- Gasoline
- Paint thinners
- Fingernail polish remover
- Cleaning fluid
- Dry erase markers
- Liquid Correction Fluid
- Paint
- Various glues



Advanced Roadside Impaired Driving Enforcement 6-90

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These chemicals are usually inhaled directly from their source.

Some of these include:


- Gasoline
- Paint thinners
- Fingernail polish remover
- Cleaning fluid
- Dry erase markers
- Liquid Correction Fluid
- Paint
- Various glues

Session 6 – Seven Major Drug Categories

### Aerosols

These are usually inhaled from a secondary source such as a:

- Soaked rag
- Paper bag
- Plastic bag



Advanced Roadside Impaired Driving Enforcement 6-91

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These chemicals are discharged from pressurized containers by propellants or compressed gas.

These are usually inhaled from a secondary source such as a:


- Soaked rag
- Paper bag
- Plastic bag

Session 6 – Seven Major Drug Categories

### Aerosols (Cont.)

Some of the commonly abused aerosols include:

- Hair sprays
- Deodorants
- Vegetable frying pan lubricants
- Insecticides
- Spray paint



Advanced Roadside Impaired Driving Enforcement 6-92

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Some of the commonly abused aerosols include:


- Hair sprays
- Deodorants
- Vegetable frying pan lubricants
- Insecticides
- Spray paint

Session 6 – Seven Major Drug Categories

## Anesthetic Gases

Some of the anesthetic gases include:

- Chloroform
- Amyl nitrite
- Butyl nitrite
- Isobutyl nitrite
- Nitrous oxide
  - Whipped cream (gas)



Advanced Roadside Impaired Driving Enforcement

NHTSA

6-93

Notes: \_\_\_\_\_

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This category is the least abused of the three, mainly because of the expense and unavailability.

Anesthetic gases are drugs which allow the user to disassociate pain and are generally used for medical procedures involving surgery.

These can be inhaled from the source directly.


Some of the anesthetic gases include:

- Chloroform
- Amyl nitrite
- Butyl nitrite
- Isobutyl nitrite
- Nitrous oxide
  - Whipped cream (gas)

Session 6 – Seven Major Drug Categories

### Methods and Signs of Ingestion

- Sprayed into an empty soda can and inhaled through the opening in the top
- Sprayed into a balloon and inhaled
- Soaked in a cloth (scrunchies/socks) and placed on the nose/mouth and inhaled



Advanced Roadside Impaired Driving Enforcement 6-94

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*Spray paint and other inhalants:*


- Can be sprayed into an empty soda can and inhaled through the opening in the top
- Sprayed into a balloon and inhaled
- Soaked in a cloth (scrunchies/socks) and placed on the nose/mouth and inhaled

Session 6 – Seven Major Drug Categories

### Methods and Signs of Ingestion

Persons abusing inhalants will frequently have the abused substance on their:

- Hands
- Face
- Mouth



Advanced Roadside Impaired Driving Enforcement 6-95

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Persons abusing inhalants will frequently have the abused substance on their:

- Hands
- Face
- Mouth

Session 6 – Seven Major Drug Categories

### Effects of Inhalants

- The effects of inhalants will vary widely depending on the substance inhaled
- Typically the inhalant abuser will generally appear to be intoxicated on alcohol



Advanced Roadside Impaired Driving Enforcement 6-96

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### *Effects of Inhalants*

The effects of inhalants will vary widely depending on the substance inhaled.



Typically the inhalant abuser will generally appear to be intoxicated on alcohol.

Inhalant abusers can be detected and distinguished from other drug abusers because they will usually carry a chemical odor of the inhaled substance about their breath and person.

Session 6 – Seven Major Drug Categories

### General Indicators

- Confusion
- Flushed face
- Intense headaches
- Bloodshot, watery eyes
- Lack of muscle control
- Odor of substance



Advanced Roadside Impaired Driving Enforcement 6-97

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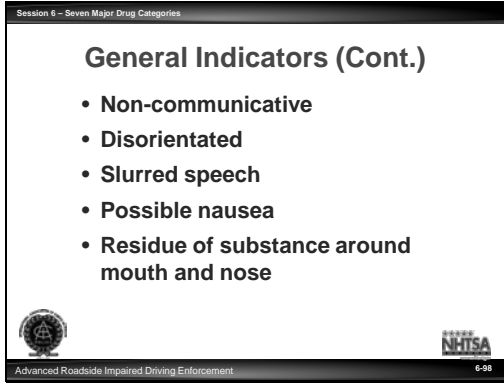
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### *General Indicators*

- Confusion
- Flushed face
- Intense headaches
- Bloodshot, watery eyes
- Lack of muscle control
- Odor of substance



Notes: \_\_\_\_\_

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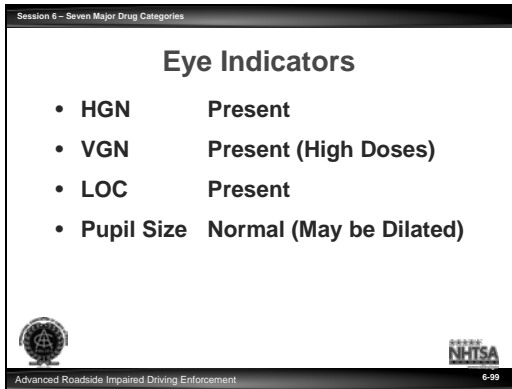
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- Non-communicative
- Disorientated
- Slurred speech
- Possible nausea
- Residue of substance around mouth and nose



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*Eye Indicators*

- HGN Present
- VGN Present (High Doses)
- Pupil Size Normal (May be Dilated)
- LOC Present

Session 6 – Seven Major Drug Categories

### Duration of Effects

- **Volatile Solvents**            **6-8 hours**
- **Anesthetic Gases**            **Very Short**
  - **Nitrous Oxide**            **< 5 Minutes**
  - **Amyl Nitrite/ Butyl Nitrite**    **Few seconds to 20 minutes**



Advanced Roadside Impaired Driving Enforcement    6-100

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*Duration of Effects*


Volatile Solvents	6-8 hours
Anesthetic Gases	Very Short
Nitrous Oxide	< 5 Minutes
Amyl Nitrite/Butyl Nitrite	Few seconds to 20 minutes

Session 6 – Seven Major Drug Categories

### Overdose Signs and Symptoms

The primary overdose signs for inhalants are:

- **Coma**
- **Sudden sniffing death**



Advanced Roadside Impaired Driving Enforcement    6-101

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*Overdose Signs and Symptoms*

The primary overdose sign for an inhalant is coma or “sudden sniffing death.” This is where the individual stops breathing from inhaling a substance. This may occur during the first experience with an inhalant.

Session 6 – Seven Major Drug Categories

## Conditions That May Mimic Drug Impairment

There are two conditions that may mimic inhalant impairment:

- Severe head injuries
- Inner ear disorders / Equilibrium



Advanced Roadside Impaired Driving Enforcement 6-102

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### Conditions That May Mimic Drug Impairment

There are two conditions that may mimic impairment by an Inhalant. These may be, but are not limited to:

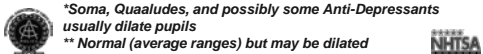
- Severe head injuries
- Inner ear disorders / Equilibrium

Session 6 – Seven Major Drug Categories

## Drug Matrix

	CNS Dep.	CNS Stim.	Hall.	Dissoc. Anest.	Narc. Analg.	Inhalant	Cannabis
HGN	Present	None	None	Present	None	Present	
VGN	Present	None	None	Present	None	Present	
LOC	Present	None	None	Present	None	Present	
Pupil Size	Normal *	Dilated	Dilated	Normal	Constricted	Normal **	

*\*Soma, Quaaludes, and possibly some Anti-Depressants usually dilate pupils*  
*\*\* Normal (average ranges) but may be dilated*



Advanced Roadside Impaired Driving Enforcement 6-103

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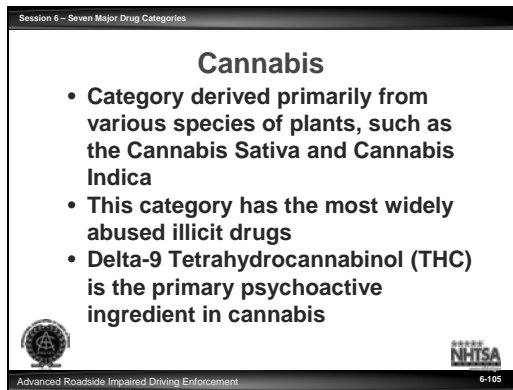
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### Cannabis



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Cannabis is a category of drugs derived primarily from various species of plants, such as the Cannabis Sativa and Cannabis Indica.

The drugs in this category are the most widely abused illicit drugs.

They can be extremely impairing even though they are often believed to be fairly benign.

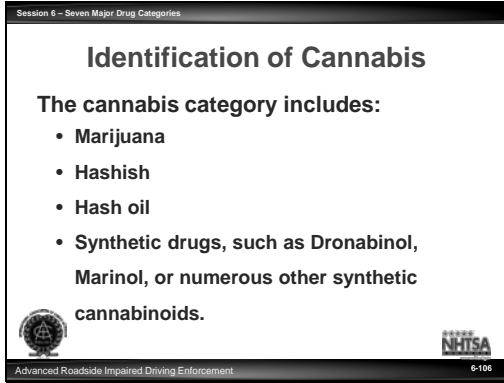
The primary psychoactive ingredient in cannabis is:

- Delta-9 Tetrahydrocannabinol (THC)

THC is found primarily in the leaves and flower of the marijuana plant.

Different varieties of cannabis contain various concentrations of THC.

Marijuana is usually found as green leaves.



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The cannabis category includes:

- Marijuana
- Hash
- Hash oil
- Synthetic drug, such as dronabinol, marinol, or numerous other synthetic cannabinoids.



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Marijuana is the most common and well-known of the drugs in this category, but there are other forms as well.

Session 6 – Seven Major Drug Categories

### Identification of Cannabis

- **Marinol, a synthetic form of cannabis, has a legitimate medicinal use as an anti-vomiting agent, commonly associated with cancer chemotherapy**
- **Other uses for Marinol include treatment of glaucoma or as an appetite enhancer for anorexia disorders**



Advanced Roadside Impaired Driving Enforcement 6-108

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Marinol, a synthetic form of cannabis, has a legitimate medicinal use as an anti-vomiting agent, commonly associated with cancer chemotherapy.


Other forms are used for glaucoma patients or as an appetite enhancer for anorexia disorders.

Session 6 – Seven Major Drug Categories

### Identification of Cannabis (Cont.)

The effects of cannabis depend on the strength of the THC in the dose consumed.

- **THC concentrations decades ago, peaked at relatively low levels (3-6 %).**
- **Current levels are being reported at more than 30%**



Advanced Roadside Impaired Driving Enforcement 6-109

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The effects of cannabis depend on the strength of the THC in the dose consumed.

THC concentrations decades ago, peaked at relatively low levels (3-6 %), however, current levels are being reported at more than 30%.

The increase in THC levels is due to hybridization and better cultivation techniques used by producers.

There are several chemicals in marijuana smoke.

Some of these chemicals are water soluble (meaning they combine with the water) and some are not (THC).



Session 6 – Seven Major Drug Categories

### Methods and Signs of Ingestion

Marijuana is usually rolled into cigarettes and smoked

- Since these cigarettes lack a filter, small bits and pieces of marijuana debris may be found stuck between the teeth of the user
- Burn marks may be found on the thumb and index finger

The user may also use a “water pipe” or “bong” to smoke

Advanced Roadside Impaired Driving Enforcement 6-110

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Marijuana is usually rolled into cigarettes and smoked.

Since these cigarettes lack a filter, small bits and pieces of marijuana debris may be found stuck between the teeth of the user.

Burn marks may be found on the thumb and index finger.

The user may also use a “water pipe” or “bong” to smoke marijuana.



- By passing the marijuana smoke through the water, the smoke is not only more pure, but also cooler.

Session 6 – Seven Major Drug Categories

### Effects of Cannabis

People under the influence of cannabis may display:

- Brief attention span
- Divided attention impairment

Advanced Roadside Impaired Driving Enforcement 6-111

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*Effects of Cannabis*

People under the influence of cannabis may not to be able to:

- Pay attention
- May have a very brief attention span.


The subjective effects can vary considerably, but they will exhibit divided attention impairment.

The consequences of this in the classroom may be obvious, but the consequences when driving can be fatal.

Session 6 – Seven Major Drug Categories

### General Indicators

- Marked reddening of the conjunctiva
- Odor of marijuana
- Marijuana debris in the mouth
- Body tremors
- Increased appetite



Advanced Roadside Impaired Driving Enforcement 6-112

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### General Indicators

- Marked reddening of the conjunctiva
- Odor of marijuana
- Marijuana debris in the mouth
- Body tremors
- Increased appetite

Session 6 – Seven Major Drug Categories

### General Indicators (Cont.)

- Relaxed inhibitions
- Disoriented
- Possible paranoia
- Impaired perception of time and distance
- Eyelid tremors



Advanced Roadside Impaired Driving Enforcement 6-113

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- Relaxed inhibitions
- Disoriented
- Possible paranoia
- Impaired perception of time and distance
- Eyelid tremors

Session 6 – Seven Major Drug Categories

### Eye Indicators

- HGN            Not Present
- VGN            Not Present
- LOC            Present
- Pupil Size    Dilated (May be normal)



Advanced Roadside Impaired Driving Enforcement      6-114

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*Eye Indicators*

HGN                                  Not Present

VGN                                  Not Present

Pupil Size                          Dilated (May be normal)


LOC                                    Present

Session 6 – Seven Major Drug Categories

### Duration of Effects

**Marijuana**

- Peak                                  10-30 minutes
- Duration                              2-3 hours
- Dissipates                            3-5 hours
- Residual Effects                    Up to 24 hours



Advanced Roadside Impaired Driving Enforcement      6-115

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*Duration of Effects*

When marijuana is smoked, the user will experience peak effects

- Within 10 to 30 minutes.

Typical marijuana users usually exhibit the effects for 2 to 3 hours, with most behavioral and physiological effects dissipating after 3-5 hours.


Some research suggests that residual effects can impact specific behaviors for up to 24 hours.

Session 6 – Seven Major Drug Categories

### Duration of Effects

**Dronabinol/Marinol**

- Onset                      30-60 minutes
- Peak                        2-4 hours
- Appetite Stimulant      Up to 24 hours



Advanced Roadside Impaired Driving Enforcement      6-116

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Dronabinol has an onset of 30 minutes to 1 hour with peak effects occurring between 2 and 4 hours.


It can stimulate appetite for up to 24 hours

Session 6 – Seven Major Drug Categories

### Overdose Signs and Symptoms

Overdose signs and symptoms may include, but are not limited to:

- Paranoia
- Fatigue



Advanced Roadside Impaired Driving Enforcement      6-117

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Overdose signs and symptoms of cannabis may include, but are not limited to:

- Paranoia
- Fatigue

Generally speaking, cannabis impairment will not be confused with any other medical condition as noted in the other drug categories.



However, a person diagnosed with an attention deficit disorder may mimic a cannabis user's inability or unwillingness to pay attention.

Session 6 – Seven Major Drug Categories

### Drug Matrix

	CNS Dep.	CNS Stim.	Hall.	Dissoc. Anest.	Narc. Analg.	Inhalant	Cannabis
HGN	Present	None	None	Present	None	Present	None
VGN	Present	None	None	Present	None	Present	None
LOC	Present	None	None	Present	None	Present	Present
Pupil Size	Normal *	Dilated	Dilated	Normal	Constricted	Normal **	Dilated ***

*\*Soma, Quaaludes, and possibly some Anti-Depressants usually dilate pupils*  
*\*\*Normal (average range) but may be dilated*  
*\*\*\*Dilated, may be normal (average range)*



Advanced Roadside Impaired Driving Enforcement 6-118

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### Drug Matrix

Session 6 – Seven Major Drug Categories

# QUESTIONS?



Advanced Roadside Impaired Driving Enforcement 6-119

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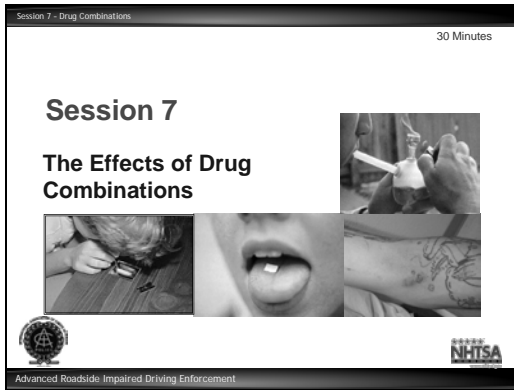
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## Participant Manual ARIDE - Session 7 – The Effects of Drug Combinations



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Session 7 – Drug Combinations

### Learning Objectives

- Describe the prevalence of drug and alcohol use (individually and in combination) as well as poly drug use
- Define poly drug use
- Articulate possible effects of poly drug use related to the general indicators of alcohol and drugs



Advanced Roadside Impaired Driving Enforcement 7-2

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Upon successful completion of this Session the participant will be able to:

- Describe the prevalence of drug and alcohol use (individually and in combination) as well as poly drug use.
- Define poly drug use.
- Articulate possible effects of poly drug use related to the general indicators of alcohol and drugs.

**Content Segments**

- A. Prevalence of drug and alcohol use
- B. Research on poly drug use
- C. Potential effects of poly drug
- D. Types of drug combinations
- E. Combinations including alcohol


**Learning Activities**

- Instructor-Led Presentation
  
  
  
  
  
- Instructor-Led Presentation

Session 7 - Drug Combinations

### Prevalence of Drug and Alcohol Use

- In 2010 approximately 7 million people aged 12 years or older used psychotherapeutic drugs non-medically (NSDUH, 2010)



Advanced Roadside Impaired Driving Enforcement

NHTSA

7-3

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#### **A. Prevalence of Drug and Alcohol Use**

- In 2010, approximately 7 million people aged 12 years or older used psychotherapeutic drugs non-medically.  
*Source: National Survey on Drug Use and Health (NSDUH, 2010).*
- The exact number of prescription drug users in the U.S. is unknown. However, in 2011 a record 4 billion drug prescriptions were written in the U.S.  
*Source: Medical News Today, September 18, 2012.*
- Among those aged 50 to 59, the rate of past month illicit drug use increased from 2.7 percent in 2002 to 5.8 percent in 2010. This trend may partially reflect the aging into this age group of the "Baby Boomer" generation, whose lifetime rate of illicit drug use is higher than those of older cohorts.
- Approximately 6.0 million Americans abuse prescription drugs each year.  
*Source: NSDUH Report, 2010.*
- In 2010, 10.6 million persons aged 12 or older reported driving under the influence of illicit drugs during the past year. This corresponds to 4.0 percent of the population aged 12 or older. In 2010, the rate was highest among young adults aged 18 to 25 (12.7 percent).

Session 7 - Drug Combinations

### Prevalence of Drug and Alcohol Use (Cont.)

- Alcohol is the most popular "mixer" with other drugs
- Cannabis is another popular "mixer", and frequently shows up in combination with Cocaine, PCP, and various other drugs
- The "speedball", a combination of Cocaine and Heroin, remains popular



Advanced Roadside Impaired Driving Enforcement 7-5

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- Research has shown that Alcohol is the most popular "mixer" with other drugs.
- Cannabis is another popular "mixer", and frequently shows up in combination with Cocaine, Dissociative Anesthetics, and various other drugs.
- The "speedball", a combination of Cocaine and Heroin, remains popular

Law enforcement officers should not be surprised to encounter virtually any possible combination of drugs.

Law enforcement officers may find more poly-drug users than single drug users.


This means that if the law enforcement officer is to do a good job at interpreting the results of observations, they must understand the basic mechanisms of drug interaction.

This session will help the participant understand the effects of poly-drug use.

Session 7 - Drug Combinations

### Poly Drug Use

- When a person ingests two or more drug categories into their body, each drug works independently
- The body will exhibit a combination of these effects



Advanced Roadside Impaired Driving Enforcement 1-4

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### **B. Define Poly Drug Use**

Poly Drug Use: When a person ingests two or more different drug categories.

Session 7 – Drug Combinations

### Potential Effects of Poly Drug Use

Four types of combined effects can, and generally will, occur when two drug categories are used together:

- Null Effect
- Overlapping Effect
- Additive Effect
- Antagonistic Effect

Advanced Roadside Impaired Driving Enforcement 7-6

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### **C. Potential Effects of Poly Drug Use**

Four types of combined effects can, and generally will occur when two or more drug categories are used together:

- Null Effect
- Overlapping Effect
- Additive Effect
- Antagonistic Effect

Session 7 - Drug Combinations

### Null Effect

If neither drug affects some particular indicator of impairment, their combination also will not affect that behavior

Nothing + Nothing = Nothing

Advanced Roadside Impaired Driving Enforcement 7-7

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## D. Types of Drug Combinations

### *Null Effect*

The simplest way to explain the null effect is using the phrase: "zero plus zero equals zero"

When a subject consumes one drug which does not cause HGN and they also ingest another drug which does not cause HGN, then the officer should not expect to see HGN.

Another example of the null effect is the pupil size of a suspect who was under the influence of Dissociative Anesthetic and a CNS Depressant.

Dissociative Anesthetics do not affect pupil size and neither do CNS Depressants. The combination of these drugs should not affect the size of the pupils.

If neither drug affects some particular indicator of impairment, then their combination also will not affect that indicator.

Session 7 - Drug Combinations

### Overlapping Effect

If one drug affects some particular indicator of impairment and another does not, their combination also will affect that behavior.

Action + Nothing = Action

Advanced Roadside Impaired Driving Enforcement 7-8

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### *Overlapping Effect*

The overlapping effect comes into play when one drug does affect an indicator of impairment and the other drug has no effect on that indicator.

Session 7 - Drug Combinations



### Overlapping Effect Examples

Narcotic Analgesics typically cause:

- HGN - Not present
- VGN – Not present
- Pupil Size – Constricted
- LOC – Not present

CNS Depressants typically cause:

- HGN - Present
- VGN – Possibly Present
- Pupil Size – Normal (Average range)
- LOC – Present



Advanced Roadside Impaired Driving Enforcement 7-9

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### *Overlapping Effect Examples*

Examples:

Narcotic Analgesics typically cause:

- HGN - Not present
- VGN – Not present
- Pupil Size – Constricted
- LOC – Not present

CNS Depressants typically cause:


- HGN - Present
  - VGN – Possibly Present
- Note: VGN is present in high doses.
- Pupil Size – Normal (Average range)
  - LOC – Present

Session 7 - Drug Combinations

### Likely Effects of the Combination

- HGN - Present
- VGN - Possibly Present
- Pupil Size - Constricted
- LOC - Present

**Action** + **Nothing** = **Action**



Advanced Roadside Impaired Driving Enforcement 7-10

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The specific combination of a CNS Depressant and Narcotic Analgesic can present four different overlapping effects:

- HGN - Present
- VGN - Possibly Present
- Pupil Size - Constricted
- LOC - Present


Action plus nothing equals action.

Session 7 - Drug Combinations

### Additive Effect

If both drugs affect some particular indicator of impairment, their combination also will affect that behavior.

**Action** + **Action** = **Greater Action**



Advanced Roadside Impaired Driving Enforcement 7-11

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### *Additive Effect*

The additive effect occurs when two drug categories affect the same indicator in the same way.

In other words, the effects 'add together' or reinforce each other to produce a greater effect than one of the drugs could produce individually.





Session 7 - Drug Combinations

### Likely Effects of Combination Depressant and Inhalant

- Both cause HGN and VGN
- Expect to see more clues or more pronounced HGN and/or VGN than seen with an individual under the influence of either a depressant or an inhalant alone

**Action** + **Action** = **Greater Action**



Advanced Roadside Impaired Driving Enforcement 7-12

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If an officer observes general indicators related to a depressant and an inhalant:

- Both cause HGN and VGN.
- We might expect to see more clues or more pronounced HGN and/or VGN than we might see with an individual under the influence of either a depressant or an inhalant alone.

The simplest way to explain the additive effect is to say "action plus action equals greater action".

One thing we can't say for certain is how much the two drugs will reinforce each other.

Sometimes the reinforced effect is as simple as "one plus one equals two", while other drug combinations may produce a combined effect, which is greater than the individual combinations of the two drugs

"one plus one equals five"

For the purpose of this course, we use the term additive effect to cover all situations where two drugs impact an indicator in the same way.

Session 7 – Drug Combinations



### Additive Effect Examples

Alcohol typically causes:

- HGN – Present
- VGN – Possibly present
- Pupil Size – Normal (Average range)
- LOC – Present

CNS Depressants typically cause:

- HGN – Present
- VGN – Possibly present
- Pupil Size – Normal (Average range)
- LOC – Present



Advanced Roadside Impaired Driving Enforcement 7-13

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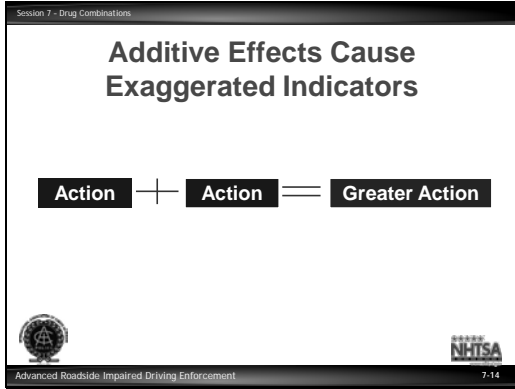
*Additive Effect Examples*

Alcohol typically causes:

- HGN – Present
- VGN – Possibly present
- Pupil Size – Normal (Average range)
- LOC – Present

CNS Depressants typically cause:

- HGN – Present
- VGN – Possibly present
- Pupil Size – Normal (Average range)
- LOC – Present



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The additive effects may cause the indicators to be exaggerated.

Action + Action = Greater Action

Note: Pupils may be dilated. What you see with HGN usually will not be consistent with the BAC.

Note: VGN usually will not be present unless it's a high dose for that individual. The combination may allow the VGN to be observed at a low BAC.

Session 7 - Drug Combinations

### Antagonistic Effect

When two drugs affect some indicator in exactly the opposite way, their combination will be unknown

**Action** + **Opposite Action** = **Unknown**

Effects will be dependant on which drug is more dominant in the system at any given time

Advanced Roadside Impaired Driving Enforcement 7-15

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### *Antagonistic Effect*

An antagonistic effect occurs when two drug categories affect an indicator in exactly the opposite ways.

For example:

- Stimulant use results in dilated pupils while narcotic analgesics cause the pupils to be constricted.
- An officer may observe normal, constricted, or dilated pupils due to the antagonistic effect.

When we deal with an antagonistic effect, we cannot always predict the outcome effect.

The effects that you will see will be dependent on which drug is more dominant in the system at any given time.

Example:

- If the stimulant is the psychoactive drug in the system, the pupils may be dilated.
- If the narcotic analgesic is more psychoactive drug, the pupils may be constricted.
- If the drugs are acting on the system in an equal manner you may see normal (Average range) pupils.


”Action plus opposite action may be unpredictable”

Session 7 - Drug Combinations

### Summary

The actual effects can depend on a number of factors including, but not limited to:

- Dose levels
- Time of ingestion
- An individual's metabolism



Advanced Roadside Impaired Driving Enforcement 7-16

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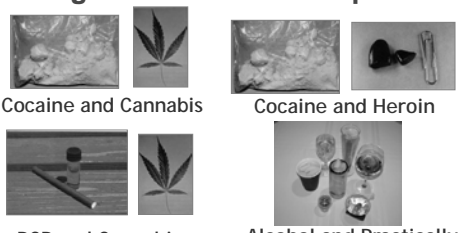
### Summary

The actual effects can depend on a number of factors including, but not limited to:

- Dose levels
- Time of ingestion
- A subject's metabolism


Session 7 - Drug Combinations

### Drug Combination Examples



Cocaine and Cannabis      Cocaine and Heroin

PCP and Cannabis      Alcohol and Practically Anything Else



Advanced Roadside Impaired Driving Enforcement 7-17

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### **E. Combinations Including Alcohol**

In order to illustrate the possible effects of drug combinations, the following examples we will show a cumulative drug symptomatology matrix for two different drug combinations.

Session 7 - Drug Combinations

### Combination Dissociative Anesthetic and Narcotic Analgesic

Impairment Indicator	Effect due to Dissociative Anesthetic	Effect due to Narcotic Analgesic	Type of Combined Effect	What we will see
HGN	Present	None	Overlapping	Present
VGN	Present	None	Overlapping	Present
LOC	Present	None	Overlapping	Present
Pupil size	Normal	Constricted	Overlapping	Constricted



Advanced Roadside Impaired Driving Enforcement 7-18

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Session 7 - Drug Combinations

### Combination Cannabis and Stimulant

Impairment Indicator	Effect Due to Cannabis	Effect Due to Stimulant	Type of Combined Effect	What we will see
HGN	None	None	Null	None
VGN	None	None	Null	None
LOC	Present	None	Overlapping	Present
Pupil size	Dilated or Normal	Dilated	Overlapping	Dilated



Advanced Roadside Impaired Driving Enforcement 7-19

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Session 7 - Drug Combinations

# QUESTIONS?



Advanced Roadside Impaired Driving Enforcement 7-20

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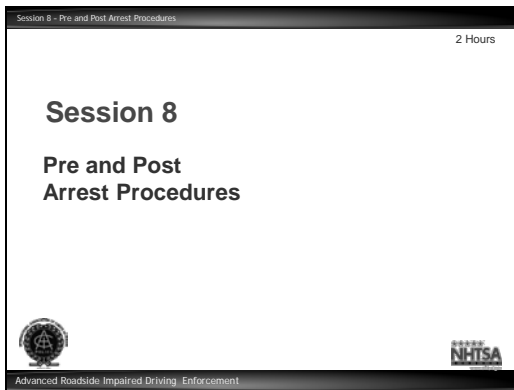
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## ARIDE Participant Manual – Session 8 Pre and Post Arrest Procedures



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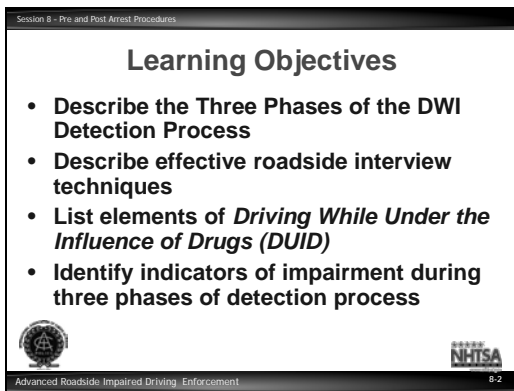
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Upon completion of this session participants will be able to:

- Describe the three phases of the detection process: Vehicle in Motion, Personal Contact and Pre-Arrest Screening
- Describe effective roadside interview techniques
- List the elements of the offense of DUID
- Identify the indicators of impairment observed during the three phases of the detection process

Session 8 - Pre and Post Arrest Procedures

### Learning Objectives (Cont.)

- Accurately document, in sequence, observed impairment in each of the three phases of the detection process
- Identify additional resources to support prosecution
- Articulate relevant evidence as it relates to case preparation and prosecution



Advanced Roadside Impaired Driving Enforcement 8-3

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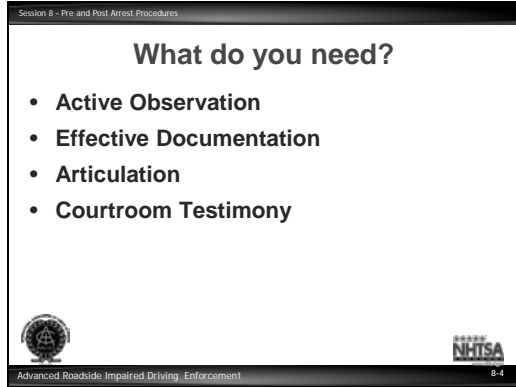
- Accurately document, in the proper event sequence order, observed impairment in each of the three phases of the detection process
- Identify additional resources to support prosecution
- Articulate relevant evidence as it relates to case preparation and prosecution

**Content Segments**

**Learning Activities**

A. What is DWI Detection?	Instructor-Led Presentation
B. Three phases of the detection process	Instructor-Led Presentation
C. Effective roadside interview techniques	Instructor-Led Presentation and Student Practice Session
D. Identifying and documenting observed indicators of impairment	Instructor-Led Presentation and Student Practice Session
E. Case studies and scenarios	Student Practical Exercise
F. Case preparation and prosecution	Instructor-Led Presentation and Student Practice Session





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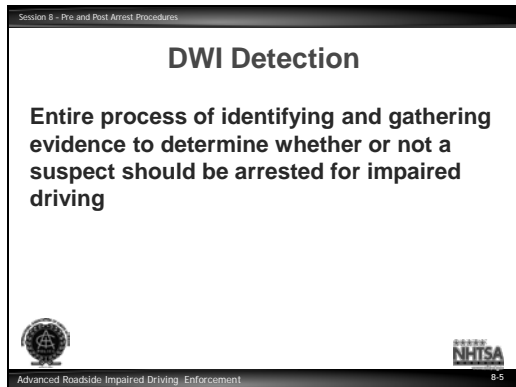
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Although this course is designed to make the Participant aware of: impairment of drugs, alcohol or a combination of drugs and alcohol, the mission is also to reinforce skills which, taught in previous courses dealing with:

- Active Observation
- Effective Documentation
- Articulation
- Courtroom Testimony

To effectively gather and present the collective evidence as part of a DWI arrest and prosecution, the law enforcement officer, prosecutor and other supporting professionals must consider information in terms of the totality of the evidence.



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**A. What is DWI Detection?**


DWI detection will be defined as:

“The entire process of identifying and gathering evidence to determine whether or not a suspect should be arrested for impaired driving attributed to alcohol, drug or a combination of alcohol and drugs.”

Session 8 - Pre and Post Arrest Procedures

### Three Phases

- Vehicle in Motion
- Personal Contact
- Pre-Arrest Screening



Advanced Roadside Impaired Driving Enforcement 8-6

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### **B. Three Phases of the Detection Process**

We will look at the collection and articulation of evidence in terms of the three phases of DWI detection.

- Vehicle in Motion
- Personal Contact
- Pre-Arrest Screening

Session 8 - Pre and Post Arrest Procedures


### The Detection Process

**When does it begin?**

- What draws your attention to a vehicle?

**When does it end?**

- What do you base the arrest decision on?



Advanced Roadside Impaired Driving Enforcement 8-7

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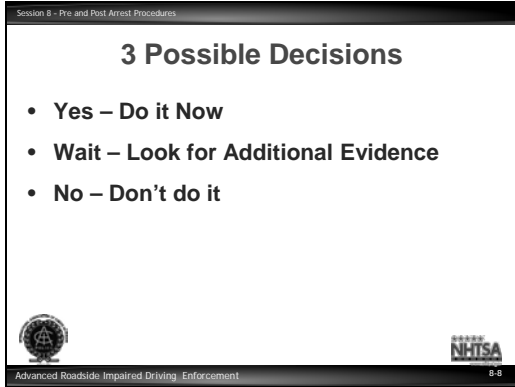
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The detection process:

- Yes - Do it now
- Wait - Look for additional evidence
- No - Don't do it

When does it begin?

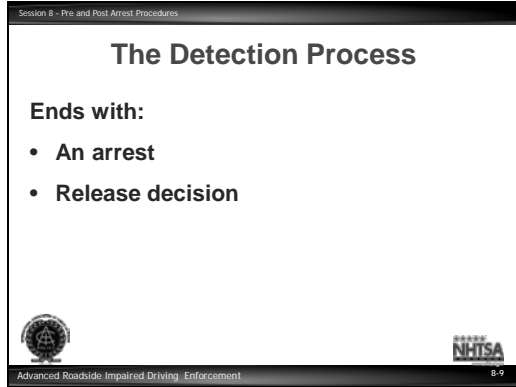
- When the law enforcement officer attention is first drawn to a vehicle.

The detection process ends when the officer decides that there is or there is not sufficient probable cause to arrest the suspect for DWI.

The officer's attention may be drawn to a particular vehicle or individual for a variety of reasons.

The precipitating event may be a loud noise; an equipment or moving violation; behavior that is unusual, but not necessarily illegal; or almost anything else.

Initial detection may or may not carry with it a suspicion that the driver is impaired.



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The detection process ends with:

- An Arrest
- Release Decision

That decision, should ideally, be based on:

- The totality of the evidence collected throughout each of the three phases.

However, situations and circumstances may vary in a manner that could preclude the completion of all three phases.

*Examples of these circumstances would be:*

- Police pursuits
- Motorist assists
- Vehicle crashes
- Traffic direction
- Sobriety Checkpoints


Law enforcement officers should not leap to the arrest/no arrest decision, but rather proceed carefully through each of the three phases when possible.

This process helps to identify all the available evidence needed to make an arrest decision.

Session 8 - Pre and Post Arrest Procedures

### Phase I: Vehicle in Motion

- What do you observe?
- What is the standard?
- What do you do?
- When might Phase I not occur?



Advanced Roadside Impaired Driving Enforcement 8-10

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*Phase I: Vehicle in Motion*

In Phase One, you usually observe the driver operating the vehicle.

Session 8 - Pre and Post Arrest Procedures

### Phase II: Personal Contact

- What do you observe?
- What do you do?
- When might Phase II not occur?



Advanced Roadside Impaired Driving Enforcement 8-11

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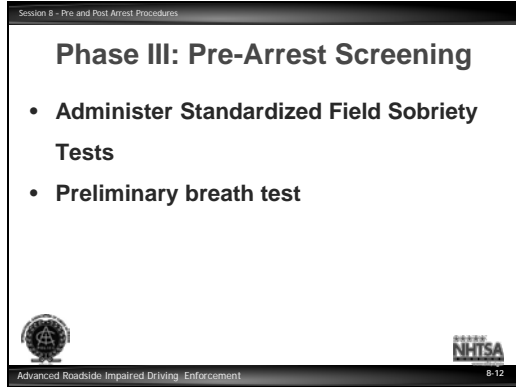
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*Phase II: Personal Contact*

In Phase Two, after you have stopped the vehicle, there usually is an opportunity to observe and speak with the driver face-to-face.

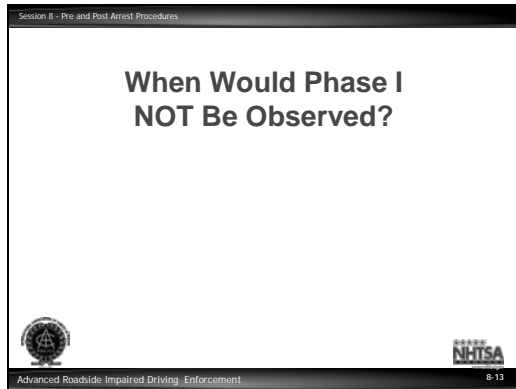


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### Phase III: Pre-Arrest Screening

In Phase Three, you usually have an opportunity to administer the Standardized Field Sobriety Tests (SFSTs) to the driver to evaluate whether there is any degree of impairment.

You may, depending upon your agency policies and state laws, administer a preliminary breath test in addition to SFSTs to verify that alcohol is or is not the cause or a contributing factor of the impairment.

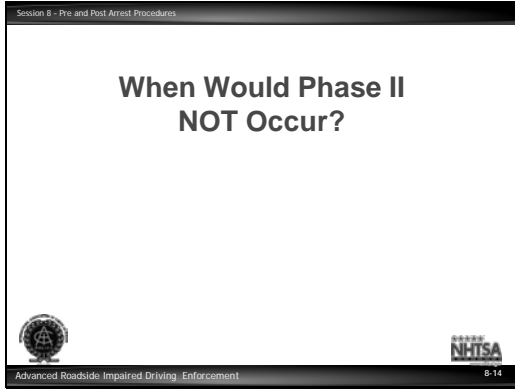


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The DWI detection process does not always include all three phases. Sometimes DWI detection occurs when Phase One is absent, such as, cases in which you have no opportunity to observe the vehicle in motion.

Examples include:

- Crashes
- Sobriety checkpoint
- Motorist assistance

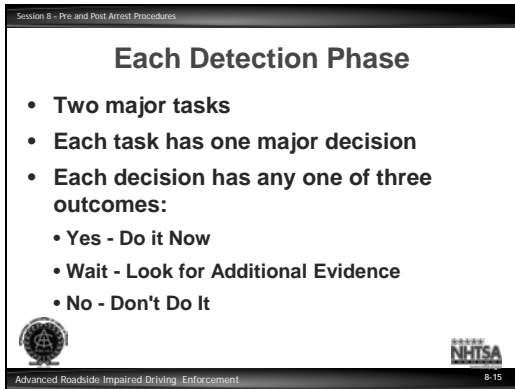


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Sometimes there are situations when Phase Two does not occur.

Examples include:

- Crashes where drivers are transported to the hospital and significant time passes before an investigating officer makes contact with the driver.



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Each detection phase usually involves two major tasks and one major decision. Each of the major decisions can have any one of three different outcomes:

- Yes - Do it Now
- Wait - Look for Additional Evidence
- No - Don't Do It

Session 8 - Pre and Post Arrest Procedures

### Phase I - Task One

- Observe the vehicle in motion
- Decision point: *Is there reasonable suspicion to stop the vehicle?*



Advanced Roadside Impaired Driving Enforcement 8-16

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**Phase One:**


- Task 1 Observe the vehicle in operation.

Decision Point: *Is there reasonable suspicion to stop the vehicle?*

Session 8 - Pre and Post Arrest Procedures

### Phase I - Task Two

- Continue to observe the vehicle and the stopping sequence
- Decision point: *Is there reasonable suspicion to stop the vehicle?*



Advanced Roadside Impaired Driving Enforcement 8-17

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**Phase One:**

- Task 2 Continue to observe the vehicle and the stopping sequence.


Decision point: *Is there reasonable suspicion to stop the vehicle?*



Session 8 - Pre and Post Arrest Procedures

### Phase II - Task One

- Observe and interview the driver face-to-face
- Decision point: *Should you instruct the driver to step from the vehicle for further investigation?*



Advanced Roadside Impaired Driving Enforcement 8-18

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### Phase Two:

- Task 1: Observe and interview the driver face-to-face.


Note: Officer should follow their departmental policy governing traffic stops and investigations.

*Decision Point: Should you instruct the driver to step from the vehicle for further investigation*

Session 8 - Pre and Post Arrest Procedures

### Phase II - Task Two

- Observe the driver's exit and walk from the vehicle
- Decision point: *Is there sufficient probable cause to test the driver for DWI?*



Advanced Roadside Impaired Driving Enforcement 8-19

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- Task 2: Observe the driver's exit and walk from the vehicle.

*Decision Point: Is there sufficient probable cause to test the driver for DWI?*

Session 8 – Pre and Post Arrest Procedures

### Phase III – Task One

- Administer psychophysical tests
- Decision point: *Is there sufficient probable cause to arrest the driver for DWI?*



Advanced Roadside Impaired Driving Enforcement 8-20

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### Phase Three:


Task 1: Administer psychophysical tests.

- Decision Point: Is there sufficient probable cause to arrest the driver for DWI?

Session 8 – Pre and Post Arrest Procedures

### Phase III – Task Two

- Arrange for or administer a preliminary breath test
  - What do you observe?
    - SFST
    - HGN, VGN, WAT, OLS
    - Other Tests/Observations
    - Modified Romberg Balance, LOC, Pupil size
- Decision point: *Is there sufficient probable cause to arrest the driver for DWI?*



Advanced Roadside Impaired Driving Enforcement 8-21

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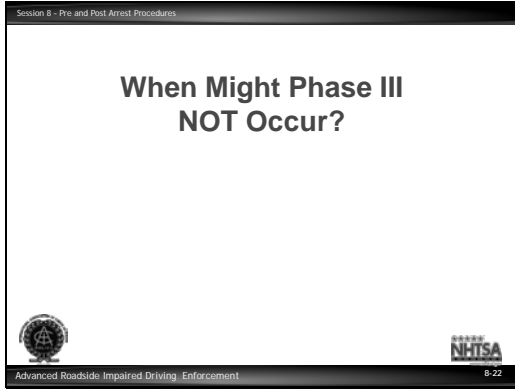
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Task 2: Arrange for or administer a preliminary breath test.

What do you observe?

- SFST
- HGN, VGN, WAT, OLS
- Other Tests/Observations
- Modified Romberg Balance, LOC, Pupil size
- Decision point: Is there sufficient probable cause to arrest the driver for DWI?
- What do you do?



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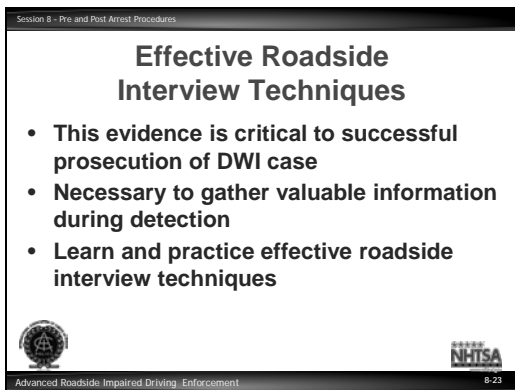
Sometimes there are situations when Phase Three does not occur.

- There are cases in which you would not or could not administer SFSTs to the driver.

Note: This decision is made by the officer.

Examples include:

- Driver is impaired to the point they are unable to safely complete the tests
- Injured to the extent they are unable to complete the tests
- Refuses to submit to tests
- Circumstances or other conditions that do not allow for the safe administration of SFSTs



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**C. Effective Roadside Interview Techniques**


This evidence is critical to the successful prosecution of DWI case.

In order for the law enforcement officer to gather valuable information during the detection process, they must learn and practice effective roadside interview techniques.

Session 8 - Pre and Post Arrest Procedures

### What You Say

- **Communication style**
- **Tailor questioning speed and tone to the situation and circumstances**



Advanced Roadside Impaired Driving Enforcement 8-24

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*What you say: Word choice, communication style*

Example: crash or accident

Note: You should tailor your word choices to the situation or circumstances that exist at the time.

*Communication style*


Example: The rate of the questioning, tone of your voice.

Note: You should tailor the speed and tone of questioning to the situation and circumstances at the time.

Session 8 - Pre and Post Arrest Procedures

### What You Do

- **Physical positioning, demeanor - avoid an over bearing posture or stance**
- **Goal: encourage cooperation**
- **Facilitate open dialog**
- **Develop a good rapport with the subject**



Advanced Roadside Impaired Driving Enforcement 8-25

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*What you do: Physical positioning, demeanor*

Physical Positioning example: Keeping officer safety in mind, avoid an over bearing posture or stance.


Demeanor example: maintain professionalism, facilitate open dialog.

Note: Ask questions that will place them at ease. Allow them to talk about themselves. Develop a good rapport with the subject.

Session 8 - Pre and Post Arrest Procedures

### What You See, Smell, Hear

- Bloodshot eyes, clothing, paraphernalia,
- Alcoholic beverage, chemical odors, marijuana
- Slurred speech, unusual and/or inappropriate statements, drug lingo



Advanced Roadside Impaired Driving Enforcement 8-26

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*What you see:* Bloodshot eyes, clothing, paraphernalia, etc...

*What you smell:* Alcoholic beverage, chemical odors, marijuana, etc...


*What you hear:* Slurred speech, unusual and/or inappropriate statements, drug lingo, etc...

Session 8 - Pre and Post Arrest Procedures

### Identifying and Documenting

Case Prep Begins with 1<sup>st</sup> Observation:

- Document in order of the 3 Phases
  - Absent extraordinary conditions NO shortcuts
  - Follow up on all indicators of impairment
- Document environmental and other conditions



Advanced Roadside Impaired Driving Enforcement 8-27

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### **D. Identifying and Documenting Observed Indicators of Impairment**

During the detection process, many different situations arise which can affect the identification and documentation of your observations.

It is the law enforcement officer's responsibility to conduct a thorough and complete investigation.

Since case preparation begins with the observation of the vehicle, absent extraordinary conditions, short cuts in the three phases of detection process should not occur.


Officers should follow up on all observations that indicate impairment to determine whether impairment is present and if that impairment is due to alcohol, drugs, or a combination of both.

Session 8 - Pre and Post Arrest Procedures

### Identifying and Documenting

**Case Prep Begins with 1<sup>st</sup> Observation:**

- Document in order of the 3 Phases
  - Absent extraordinary conditions NO shortcuts
  - Follow up on all indicators of impairment
- Document environmental and other conditions



Advanced Roadside Impaired Driving Enforcement 8-28

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During phase two of the detection process, a driver may offer a reason for their behavior or physical appearance.

Example:


- The reason they were weaving was because they were adjusting the radio.
- The reason their eyes are glassy is because they worked a double shift.

Session 8 - Pre and Post Arrest Procedures

### Explain your findings...

**Based on your training and experience:**

1. Is impairment present?
2. What is causing your observations?
3. Is more info needed to decide?



Advanced Roadside Impaired Driving Enforcement 8-29

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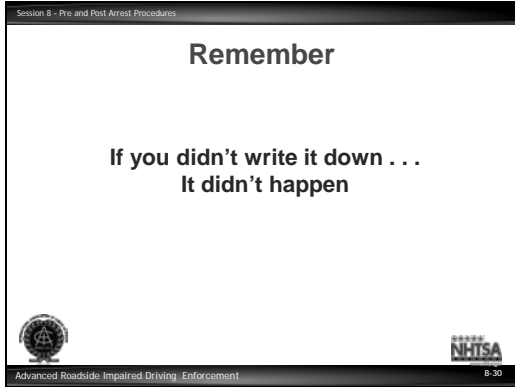
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At this point you should draw on your training and experience to determine:

- If impairment is present
- What is causing the signs that you have observed?
- If more information is needed to make a determination



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**\*\* Remember\*\***

- If you don't record the evidence, it didn't happen.

This determination, similar to the decision to arrest, is rarely based on one observation or factor. Rather these decisions are usually based on the totality of the circumstances.


The signs, symptoms and general indicators discussed during this course are meant to assist law enforcement officers in recognizing impairment based on alcohol, drugs or a combination of both.

Additionally, it is intended to assist criminal justice professionals with understanding impairment based on alcohol, drugs or a combination of both.

Session 8 - Pre and Post Arrest Procedures

**If you didn't write it down . . .  
It didn't happen**

- Use the drug matrix as a field reference
- Organize observations during traffic stop
- Articulate the circumstances and environment in which the stop was conducted
- Descriptive information will *paint a picture* for the prosecutor and the court



Advanced Roadside Impaired Driving Enforcement 8-31

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The information presented as part of this course is not intended nor meant to equip the officer with the knowledge or ability to categorize the impairment observed with a specific drug category

In an effort to help the Participant learn what types of observations may be important as part of the detection process, we have included a matrix which lists many common indicators of impairment.

It is suggested that officers use this matrix or another documentation tool as a field reference.

The matrix will help the officer to organize their observations during the traffic stop.

In addition to documenting the indicators, the officer should take care to articulate the circumstances and environment in which the stop was conducted.

This descriptive information will *paint a picture* for the prosecutor and the court, thereby presenting the evidence in an effective fashion.




Session 8 - Pre and Post Arrest Procedures

### Exercise: Document Observations

For each of the scenarios/case studies:

- Describe the process of assessing the impaired driver
- Evaluate scenario/case study information
- Articulate observations related to the general indicators of impairment and the basis for that interpretation



Advanced Roadside Impaired Driving Enforcement 8-32

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### E. Case Studies and Scenarios

Practical Exercise: During this exercise, apply the information you have learned during this course in order to effectively document observations offered in the written scenarios and case studies.


The Participant will complete the following for each of the scenarios/case studies provided in the class:

- Describe the process of assessing the impaired driver in the context of the traffic safety related scenario/case study
- Evaluate scenario/case study information: How to analyze information/observations and describe what the results indicate
- Demonstrate the ability to articulate observations related to the general indicators of impairment and the basis for that interpretation.

Session 8 - Pre and Post Arrest Procedures

### Case Preparation: When does it begin?

- Know your Legal Requirements (Statutes)
- Develop a Case File
  - Accurately document all observations
    - 3 Phases
- Don't skip steps
  - Consistency Yields Reliability
- Know your limitations
- Ask for help



Advanced Roadside Impaired Driving Enforcement 8-33

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### **F. Case Preparation and Prosecution**

Case preparation begins with the first observations of the vehicle during Phase I of the detection process.


Although state DWI/DUID statutes are different and the legal requirements necessary to prove each element of the offense differs from state to state, the detection process remains the same.

Therefore, regardless of what the statute requires, it is important that law enforcement officers understand both the elements of the state statutes, and what evidence the prosecution needs to prove each element.

Session 8 - Pre and Post Arrest Procedures

### During the Detection Process

- Keep in mind your State legal requirements
- Organize and document observations in terms of the three detection phases
- A successful prosecution for impaired driving begins with building a DWI Prosecution Team
  - The most important part of this process is to remember that it does not matter who leads the effort



Advanced Roadside Impaired Driving Enforcement 8-34

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During the detection process, it is critical that officers keep in mind the legal requirements of their state. It is equally important that the officer organize and document their observations in terms of the three detection phases.

By doing this, you will assist the prosecutor in case preparation and presentation in court.


A successful prosecution for impaired driving begins with building a DWI Prosecution Team.

The most important part of this process is to remember that it does not matter who leads the effort.

Session 8 – Pre and Post Arrest Procedures

### Prosecution Team

- More comprehensive case preparation
- More effective prosecution
- Foundation for a strong DWI Prosecution Team is the relationship between the law enforcement officer(s) involved with the arrest and the prosecuting attorneys associated with the case



Advanced Roadside Impaired Driving Enforcement 8-35

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The most significant benefit of the team is more comprehensive case preparation and a more effective prosecution.

- What does that mean – DWI Prosecution Team?
- Who is on that team?
- Why isn't the officer's word and observations enough?
- Doesn't this mean more work?
- How does this help me do my job?


The foundation for a strong DWI Prosecution team is the relationship between the law enforcement officer(s) involved with the arrest and the prosecuting attorneys associated with the case.

Effective communication and a clear understanding of each group's objectives and expectations is essential to the success of the DWI prosecution team.

Session 8 - Pre and Post Arrest Procedures

### Prosecution Team (Cont.)

- Toxicologists
- Breath testing professionals
- DREs and other expert witnesses
- Provide specific details that help build the case and support the law enforcement officer's testimony



Advanced Roadside Impaired Driving Enforcement 8-36

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Additionally, toxicologists, breath testing professionals, DREs and other expert witnesses provide specific details that help build the case as well as support the law enforcement officer's testimony during the trial.

We often forget about the other potential members of the team who are not directly part of the case preparation.


This section will use the word process to describe the sequence of activities and actions which take place during a DWI traffic stop, arrest, and prosecution.

This word is not used by accident. It is important for the Participants in this course to begin to view DWI enforcement and prosecution as a process which can be continually improved and refined.

Session 8 - Pre and Post Arrest Procedures

### Common Elements

- Concentrate on common elements and work to optimize how we handle them
- Work together to utilize this team in order to follow a similar protocol with each case
- *Consistency Yields Reliability*



Advanced Roadside Impaired Driving Enforcement 8-37

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It is rational to believe that every DWI traffic stop, arrest and prosecution are different, but it is also reasonable to assume that there are common elements each time an officer encounters an impaired driver and a prosecutor prepares a DWI case.

If we can concentrate on common elements and work to optimize how we handle them, then we can be better prepared for court and common defense strategies and challenges.

We must work together to utilize this team in order to follow a similar protocol with each case. Remember, **Consistency Yields Reliability.**



Throughout this course, we have discussed information in terms of the three phases of DWI detection process.

Session 8 - Pre and Post Arrest Procedures

### What is in a Case File?

- All Observations
- All Evidence
- Potential Witness List
- Chemical Test Results
- Photos, Diagrams, Scene Sketch
- Other?

*Remember: Comprehensive Case Prep Yields Effective Courtroom Presentation*



Advanced Roadside Impaired Driving Enforcement 8-38

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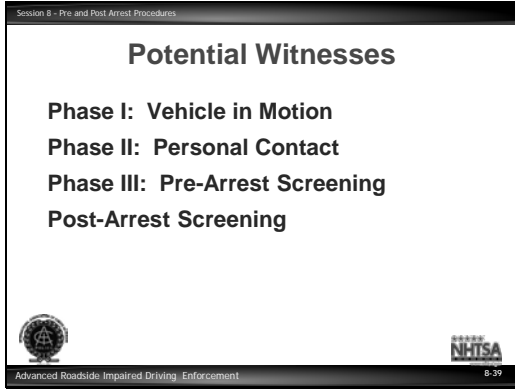
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### What is a Case File?

- All Observations
- All Evidence
- Potential Witness List
- Chemical Test Results
- Photos, Diagrams, Scene Sketch
- Other?

Remember: Comprehensive Case Prep Yields Effective Courtroom Presentation



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### Phase I: Vehicle in Motion

(Observation of the suspect's driving)

Preparation for trial begins with the first observation of the vehicle in motion, which is usually the first point of attack.

In some cases, the reasonable suspicion for the traffic stop may not be associated with driving behavior consistent with the impairment, for example an equipment violation.

Therefore, all observations during the vehicle in motion phase should be noted in order to illustrate the environment to the court later.


Potential team members involved at this point may be involved at this point may include:



Session 8 - Pre and Post Arrest Procedures

### Phase I: Who Can Help?

- Law enforcement officer who observed the driving and/or made the traffic stop
- Other law enforcement officers who may have made observations or were called in to assist
- Lay witnesses, including other people in the vehicle or other motorists



Advanced Roadside Impaired Driving Enforcement 8-40

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- Law enforcement officer who observed the driving and/or made the traffic stop
- Other law enforcement officers who may have made observations or were called in to assist
- Lay witnesses, including other people in the vehicle or other motorists.



Law enforcement officers should note every observation made regarding driving. This includes observations before and after you activate your emergency equipment.

If there is a crash involved, the officer probably will not actually observe driving. Therefore, witnesses to the crash should be noted to prove state specific statutory requirements.

Session 8 - Pre and Post Arrest Procedures

### Phase II: Document Observations

- Note every observation made regarding personal contact
- Include your observations before and after the subject exits the vehicle
- Documenting and articulating these observations can reinforce the reasonable suspicion for the stop

Advanced Roadside Impaired Driving Enforcement 8-41

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### Phase II: Personal Contact

(Observations of the suspect after the stop)

Preparation for trial continues with the traffic stop. Observations made before and after the suspect exits the vehicle should be documented.

Example:

- Odor of alcohol
- Slurred speech
- Red glassy eyes
- Inappropriate responses
- Using the vehicle for support during exit and/or while walking
- Accurate documentation is essential due to the length of time cases are adjudicated.
- Potential team members involved at this point may include:
  - Law enforcement officer(s) who observed the subjects following the traffic stop.
  - Other law enforcement officers who may have made observations or were called in to assist
  - Lay witnesses, including other people in the vehicle or other motorist.


Law enforcement officers should note every observation made regarding personal contact. This includes your observations before and after the subject exits the vehicle.

Documenting and articulating these observations can reinforce the reasonable suspicion for the stop.

Session 8 - Pre and Post Arrest Procedures

### Phase III: Thoroughly Document

- HGN, WAT, OLS and other sobriety tests, including the associated clues
- Potential team members:
  - Law enforcement officer(s)
  - Lay witnesses



Advanced Roadside Impaired Driving Enforcement 8-42

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### Phase III: Pre-Arrest Screening

(Observations of the suspect while performing all sobriety tests)

Preparation for trial continues with the officer conducting pre-arrest screening.

Observations made during HGN, WAT, OLS and other sobriety tests, including the associated clues, must be thoroughly documented.

Example: During the Walk and Turn Test, the suspect may not count their steps out loud while walking. This is considered an observation. The suspect may start walking before being instructed to do so. This is considered a clue.

Potential team members involved at this point may include:

- Law enforcement officer(s) who conducts the field sobriety tests
- Other law enforcement officers who may have made observations or were called in to assist
- Lay witnesses including other people in the vehicle or at the scene


Law enforcement officers should note every observation made regarding pre-arrest screening.

This includes observations before, during and after the field sobriety tests. Recording and articulating these observations can reinforce the reasonable suspicion for the arrest.

Session 8 - Pre and Post Arrest Procedures

### Post Arrest Screening Potential Team Members

- Breath testing operators/technical supervisors.
- Drug Recognition Experts (DREs)
- Medical personnel
- Jail personnel



Advanced Roadside Impaired Driving Enforcement 8-43

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### *Post Arrest Screening*

During post arrest screening the team will potentially include:

- Breath testing operators/technical supervisors.
- Drug Recognition Experts (DREs)
- Medical personnel
- Jail personnel



DRE's should be utilized whenever available. The officer should document what DRE was contacted, when they were contacted, and when they arrived for the evaluation.

If a DRE is not available at the time of arrest, they may still be useful at trial to bridge the gap between the observations made by the arresting officer and any biological test results.

Session 8 - Pre and Post Arrest Procedures

### Pre-Trial Preparation Who Can Help?

- Local Prosecutor
- Toxicologist
- DRE/DRE State Coordinator
- TSRP
- NHTSA/NAPC Prosecutor Fellow
- NTLC



Advanced Roadside Impaired Driving Enforcement 8-44

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### *Pre-Trial Preparation*

For this reason, it remains essential to document, in detail, all observations including those made after arrest.



As preparation for trial begins the team should expand:

- Local prosecutor
- Toxicologist or representative from the appropriate state or contract lab
- DRE Officer / DRE State Coordinator
- Traffic Safety Resource Prosecutor (TSRP) (If available)
- National Highway Traffic Safety Administration (NHTSA)/National Association of Prosecutor Coordinators (NAPC) Prosecutor Fellow
- National Traffic Law Center

Session 8 - Pre and Post Arrest Procedures

### Pre-Trial

- Review your case file
- Meet with the prosecutor
- Anticipate the defense
- Develop visual aids
- Others?



Advanced Roadside Impaired Driving Enforcement 8-45

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When possible, at a minimum, the local prosecutor and the arresting officers should meet to discuss the details of the case and determine potential prosecution strategies.

The toxicologist in a DEC state can be used to corroborate the testimony of the DRE.

The DRE / DRE State Coordinator may be able to assist in identifying additional DRE resources.

In a non-DEC state, the toxicologist can be used to bridge the gap between the observations of the arresting officer and the lab report.



If your state has a TSRP they can be utilized as a resource to assist both prosecutors and law enforcement.

NTLC, the NAPC Prosecutor Fellow, and NHTSA and the IACP may also serve as additional resources.

Session 8 - Pre and Post Arrest Procedures

### Visual Aids

- Pictures or video
- Location of stop
- Appearance of the defendant
- Performance on SFST
- Charts or diagrams
- Officer's training and experience
- Factual concepts
- Elements



Advanced Roadside Impaired Driving Enforcement 8-46

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Session 8 - Pre and Post Arrest Procedures

### Trial

#### Direct Examination

- Use Visual Aids
- Use Plain English
- Listen Carefully to the Question
- Think Before You Answer
- Ask for Clarity if Needed
- Relate Training and Experience
- Talk to Your Audience



Advanced Roadside Impaired Driving Enforcement 8-47

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At trial, it is imperative that the prosecutor, arresting officer, DRE (if applicable), toxicologist and any other witness avoid using legal, law enforcement or medical specific language. The use of plain English assists the judge, jury and others who are involved in the case to understand the specifics of all testimony.

The team must work together to illustrate the entire process. Visual aids should be used to illustrate the location of the stop, physical appearance of defendant, and/or performance on the field sobriety tests.

Visual aids may also assist in explaining the officers' training and experience, factual concepts, and/or the legal elements of the offence.

Remember, visual aids engage the judge/jury and increase retention of information.

From the time of the traffic stop through post arrest screening, and remain a consistent team until after the case is adjudicated.


The prosecutor may be added to the team at any time. Ideally, the prosecutor would be on board immediately, especially in the case of serious injury or fatal crashes.

Session 8 - Pre and Post Arrest Procedures

### Trial (Cont.)

#### Cross Examination

- Be Professional
- Answer only the Question Asked
- If You Don't Know the Answer Just Say So
  - I do not know
  - I do not recall
- I cannot answer that question without explanation



Advanced Roadside Impaired Driving Enforcement 8-48

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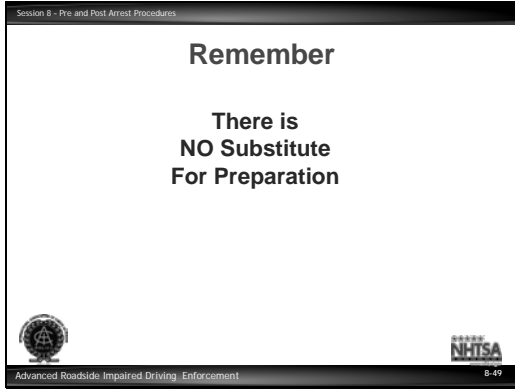
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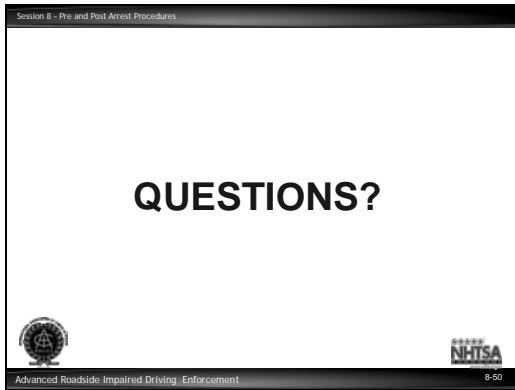
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# REPORT FROM THE IMPAIRED DRIVING SAFETY COMMISSION

MARCH 2019



# INTRODUCTION

## IMPAIRED DRIVING SAFETY COMMISSION ACT:

Public Act 350 of 2016 (effective: 3-21-2017) created the Impaired Driving Safety Commission Act. The Commission was created within the Michigan State Police (MSP) pursuant to the Act and is required to research and recommend a scientifically supported threshold of  $\Delta^9$ -THC bodily content to provide evidence for per se impaired driving in the state of Michigan.

This report includes the results of the Commission's research, recommendations for the appropriate threshold of  $\Delta^9$ -THC bodily content to provide evidence for per se impaired driving, and recommendations for future legislative actions.

Appointed by Governor Rick Snyder, the Commission consisted of six members:

The Director of the Michigan State Police:

**Col. Kriste Kibbey Etue**

The MSP Director's designated representative:

**Lt. Col. Richard Arnold**

A qualified and registered patient under the Michigan Medical Marihuana Act:

**Ms. Margeaux Bruner**

A forensic toxicologist:

**Mr. Nicholas J. Fillingner**

A professor from a public research university in this state:

**Dr. Carol Ann Cook Flannagan**, whose expertise is in traffic safety

A professor from a public research university in this state:

**Dr. Norbert E. Kaminski**, professor of pharmacology and toxicology, whose expertise is in the area of cannabis pharmacology and toxicology

A physician licensed under the Public Health Code:

**Dr. William Ray Morrone**

(Legislature Service Bureau, 2017).

# STATUS OF MEDICAL AND RECREATIONAL MARIHUANA LAWS AND DRIVING PER SE LIMITS

## IN MICHIGAN:

Pursuant to MCL 257.625(1), Michigan law prohibits a driver from operating a motor vehicle while intoxicated. To be found guilty under this statute, prosecutors must show that the defendant was “under the influence” at the time he or she operated the motor vehicle. There are three ways a person can be “under the influence” per Michigan law. These three categories are alcoholic liquor, a controlled substance, or an intoxicating substance (or any combination of these three categories). Marihuana falls under MCL 257.625(1) because it is a controlled substance. In addition to the above, Michigan also has what is commonly referred to as the zero-tolerance drugged driving law. Pursuant to MCL 257.625(8), a driver shall not operate a motor vehicle if he or she has any amount of a Schedule 1 controlled substance in his or her body. Marihuana falls under this law because it is listed as a Schedule 1 controlled substance by both the Drug Enforcement Administration and the Michigan Public Health Code.

In 2008, Michigan voters passed the Michigan Medical Marihuana Act (MMMA). Under MCL 333.26427, the MMMA prohibits qualifying patients from operating, navigating, or being in actual physical control of any motor vehicle, aircraft, or motorboat while “under the influence” of marihuana. However, qualifying patients are protected when they engage in the medical use of marihuana, which includes “the acquisition, possession, cultivation, manufacture, use, internal possession, delivery, transfer, or transportation of marihuana or paraphernalia relating to the administration of marihuana to treat or alleviate a registered qualifying patient’s debilitating medical condition or symptoms associated with the debilitating medical condition.” MCL 333.26423(f).

In the 2013 Michigan Supreme Court case of *People v. Koon*, 494 Mich 1; 832 N.W.2d 724, the Court carved out an exception to Michigan’s zero-tolerance drugged driving law for qualifying patients. The Court held that it is not enough for a prosecutor to show that a patient has  $\Delta^9$ -THC in his or her system. In other words, the zero-tolerance drugged driving law does not apply to qualifying patients who comply with the MMMA. Rather, the standard for a patient is “under the influence,” as established under the MMMA, which generally means that the marihuana must have had a significant effect on a person’s mental or physical condition so that he or she was no longer able to operate a vehicle in a normal manner.

Another important Michigan Supreme Court decision deals with how the metabolite of marihuana is dealt with under the zero-tolerance drugged driving law. In 2010, the Court held in *People v. Feezel*, 486 Mich 184; 783 N.W.2d 67, that the presence of a marihuana metabolite, also known as 11-carboxy-THC, is not a Schedule 1 drug, and therefore a person cannot be prosecuted under MCL 257.625(8) if he or she has only the metabolite in his or her blood.

On November 6, 2018, Michigan voters chose to legalize recreational marihuana. The law went into effect on December 6, 2018, and is officially known as the Michigan Regulation and Taxation of Marihuana Act (MRTMA). Similar to the MMMA, the MRTMA also prohibits a person from operating, navigating, or being in physical control of any motor vehicle while “under the influence” of marihuana. While the Michigan Supreme Court’s opinion in *Koon* only provided an exception

# STATUS OF MEDICAL AND RECREATIONAL MARIHUANA LAWS AND DRIVING PER SE LIMITS

to the zero-tolerance drugged driving law for qualifying patients in compliance with the MMMA, due to the adoption of the same “under the influence” standard under the MRTMA, the exception to the zero-tolerance drugged driving law may now also apply to persons consuming marihuana under the MRTMA.

## IN THE UNITED STATES:

As of the date of this report, both recreational and medical marihuana have been legalized in 33 states and Washington DC (Procon.org, 2019). Currently six states have set impaired driving per se thresholds of  $\Delta^9$ -THC bodily content in blood (ng/ml) to provide evidence for per se impaired driving (Edmondson, L., 2016):

- Colorado: 5 ng/ml
- Montana: 5 ng/ml
- Nevada: 2 ng/ml
- Ohio: 2 ng/ml
- Pennsylvania: 1 ng/ml
- Washington: 5 ng/ml

Unlike the other states listed, Colorado’s limit of 5 ng/ml is a reasonable inference. A reasonable inference allows a jury to infer that a driver was impaired if his or her blood test result is 5 or more ng/ml  $\Delta^9$ -THC, but that inference can be rebutted by the defendant in legal proceedings with evidence to the contrary.

In Canada, the amount of  $\Delta^9$ -THC in one’s blood determines how the impaired driving offense is charged. An impaired driving charge for a person with  $\Delta^9$ -THC levels of 2-5 ng/ml blood carries a lesser penalty than a charge for  $\Delta^9$ -THC greater than 5 ng/ml blood. Canada also has a hybrid offense for impaired driving with  $\Delta^9$ -THC level of greater than 2.5 ng/ml blood combined with a Blood Alcohol Concentration (BAC) of 0.05 grams/100 ml.

The Commission reviewed and considered the legislation enacted in these jurisdictions as it went about its work.

## COMMISSION MEETINGS:

The Commission met throughout 2018 and into March 2019, to fulfill its charge. Commissioners received presentations from subject matter experts in the following areas: Michigan criminal law; impaired driving prosecution, defense, investigation, and enforcement; substance abuse treatment; traffic safety research, analysis, and programming; pharmacology and toxicology; and forensic toxicology. Presentations and review of relevant research literature informed discussion resulting in completion of this report and the recommendations contained herein.

## PHARMACOKINETICS OF $\Delta^9$ -THC:

The plant, *cannabis sativa*, contains over 100 structurally-related compounds, termed cannabinoids. The primary cannabinoid responsible for the psychotropic effects (e.g., euphoria) produced by cannabis is  $\Delta^9$ -tetrahydrocannabinol ( $\Delta^9$ -THC). The chemical structure of  $\Delta^9$ -THC was first described in 1964 (Gaoni & Mechoulam, 1964).  $\Delta^9$ -THC produces its psychotropic effects, by binding to and activating a specific protein that is highly abundant in the brain, named cannabinoid receptor 1 (Matsuda, Lolait, Brownstein, Young & Bonner, 1990). The majority of cannabinoids present in cannabis do not possess psychotropic properties because they do not bind well to cannabinoid receptor 1 and therefore do not activate this receptor. An example of such a cannabinoid that is widely used for medicinal purposes (e.g., Epidiolex) and that possesses no psychotropic activity is cannabidiol, also known as CBD. Therefore, the psychotropic activity of cannabis or various preparations of  $\Delta^9$ -THC (e.g., oils and edibles) is achieved through delivery via the blood stream of  $\Delta^9$ -THC and its metabolite, 11-hydroxy-THC, to the brain.

The most common route of  $\Delta^9$ -THC administration is through inhalation, either by smoking cannabis or through the vaporization of various preparations containing  $\Delta^9$ -THC. A second common route of  $\Delta^9$ -THC administration is through oral consumption of products containing  $\Delta^9$ -THC or cannabis, termed “marihuana-infused products” or “edibles.”  $\Delta^9$ -THC can also be delivered via the oromucosal route (i.e., direct application to the mucus membrane in the mouth) through the use of cannabis tincture, which is most often an alcohol extract of cannabis. Cannabis tincture can also be used for topical application to the skin.

The pharmacokinetics and time to onset of psychotropic effects by  $\Delta^9$ -THC is highly dependent on the route of administration. This dependency is one of several particular challenges for measurement of  $\Delta^9$ -THC impairment in the context of driving, as will be described in later sections. Below, the basic pharmacokinetics—i.e., the processes of absorption, metabolism, distribution, and excretion—of  $\Delta^9$ -THC are described in the next paragraphs.

### Absorption

Inhalation of smoked cannabis or vaporization of  $\Delta^9$ -THC-containing products results in very rapid delivery of  $\Delta^9$ -THC to the bloodstream. After the first puff of a cannabis cigarette,  $\Delta^9$ -THC is detectable in plasma within seconds due to the lungs being highly vascularized and capable of rapid and efficient gas exchange. The peak plasma concentration of  $\Delta^9$ -THC is achieved within 3-10 minutes upon initiation of smoking cannabis (Grotenhermen, 2003). The amount of  $\Delta^9$ -THC delivered via the respiratory route is not only dependent on the amount of  $\Delta^9$ -THC inhaled but is also dependent on the duration of the puff, depth of inhalation and the duration of the breath hold. In general, the percentage of total  $\Delta^9$ -THC that is absorbed via the respiratory route is similar whether delivered via cannabis cigarette, pipe, or through vaporization.

Administration of  $\Delta^9$ -THC via the oromucosal route by application of tincture also results in rapid absorption of  $\Delta^9$ -THC. With  $\Delta^9$ -THC being dissolved in alcohol and applied to the inside of the mouth, delivery to the blood stream is expected to be rapid but neither as efficient nor as rapid as via inhalation.

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Oral administration of  $\Delta^9$ -THC by eating products that contain  $\Delta^9$ -THC results in slower and more variable absorption of  $\Delta^9$ -THC compared to inhalation. Peak plasma concentrations for oral administrations are typically attained approximately 120 minutes after consumption (Grotenhermen, 2003; Huestis, 2005).

Oral administration generally results in lower  $\Delta^9$ -THC blood concentrations than the same dosage of  $\Delta^9$ -THC delivered by inhalation.

## Distribution

Upon absorption,  $\Delta^9$ -THC rapidly distributes via the circulating blood to organs that are highly vascularized including the brain, kidney, liver, lungs, and heart. In addition, because cannabinoids, including  $\Delta^9$ -THC, are highly fat-soluble compounds they are readily stored in fat tissue and are then slowly released back into circulating blood over time. Due to this property, higher levels of cannabinoid accumulation in fat are observed in chronic cannabis users compared to occasional users.

## Metabolism and Excretion

The metabolism of  $\Delta^9$ -THC has been studied extensively. The primary site of  $\Delta^9$ -THC metabolism is the liver where  $\Delta^9$ -THC is converted to two major metabolites: 11-hydroxy-THC (11-OH-THC) and 11-carboxy-THC (11-COOH-THC) (Leighty, 1973). These metabolites undergo further processing, which make them more water soluble to facilitate excretion by urine and feces. 11-OH-THC possesses psychotropic properties that are the same as  $\Delta^9$ -THC.

Elimination of compounds is often measured in terms of half-life, the amount of time required to eliminate one half of the total amount of a given compound that has been absorbed. Elimination of  $\Delta^9$ -THC occurs in two distinct phases. There is an initial rapid elimination phase with a half-life of approximately 6 minutes followed by a long terminal elimination phase with a half-life of approximately 22 hours (Heuberger, Guan, Oyetayo, Klumpers, Morrison, Beaumer, van Gerven, Cohen & Freijer, 2015). This long terminal elimination phase is primarily due to rapid absorption of  $\Delta^9$ -THC in fat tissue followed by its slow release over time back into circulation (Lucas, Galettis, Song, Solowij, Reuter, Schneider, & Martin, 2018). In chronic users blood-plasma concentrations of  $\Delta^9$ -THC can remain above measurable levels (i.e., 1 ng/ml) for 48-72 hours after administration (Wall, Sadler, Brine, Taylor, & Perez-Reyes, 1983).

## Key Point

Due to the initial rapid elimination phase of  $\Delta^9$ -THC followed by the long terminal elimination phase, blood-plasma concentrations of  $\Delta^9$ -THC are indicative of *exposure*, but are not a reliable indicator of whether an individual is *impaired*.

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## BEHAVIORAL EFFECTS OF $\Delta^9$ -THC:

The behavioral effects of cannabis include euphoria and relaxation, altered time perception, hallucinations, lack of concentration, impaired learning and memory, and mood changes such as panic reactions and paranoia. The intensity varies with dose, administration route, expectation of effects and the user's environment and personality. This spectrum of behavioral effects prevents classification as a stimulant, sedative, tranquilizer, or hallucinogen. The physiological effects of cannabis include heart rate and diastolic blood pressure, conjunctival suffusion, dry mouth and throat, increased appetite, vasodilation, and decreased respiratory rate. Most behavioral and physiological effects of  $\Delta^9$ -THC return to baseline levels within 3-6 hours after exposure (Baselt, 2004; Huestis, 2007; Hartman & Huestis, 2013; Huestis, 2002).

Long-term cannabis use is associated with neuropsychological deficits such as memory impairment and changes in brain morphology (Lorenzetti, Lubman, Shittle, Solowij & Yücel, 2010). Chronic cannabis use may also lead to impairment in driving-related tasks, even after cessation. Chronic daily cannabis smokers abstaining from use performed poorly on critical tracking, which assesses human operator performance when a person perceives a discrepancy between a desired and actual state and aims to reduce the error by compensatory movement. While critical tracking did recover after 3 weeks of abstinence, it was still significantly worse compared to critical tracking in the control group. Similar results were observed in divided attention tasks, such as tracking performance and tracking control (Bosker, Karschner, Lee, Goodwin, Hirvonen, Innis, Theunissen, Kuypers, Huestis, & Ramaekers, 2010). In a somewhat related study, a cohort of heavy chronic cannabis smokers showed no significant differences in critical tracking or divided attention task performance up to six hours after smoking as compared to before smoking (Schwope, Bosker, Ramaekers, Gorelick, & Huestis, 2012).

## THC IMPAIRMENT AND RELATIONSHIP TO TRAFFIC SAFETY:

The relationship between ingesting cannabis and impairment in driving skills has been established in a number of studies, which are summarized in this section. These include laboratory studies of how  $\Delta^9$ -THC, the main active ingredient in cannabis, influences cognitive and motor skills, as well as analyses of crash data linking  $\Delta^9$ -THC detected in blood tests and crash risk and injury outcome.

In laboratory studies, including those using driving simulators and instrumented vehicles,  $\Delta^9$ -THC affects areas of the brain that control movement, balance, coordination, memory, and judgment (Lenné, Dietze, Triggs, Walmsley, Murphy, & Redman, 2010; Hartman, Huestis, 2013; Hartman, Brown, Milavetz, et al, 2015). Cannabis has been shown to impair critical driving-related skills including psychomotor abilities like reaction time, tracking ability, and target detection, cognitive skills like judgment, anticipation and divided attention, and executive functions like route planning and risk taking (Ramaekers, Robbe, & O'Hanlon, 2000; Robbe & O'Hanlon, 1993; Liguori, Gatto & Robinson, 1998; Hartman & Huestis, 2013).

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Interestingly, in most of the simulator and vehicle studies, cannabis-impaired subjects typically drive slower, keep greater following distances, and take fewer risks than when sober (Compton, 2017). These effects appear to suggest that the drivers are attempting to compensate for the subjective effects of using cannabis. This is contrasted with alcohol-impaired subjects, who typically drive faster, follow more closely, and take more risks than when sober. That said, cannabis-impaired drivers attempting to compensate for the effects of cannabis are not likely to fully mitigate the effects of the drug on driving skills. Moreover, at least one study indicated that acute cannabis intoxication can result in *more* risk taking rather than risk compensation.

In spite of the relatively clear evidence of reduced driving-related skills in controlled studies (with known dosages), the relationship between cannabis ingestion and crash risk in the field is less well understood. The Governor's Highway Safety Association (GHSA) report on Drug-Impaired Driving (Hedlund, 2017) reviewed a number of studies, including several meta-analyses, that attempt to summarize the results of a larger number of individual studies.

One such review and meta-analysis by Elvik (2013) concluded that the best estimate of the crash risk increase due to cannabis is 26%, but that this is not statistically significant. Another meta-analysis by Schulze et al. (2012) concluded that ingesting cannabis increases crash risk by a factor of 1 to 3. Finally, another review by the National Academies of Sciences (2017) concluded that "there is substantial evidence of a statistical association between cannabis use and increased risk of motor vehicle crashes" and estimated the increased risk at 22% - 36%.

A carefully controlled epidemiological study by the National Highway Traffic Safety Administration (NHTSA) found the same 25% increase in risk when comparing crash-involved drivers to a control sample of non-crash-involved drivers who were selected from the same location as the crash, a week later (Compton, 2017; Lacey, Kelley-Baker, Berning, Romano, Ramirez, Yao & Compton, 2016). However, when the authors accounted for other risk factors such as age, gender, and the presence of alcohol, the effect disappeared. This suggests that the 25% risk increase might be at least partially due to other risk factors that co-occur with cannabis use. This includes drinking alcohol, which was often found with  $\Delta^9$ -THC in the blood. That said, this study focused on all crashes and most of the crashes were of low severity. In addition, because there is no clear relationship between blood levels of  $\Delta^9$ -THC and impairment, it is not known how impaired the  $\Delta^9$ -THC-positive drivers were in this study.

While there is some uncertainty as to the crash risk associated with cannabis impairment alone, the research is clear that the risk is lower than that of alcohol impairment (Compton & Berning, 2015). However, cannabis users are more likely to also drink alcohol before driving than non-users. Thus, polydrug use (use of 2 or more drugs, including alcohol) is quite prevalent among cannabis-impaired drivers. Since alcohol use while driving has been going down (Berning, Compton & Wochinger, 2015), the co-occurrence of alcohol and cannabis use can in itself be a risk that may increase with increasing cannabis use.



# SUPPORTING SCIENCE

From a public health perspective, it is important to know how much cannabis legalization affects crashes. A 2017 study of Colorado and Washington (Aydelotte, Brown, Luftman, Mardock, Teixeira, Coopwood, & Brown, 2017) looked at overall traffic fatality rates per travel mile in Colorado, Washington, and eight control states between 2009 and 2015. Compared to control states, the study found that there was a small but non-significant increase in fatalities per billion miles in those states compared to the controls. A 2018 study (Lee, Abdel-Aty, & Park, 2018) looked at the change in cannabis-related fatal crashes in states as a function of changes to laws in those states. Law categories included 1) prohibition, 2) decriminalization, 3) medical, and 4) full (recreational). At the time of the analysis, only 18 states fully prohibited cannabis. The study found that legalizing only medical cannabis had no statistically significant effect on fatal crashes involving cannabis. However, either decriminalizing or legalizing cannabis significantly increased cannabis-related fatal crashes by anywhere from 31-174%. It is likely that the difference in significance between these studies was due to the focus of the 2018 study on cannabis-positive fatalities as opposed to all fatalities. It is important to note that these studies do not determine whether or not the cannabis caused the fatalities, nor do they account for concurrent effects of alcohol.

## PUBLIC ATTITUDES:

Finally, surveys of attitudes towards cannabis use and driving indicate that the public, especially regular cannabis users, is unaware of the risks associated with cannabis use and driving. The GHSA reported that:

In a survey, drivers believed that driving after drinking is a greater problem than driving after using cannabis (64% vs. 29%) and that driving after drinking is more common and increases crash risk more than driving after using cannabis (56% vs. 34% and 98% vs. 78%). Compared to drivers in other states, drivers in states with legal recreational cannabis more often said driving after using cannabis is a problem (43% vs. 28%) and were twice as likely to report using cannabis within the past year (16% vs. 8%) (Eichelberger, 2016).

In surveys and focus groups with regular marijuana users in Colorado and Washington, almost all believed that marijuana doesn't impair their driving, and some believed that marijuana improves their driving (CDOT, 2014; PIRE, 2014; Hartman & Huestis, 2013). Most regular marijuana users surveyed in Colorado and Washington drove "high" on a regular basis. They believed it is safer to drive after using marijuana than after drinking alcohol. They believed that they have developed a tolerance for marijuana effects and can compensate for any effects, for instance by driving more slowly or by allowing greater headways.

# SUPPORTING SCIENCE

## THC AND DRIVING IN MICHIGAN:

Table 1 shows the count of drug-involved crashes and drug-involved fatalities in Michigan using the most recent five years of data (University of Michigan, 2019). During the five-year period from 2013 to 2017, the number of drug-involved crashes and fatal crashes have increased steadily, with an overall increase of 44% for all crashes and 56% for fatalities over the five-year period. Note that specific drug test results were not available for drivers in more than 95% of these crashes. However, among those who were tested, cannabinoids were present in 70% of drivers.

*Table 1: Drug-Involved Crashes and Fatal Crashes in Michigan*

Year	All Drug-Involved Crashes	Fatal Drug-Involved Crashes
2013	2,002	142
2014	1,944	131
2015	2,227	159
2016	2,667	216
2017	2,880	221
<b>Total</b>	<b>11,720</b>	<b>869</b>

Positive tests for cannabinoids in crash-involved drivers have more than doubled over the five-year time frame. The total number of crash-involved drivers testing positive for cannabinoid drugs are shown in Table 2. It is likely that both the amount of drug testing and the number of  $\Delta^9$ -THC-positive drivers have increased during this time. With the small amount of testing and potential changes in testing, it is difficult to determine just how much the incidence of cannabis-impaired driving is changing in Michigan. However, it is very likely to be increasing (as the data suggest). Given the experience in other states, we expect that the number will continue to go up as Michigan implements its recreational marijuana policies (Aydelotte et al., 2017).

*Table 2: Count of Crash-Involved Drivers who Tested Positive for  $\Delta^9$ -THC or Other Cannabinoids*

Positive for cannabinoids	2013	2014	2015	2016	2017	Total
<b>Total</b>	79	92	102	165	174	612

Finally, of the 612 drivers who tested positive for cannabinoids, 540 of them also had alcohol tests with known results. Of these, 44% had been drinking before driving (i.e., had non-zero BAC) and 11% were over the 0.08 BAC limit. Since drug toxicology tests are often not done for crash-involved drivers with  $BAC \geq 0.1$ , it is likely that the actual proportion of over-BAC-limit cannabis-positive drivers is higher than 11%.

## STANDARDIZED FIELD SOBRIETY TESTS:

The Standardized Field Sobriety Tests (SFSTs) are a battery of tests performed during a traffic stop to determine if a driver is impaired. Although there are a number of different field sobriety tests, three have been scientifically validated by the NHTSA and are generally admissible in court (Burns, 2013):

1. Horizontal gaze nystagmus (HGN): The subject is instructed to follow the movement of a light (or finger or other object) with only the eyes and no head movement; impaired subjects cannot follow the movement smoothly and a distinct jerk will appear prior to 45°.
2. Walk-and-turn test (WAT): The subject must walk nine heel-to-toe steps on a line, turn, and return along the line with nine heel-to-toe steps.
3. One-leg stand (OLS): The subject must raise one leg and hold it ~6 inches up while counting slowly until told to stop (at 30 seconds).

The purpose of these tests is to determine the effect of the use of alcoholic liquor, a controlled substance, or other intoxicating substance (or a combination of these) on a person's capacity to think and act with ordinary care and therefore operate a motor vehicle safely. Therefore, the results of these standardized field sobriety tests, appropriately administered, are admissible in the trial of any civil or criminal action or proceeding arising out of an arrest for a cannabis driving offense.

The three validated tests were selected from a series of studies of many different candidate tests. The history of scientific research on these tests, the selection of the three above, and their subsequent validation in both laboratory and field tests is described by Marcelline Burns (2003). However, as Burns describes, the validation work on these tests was originally done on alcohol-impaired subjects and compared to corresponding blood or breath tests. In field studies, over 90% of officers' arrest decisions on the basis of SFSTs were supported by blood tests. In particular, the HGN test is the most scientifically reliable for detecting alcohol intoxication.

However, these tests were not originally validated on impairment by other substances, though they are used to detect any form of impairment. The use of SFSTs for detecting cannabis impairment has been studied more recently with mixed results.

The three validated SFSTs plus an additional sign associated with the HGN test—head movements or jerks (HMJ)—were investigated in a laboratory setting where cannabis intake was controlled (Papafotiou, Carter, & Stough, 2005). In that study, the SFSTs were found to be moderately associated with the level of blood  $\Delta^9$ -THC, with just under 50% of subjects in the high-THC condition identified as impaired at five minutes and 55 minutes after cannabis intake. When the HMJ test was added, the detection rate increased by 10%.

# SUPPORTING SCIENCE

Notably, studies suggest that HGN has a more limited association with cannabis impairment, which is different from its strong association with BAC. A 2016 study noted these results and looked at a wider variety of possible SFSTs to find those more closely associated with cannabis impairment. In field data, a number of SFSTs that were conducted by a Drug Recognition Expert (DRE) were compared to measured blood  $\Delta^9$ -THC levels in drivers. They found that the most diagnostic tests were the finger-to-nose (FTN) test and the Modified Romberg Balance (MRB) test with eyelid tremors (Hartman, Richman, Hayes, & Huestis, 2016).

## BLOOD LEVELS OF $\Delta^9$ -THC AND IMPAIRMENT:

The pharmacokinetics of cannabis section explains the pattern of blood levels of  $\Delta^9$ -THC as it is metabolized over time after cannabis ingestion. The key features of that process are 1) the initial rapid elimination phase, and 2) the long terminal elimination phase. The specific levels and time-course are different for different methods of ingestion.

Numerous studies of the relationship between blood levels of  $\Delta^9$ -THC and performance measures are reviewed in detail in Huestis (2002). Another review focused specifically on driving-related skills can be found in Hartman & Huestis (2013). A critical observation in these studies is that there is a delay in the observed effects of impairment relative to when blood levels of  $\Delta^9$ -THC peak. That is, the effect of  $\Delta^9$ -THC on the central nervous system occur after the initial rapid elimination phase, decoupling the measured blood levels of  $\Delta^9$ -THC from the impairment that it produces.

For example, Papafotiou et al. (2005) conducted a laboratory study in which subjects smoked controlled doses of cannabis, after which they drove on a test track and were given SFSTs at regular intervals. Blood was also extracted at regular intervals and tested for  $\Delta^9$ -THC. Immediately after completion of the smoking procedure (which took some period of time), blood  $\Delta^9$ -THC levels were at their highest measured level of 70.59 ng/ml for the high dose (2.93%  $\Delta^9$ -THC cigarette) and 55.46 ng/ml for the low dose (1.74%  $\Delta^9$ -THC cigarette). Twenty minutes later, the blood  $\Delta^9$ -THC levels were 13.85 and 12.84 ng/ml, respectively. After 75 minutes, both groups were near or below 5 ng/ml (the legal limit in several states). In contrast, driving performance did not show any significant impairment at 30 minutes after completion of smoking, but it was significantly worse at 80 minutes, as measured by lateral control (“straddling the line” while driving).

Two key points must be made about the relationship between measured blood  $\Delta^9$ -THC levels and impairment. First, behavioral measures of impairment are often negatively related to blood- $\Delta^9$ -THC levels, particularly for smoked cannabis. Peak blood levels occur very quickly after smoking and are often associated with no behavioral decrement. The effect of  $\Delta^9$ -THC on the central nervous system (resulting in impairment) occurs more slowly while the initial rapid elimination phase occurs and blood- $\Delta^9$ -THC levels drop.

## SUPPORTING SCIENCE

Second, regular users of cannabis respond differently to the same dose of  $\Delta^9$ -THC than occasional or infrequent users of cannabis due to a phenomenon termed “tolerance.” Through frequent use, drug tolerance ensues such that higher doses of a drug are required to produce the same effects as achieved initially. Indeed, there is strong scientific evidence that tolerance does occur with regular and frequent use of cannabis (Colizzi, & Bhattacharyya, 2018). The implications of tolerance to cannabis are that lower blood  $\Delta^9$ -THC levels in infrequent users may result in impairment that would only be experienced at higher  $\Delta^9$ -THC levels by regular cannabis users.

The consequence of these results for setting per se limits is that blood  $\Delta^9$ -THC can fail to detect impaired drivers (when blood levels are low and impairment is high). It can also inappropriately flag unimpaired drivers or chronic users whose blood levels are higher in general (see section on behavioral effects of  $\Delta^9$ -THC) even when not impaired.

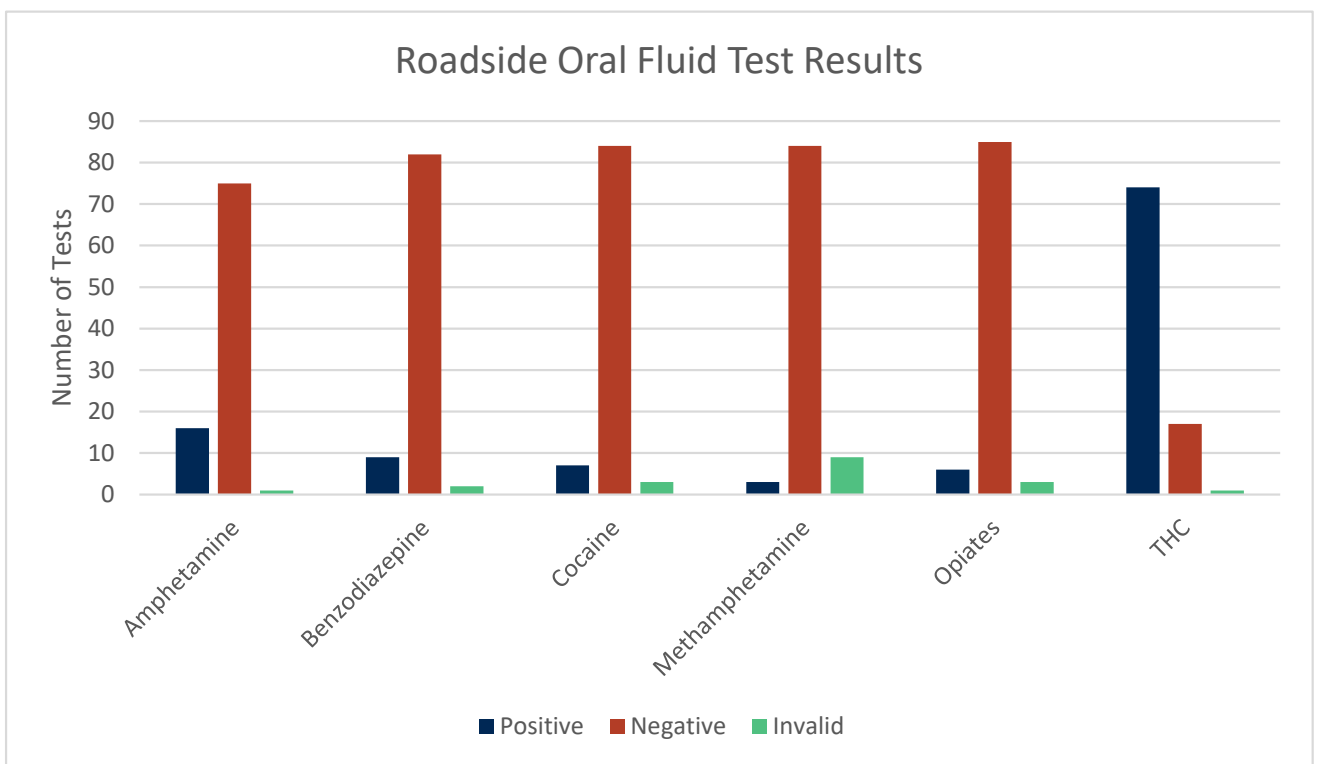
# ORAL FLUID

## STATUS IN MICHIGAN:

Public Act 243 of 2016 authorized the MSP to establish a pilot program in five counties in Michigan for roadside oral fluid testing to determine whether an individual is operating a vehicle while under the influence of a controlled substance. The legislation stipulated that the preliminary oral fluid test be performed by a certified DRE. A certified DRE means a law enforcement officer trained to recognize impairment in a driver under the influence of a controlled substance rather than, or in addition to, alcohol (Legislature Service Bureau, 2015).

## RESULTS FROM THE ORAL FLUID ROADSIDE ANALYSIS PILOT PROGRAM (MSP, 2019):

As a result of DRE-observed driver behavior and SFSTs, 89 drivers were arrested during the initial phase of the pilot program. Of those arrested, positive oral fluid roadside test results were reported for 83 drivers.



Results of the oral fluid roadside tests are detailed in the above chart (MSP, 2019). Of the 92 oral fluid roadside tests conducted, 21 returned positive results for the presence of two or more drugs. Eight tests provided negative results for all six drug categories. Six negative test results were further validated by either independent lab results, MSP forensic lab results, or both, showing negative results as well. The entirety of the Oral Fluid Roadside Analysis Pilot Program report can be viewed at: [https://www.michigan.gov/documents/msp/Oral\\_Fluid\\_Report\\_646833\\_7.pdf](https://www.michigan.gov/documents/msp/Oral_Fluid_Report_646833_7.pdf).

# FINAL RECOMMENDATIONS

## PER SE LIMIT RECOMMENDATION:

The Michigan Impaired Driving Safety Commission was created within the Michigan State Police pursuant to the Impaired Driving Safety Commission Act, 2016 PA 350 (MCL 28.791 to MCL 28.796). The Commission was charged with conducting research and to recommend a scientifically supported threshold of  $\Delta^9$ -tetrahydrocannabinol ( $\Delta^9$ -THC) bodily content to provide evidence for per se impaired driving in the state of Michigan.

The Commission carefully reviewed the most current as well as past scientific peer-reviewed literature. Likewise, the Commission invited experts in the areas of specific relevance to the Commission's charge to make presentations to the Commission and answer questions. Based on the total body of knowledge presently available, the Commission finds there is no scientifically supported threshold of  $\Delta^9$ -THC bodily content that would be indicative of impaired driving due to the fact that there is a poor correlation between driving impairment and the blood (plasma) levels of  $\Delta^9$ -THC at the time of blood collection. This poor correlation between driving impairment and the blood (plasma) concentrations of  $\Delta^9$ -THC at the time of blood collection is based on several factors that include:

1. Elimination of  $\Delta^9$ -THC undergoes very rapid elimination over several hours with a half-life (the amount of time required to eliminate one half of the total amount of  $\Delta^9$ -THC) of approximately 6 minutes followed by a long terminal elimination phase possessing a half-life of approximately 22 hours, or more (Heuberg et al., 2015). Due to the rapid initial elimination phase,  $\Delta^9$ -THC levels may be very low by the time blood is drawn for a blood test, which could underestimate the  $\Delta^9$ -THC levels at the time an individual was driving. By contrast,  $\Delta^9$ -THC has a long terminal elimination phase due to its absorption into fat tissue followed by its slow release over time back into the blood (Lucas et al., 2018). In long-term cannabis users, blood concentrations of  $\Delta^9$ -THC can remain above 1 ng/ml for 48-72 hours after administration (Wall et al., 1983). Therefore, current "no tolerance" policy in the state of Michigan, which assumes impairment at the level of detection,  $\geq 1$  ng/ml, might falsely conclude that an individual is impaired.
2. Regular users of cannabis respond differently to the same dose of  $\Delta^9$ -THC than occasional or infrequent users of cannabis due to a phenomenon termed "tolerance." Through frequent use, drug tolerance ensues such that higher doses of a drug are required to produce the same effects as achieved initially. Indeed, there is strong scientific evidence that tolerance does occur with regular and frequent use of cannabis (Colizzi, & Bhattacharyya, 2018). The implications of tolerance to cannabis are that lower blood  $\Delta^9$ -THC levels in infrequent users may result in impairment that would only be experienced at higher  $\Delta^9$ -THC levels by regular cannabis users.

*Therefore, because there is a poor correlation between  $\Delta^9$ -THC bodily content and driving impairment, the Commission recommends against the establishment of a threshold of  $\Delta^9$ -THC bodily content for determining driving impairment and instead recommends the use of a roadside sobriety test(s) to determine whether a driver is impaired.*

# FINAL RECOMMENDATIONS

## LAW ENFORCEMENT AND PROSECUTION EDUCATION:

In line with the recommendation to use a roadside sobriety test(s) to determine whether a driver is impaired, the Commission recommends additional training in impaired driving detection and investigation for law enforcement officers and prosecutors throughout the state.

Since 2010, the Michigan Commission on Law Enforcement Standards (MCOLES) has required completion of the NHTSA *DWI Detection and SFST* program for all basic law enforcement academy students. In addition, the Michigan Office of Highway Safety Planning (OHSP) requires that all officers assigned to grant funded impaired driving enforcement initiatives have completed the same program.

The Commission recommends that in addition to these existing requirements, MCOLES considers mandating all licensed officers complete the 16-hour Advanced Roadside Impaired Driving Enforcement (ARIDE) training program. The ARIDE program is designed to increase officers' ability to observe and identify the signs of driver impairment related to drugs, alcohol, or a combination of both. The program includes refresher training for administering SFSTs and is designed as an intermediate course between the SFST and DRE training programs. Currently, approximately 20% of licensed officers in Michigan have been trained in ARIDE.

The Commission also recommends expansion of the DRE training program. There are only approximately 160 active DREs in Michigan at present; there are counties that do not have a DRE within their jurisdiction. Though not feasible to require all officers be trained to the DRE level, expansion of the program to enable callout response for enforcement situations in which this level of expertise may be of assistance (injury and fatal traffic crashes, for instance) is advised.

The Commission recommends expansion of the Prosecuting Attorneys Association of Michigan (PAAM) Traffic Safety Training Program (TSTP). This program prepares prosecutors for the complexities of impaired driving case law and court practices; it is an essential component of the state's efforts to deter impaired driving.



# FINAL RECOMMENDATIONS

## PUBLIC EDUCATION:

The Commission recommends the development of public education efforts designed to inform the public about the effects of cannabis consumption and potential dangers of driving under the influence of cannabis. In addition, the Commission recommends that these efforts be developed in collaboration with cannabis stakeholder groups.

As reported in the 2018 GHSA Report, “Marijuana messaging must address two points: 1) That marijuana can impair driving, and 2) That driving while impaired by marijuana is illegal.”

## FUTURE RESEARCH:

The Commission recommends additional research be conducted to develop and validate methodologies to aid in assessing impairment of skills required for the operation of a motor vehicle due to the influence of cannabis. This may include SFSTs and oral fluid testing in assessing whether an individual is operating a vehicle while under the influence of a controlled substance.

## DRUGGED-DRIVING COMMISSION:

The Commission conducted an extensive review of the existing state of scientific knowledge to develop its recommendations. However, as research continues, future results may change our understanding of this issue. Therefore, the Commission recommends the establishment of a permanent Drugged-Driving Commission to review new research and the experience of other states to keep the Legislature apprised of emerging relevant information.

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# GLOSSARY OF TERMS

**$\Delta^9$ -tetrahydrocannabinol ( $\Delta^9$ -THC):** The primary psychotropic compound in marijuana.  $\Delta^9$ -THC belongs to a broader family of compounds that possess a similar chemical structure termed, cannabinoids.

**11-carboxy-THC:** A major metabolite of  $\Delta^9$ -tetrahydrocannabinol and possesses minimal psychotropic properties.

**11-hydroxy-THC:** A major metabolite of  $\Delta^9$ -tetrahydrocannabinol and possesses psychotropic properties.

**Absorption:** The movement of drugs and chemicals across biological membranes to enter the body.

**Binding Affinity:** The strength in which a drug binds with specificity to a protein, typically a receptor or enzyme. Typically, the higher the affinity of specific binding between a drug and receptor the greater the biological activity that is initiated.

**Bioavailability:** the percentage of the total amount of a drug or chemical that is absorbed after administration and that is available to exert its biological activity.

**Biphasic:** a process possessing two distinct phases or stages.

**Cannabidiol (CBD):** A chemical naturally produced by the cannabis sativa belonging to the family of compound termed cannabinoids. CBD has minimal psychotropic activity.

**Cannabinoid Receptor 1:** A protein on the surface of cells to which cannabinoids bind to initiate their biological activity. Cannabinoid receptor 1 is highly abundant on neural cells within the brain and is responsible for the euphoric effects associate with marijuana.

**Cannabis Sativa:** plant also termed marijuana, which is the source of plant-derived cannabinoid compounds, including  $\Delta^9$ -tetrahydrocannabinol (THC).

**Distribution:** once absorbed, the movement of drugs and chemical throughout the body that occurs primarily via circulation in the blood stream.

**Drug Half-Life:** the period of time required to metabolize and/or eliminate one half of the total amount of a drug that has been absorbed.

**Excretion:** elimination of compounds from the body in urine and feces.

**First Pass Metabolism:** the process by which when drugs and chemicals are absorbed for the gastrointestinal tract and enter the blood stream they are first transported to the liver to undergo metabolism.

**Metabolism:** the conversion of compounds by drug metabolizing enzymes primarily present in the liver to more water-soluble chemicals to enhance their utilization by the body and their excretion in urine and feces.

# GLOSSARY OF TERMS

**Oromucosal Route:** exposure that occurs through the application of chemicals to the mucosal membrane of the oral cavity.

**Peak Plasma Concentration:** the highest concentration of a drug or chemical present within plasma after initial exposure or administration.

**Plasma Concentrations:** the amount of a drug or chemical present in the liquid (i.e., non-cellular) portion of blood.

**Psychotropic Effects:** Changes in brain function and resulting in alterations in perception, mood, consciousness, cognition, and/or behavior that are typically caused by exposure to a chemical.

**Respiratory Route:** Exposure to an agent by inhalation via the lungs.

**Structurally-Related Compounds:** Chemicals possessing a similar basic chemical structure and belonging to a “family” of compounds with similar chemical and/or biological properties.

**Tincture:** a concentrated liquid herbal extract.

**Vascular:** related to blood vessels.

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# Risk of road accident associated with the use of drugs: A systematic review and meta-analysis of evidence from epidemiological studies

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## ABSTRACT

This paper is a corrigendum to a previously published paper where errors were detected. The errors have been corrected in this paper. The paper is otherwise identical to the previously published paper. A systematic review and meta-analysis of studies that have assessed the risk of accident associated with the use of drugs when driving is presented. The meta-analysis included 66 studies containing a total of 264 estimates of the effects on accident risk of using illicit or prescribed drugs when driving. Summary estimates of the odds ratio of accident involvement are presented for amphetamines, analgesics, anti-asthmatics, anti-depressives, anti-histamines, benzodiazepines, cannabis, cocaine, opiates, penicillin and zopiclone (a sleeping pill). For most of the drugs, small or moderate increases in accident risk associated with the use of the drugs were found. Information about whether the drugs were actually used while driving and about the doses used was often imprecise. Most studies that have evaluated the presence of a dose-response relationship between the dose of drugs taken and the effects on accident risk confirm the existence of a dose-response relationship. Use of drugs while driving tends to have a larger effect on the risk of fatal and serious injury accidents than on the risk of less serious accidents (usually property-damage-only accidents). The quality of the studies that have assessed risk varied greatly. There was a tendency for the estimated effects of drug use on accident risk to be smaller in well-controlled studies than in poorly controlled studies. Evidence of publication bias was found for some drugs. The associations found cannot be interpreted as causal relationships, principally because most studies do not control very well for potentially confounding factors.

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## 1. Introduction

It is well-established that driving under the influence of alcohol increases the risk of accident involvement. This has been known at least since the famous Grand Rapids study was made in the early nineteen sixties (Borkenstein et al., 1964). Less is known about the effects of drugs (medicinal or illicit) on the risk of accident involvement. A few systematic literature reviews and meta-analyses of the effects of drugs on accident risk have been reported (Thomas, 1998; Bates and Blakely, 1999; Ramaekers et al., 2004; Baldock, 2007; Orriols et al., 2009; Rapoport et al., 2009; Smink et al., 2010; Dassanayake et al., 2011; Asbridge et al., 2012). These studies deal only with a single drug or a few drugs and not all of them include a meta-analysis providing a summary estimate of the effect of drug use on accident risk.

Thomas (1998) reviewed studies of the association between benzodiazepine use and motor vehicle accidents. He listed 23 estimates of risk (Table 3 of the paper). Twelve of these indicated an odds ratio of accident involvement for users of benzodiazepines of between 1.01 and 1.50. Three estimates indicated an odds ratio between 2.01 and 2.50. Thomas concluded that use of benzodiazepines approximately doubles the risk of motor vehicle accidents. The study did not include a meta-analysis of the estimates of risk.

Bates and Blakely (1999) reviewed studies of the role of cannabis in motor vehicle accidents. The study did not include a meta-analysis. It listed the findings of a few studies and concluded that there was no evidence that the use of cannabis alone increased the risk of being held culpable for an accident. The authors added that it cannot be ruled out that use of cannabis leads to an increased risk of accidents causing less serious injuries or property damage. Ramaekers et al. (2004) argued that the effect of cannabis on the risk of accident involvement depends on the dose taken and on how long after taking cannabis driving takes place. They pointed out that the absence of a relationship between cannabis use and risk of accident involvement in some studies is probably attributable to the fact that these studies only found inactive metabolites of cannabis

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in body fluids. Metabolites of cannabis can persist for a long time after it was taken, particularly in urine. The study did not include a meta-analysis.

Baldock (2007) reviewed the literature on cannabis and the risk of accident involvement. The review was a traditional narrative review and did not include a meta-analysis. Baldock argued that many studies have methodological flaws, in particular with respect to the control for potentially confounding factors.

Orriols et al. (2009) presented a systematic review of studies of the risk associated with the use of medicinal drugs. The review included 22 studies of variable methodological quality. An assessment of study quality was made and studies rated as good, average or poor. A meta-analysis was not performed. It was concluded that the use of benzodiazepines is associated with an increased risk of accident, but that there is too little evidence to conclude anything for other medicinal drugs. Poor control for confounding factors was cited as a weakness of many studies.

Rapoport et al. (2009) reported a meta-analysis of benzodiazepine use and accident risk. The meta-analysis was based on six case-control studies and three cohort studies (a short definition of study designs is given later in this paper). The summary estimate of the odds ratio of accident involvement for benzodiazepine users was 1.61 according to the case-control studies and 1.60 according to the cohort studies. The meta-analysis did not score studies formally with respect to study quality and did not test for publication bias. Smink et al. (2010) conducted a systematic literature review of studies assessing the relationship between use of benzodiazepines and accident involvement, but did not perform a meta-analysis.

Dassanayake et al. (2011) performed a systematic literature review and meta-analysis of studies of the effects on accident risk of benzodiazepines, antidepressants and opioids. A meta-analysis was only feasible for studies of benzodiazepines. The summary estimates of the odds ratio of accident involvement for benzodiazepine users were 1.59 for case-control studies, 1.81 for cohort studies and 1.41 for culpability studies. These estimates are close to those reported by Rapoport et al. (2009). The study did not score studies formally for quality and did not test for publication bias.

Asbridge et al. (2012) conducted a meta-analysis of observational studies of the effects of acute cannabis use on the risk of accident involvement. Nine studies were included. The summary estimate of the odds ratio of accident involvement associated with use of cannabis was 2.10 for fatal accidents and 1.74 for non-fatal accidents. Study quality was scored formally by means of the Newcastle-Ottawa quality assessment scale. A test for the possible presence of publication bias was not included.

The systematic reviews and meta-analyses quoted above included only a few drugs, in particular benzodiazepines and cannabis. Not all reviews included a meta-analysis. Not all meta-analyses considered study quality. No meta-analysis addressed the possibility of publication bias.

The aim of this paper is to summarize current knowledge regarding the risks associated with the use of drugs while driving. The paper seeks to improve previous reviews by: (1) including as many drugs as possible in the systematic literature review and meta-analysis; (2) assessing study quality and testing how it influences study findings; (3) testing and adjusting for the possible presence of publication bias. Alcohol is not included in this study. The focus is on drugs used in regular medical treatment or illicit drugs used recreationally.

## 2. Systematic review of literature

### 2.1. Literature search and study retrieval

A literature search was made of several databases, including the TRANSPORT literature database, PubMed, ScienDirect (searching

**Table 1**  
Coding of studies in systematic review.

Variable coded	Codes applied
Study identification	By authors; studies numbered chronologically (oldest = 1; newest = 66)
Year of publication	1976 through 2011
Country of publication	By name: Australia, Canada, Finland, France, Great Britain, Iran, Netherlands, New Zealand, Norway, Spain, Taiwan, Thailand, United States
Study design	Coded as: (1) Case-control study; (2) Case-crossover study; (3) Cohort study (prospective or retrospective); (4) Culpability study; (5) Registry-based cohort study; (6) Sample survey
Drugs assessed	Main types: (1) Amphetamines; (2) Analgesics; (3) Anti-asthmatics; (4) Anti-depressives; (5) Anti-histamines; (6) Benzodiazepines (including barbiturates and diazepam); (7) Cannabis (including marijuana); (8) Cocaine; (9) Opiates (including morphine); (10) Zopiclone; (11) Penicillin; (12) Miscellaneous other drugs (very many)
Accident severity	Coded as: Fatal, serious injury, injury, property-damage-only
Estimator of risk	Coded as: Odds ratio (OR); relative risk (RR); standardized incidence ratio (SIR) (SIR is a measure of relative risk based on a population registry)
Measure of drug use	Coded as: Determined by clinical analysis; by prescriptions; by self-reports
Confounders controlled	Coded as: A = age; B = driver behavior; C = smoking; D = other drug use; E = education; F = body mass index; G = gender; H = drug use history; I = other disease (than drug addiction); J = use of alcohol; K = type of accident; L = time after prescription; M = miles driven; N = location or region; O = marital status; P = ethnicity; Q = mental distress, depression; R = place of residence; S = driving speed; T = time of day; V = attitude to violations; X = driver experience; Y = season; W = any other confounding variable
Dose-response assessed	Coded as yes or no
Dose-response found	Coded as yes or no

the journals Accident Analysis and Prevention, Drugs and Alcohol Dependence and Journal of Safety Research) and the SafetyLit database. In general, “drugs AND accident risk” was used as search term. Studies that were judged as relevant based on the title and the abstract were obtained and assessed with respect to inclusion in the systematic literature review and meta-analysis. A total of 102 studies were reviewed in detail. 66 of these studies were included in the meta-analysis. 36 studies could, for various reasons, not be included in the meta-analysis. Tables 2 and 3 list studies included and not included.

### 2.2. Coding of studies for systematic review

As part of the systematic review, studies were coded according to the following characteristics:

1. Year of publication. Studies were published between 1976 and 2011.
2. Country where study was made. Thirteen countries, listed in Table 1, were represented.
3. Study design. Six different study designs were identified. These are listed in Table 1.
4. Types of drug. Twelve categories, listed in Table 1, were formed to identify the drugs studied.
5. Accident severity. This was coded as fatal accident, injury accident, and property-damage-only (PDO) accident.
6. Estimator of risk. Three estimators of risk have been applied in the studies: odds ratio, relative risk, and standardized incidence ratio.

**Table 2**  
Studies included in meta-analysis.

Study number	Authors	Year	Country	Design	Drugs assessed (see Table 1)	Accident severity	Estimator of risk	Measure of drug use	Confounders controlled (see Table 1)	Dose-response assessed	Dose-response found
1	Smart, Fejer	1976	Canada	Sample survey	1-6-7-9-12	Mostly PDO	Odds ratio	Self report	A	No	No
2	Skegg et al.	1979	Great Britain	Case-control	2-3-5-11-12	Serious injury	Odds ratio	Prescriptions	AGR	No	No
3	Honkanen et al.	1980	Finland	Case-control	2-6-12	Injury	Odds ratio	Self report	None	No	No
4	Jick et al.	1981	United States	Culpability	5-6	Injury	Odds ratio	Prescriptions	None	No	No
5	Hingson et al.	1982	United States	Sample survey	7	Mostly PDO	Odds ratio	Self report	AEGJM	Yes	Yes
6	Terhune	1983	United States	Culpability	7	Mostly PDO	Odds ratio	Lab analysis	None	No	No
7	Williams et al.	1985	United States	Culpability	7	Fatal	Odds ratio	Lab analysis	None	No	No
8	Oster et al.	1987	United States	Cohort	6	Injury	Odds ratio	Prescriptions	ADGQ	No	No
9	Oster et al.	1990	United States	Cohort	6	Injury	Relative risk	Prescriptions	ADG	Yes	Yes
10	Ray et al.	1992	United States	Cohort (retro)	4-6	Injury	Relative risk	Prescriptions	AGPRY	Yes	Yes
11	Terhune et al.	1992	United States	Culpability	1-6-7-8	Fatal	Odds ratio	Lab analysis	None	No	No
12	Benzo group	1993	France	Culpability	6	Injury	Odds ratio	Lab analysis	J	No	No
13	Leveille et al.	1994	United States	Case-control	2-4-5-6	Injury	Odds ratio	Prescriptions	AEGIMOP	Yes	Yes
14	Currie et al.	1995	Great Britain	Culpability	4-6	Injury	Odds ratio	Lab analysis	None	No	No
15	Drummer	1995	Australia	Culpability	1-6-7-9-12	Fatal	Odds ratio	Lab analysis	AG	No	No
16	Neutel	1995	Canada	Cohort (pros)	6	Injury	Odds ratio	Prescriptions	L	Yes	Yes
17	Hemmelgarn et al.	1997	Canada	Case-control	6	Injury	Odds ratio	Prescriptions	ADGIR	Yes	Yes
18	Barbone et al.	1998	Great Britain	Case-crossover	4-6-10-12	Injury, PDO	Odds ratio	Prescriptions	AEGIMOPR	Yes	Yes
19	Neutel	1998	Canada	Cohort	4-6	Injury	Odds ratio	Prescriptions	ADG	No	No
20	Longo et al.	2000	Australia	Culpability	6-7	Injury	Odds ratio	Lab analysis	None	Yes	Yes
21	McGwin et al.	2000	United States	Case-control	4-10	Mostly PDO	Odds ratio	Self report	AGMP	No	No
22	Swann	2000	Australia	Culpability	7	Fatal	Odds ratio	Lab analysis	None	No	No
23	Fergusson	2001	New Zealand	Sample survey	7	Mostly PDO	Odds ratio	Self report	ABGMVX	Yes	Yes
24	Lowenstein	2001	United States	Culpability	7	Injury	Odds ratio	Lab analysis	None	No	No
25	Chipman et al.	2002	Canada	Case-control	7-8	Mostly PDO	Relative risk	Self report	AGDX	No	No
26	Dussault et al.	2002	Canada	Case-control	1-6-7-8-9	Fatal	Odds ratio	Lab analysis	Not clear	No	No
27	Gerberich et al.	2003	United States	Sample survey	7	Serious injury	Relative risk	Self report	ACEFGIJO	Yes	Yes
28	Mura et al.	2003	France	Case-control	6-7-9	Injury	Odds ratio	Lab analysis	AG	No	No
29	Wadsworth et al.	2003	Great Britain	Sample survey	4	Injury	Odds ratio	Self report	ACGJJOQW	No	No
30	Brault et al.	2004	Canada	Case-control	1-6-7-8-9	Fatal	Odds ratio	Lab analysis	AGTW	No	No
31	Drummer et al.	2004	Australia	Culpability	1-6-7-9	Fatal	Odds ratio	Lab analysis	ADGJKR	Yes	Yes
32	Etninam et al.	2004	Canada	Case-control	4	Injury	Odds ratio	Prescriptions	ADGIRW	Yes	Yes
33	Movig et al.	2004	Netherlands	Case-control	1-6-7-8-9	Injury	Odds ratio	Lab analysis	ADGJTY	No	No
34	Macdonald et al.	2004	Canada	Cohort (bef-aft)	7-8	Mostly PDO	Odds ratio	Self report	AG	No	No
35	Asbridge et al.	2005	Canada	Sample survey	7	Mostly PDO	Odds ratio	Self report	AEGJNX	Yes	Yes
36	Assum	2005	Norway	Case-control	1-6-7-8-9	Mostly fatal	Odds ratio	Lab analysis	N	No	No
37	Blows et al.	2005	New Zealand	Case-control	7	Injury	Odds ratio	Self report	AEGJMPST	No	No
38	Delaney et al.	2005	Canada	Case-control	12	Injury	Odds ratio	Prescriptions	ADGIW	No	No
39	French et al.	2005	United States	Cohort	6	Injury	Odds ratio	Prescriptions	AFGIOW	No	No
40	Lam et al.	2005	New Zealand	Case-control	4	Injury	Odds ratio	Self report	AEGJOQT	No	No
41	Laumon et al.	2005	France	Culpability	1-7-8-9	Fatal	Odds ratio	Lab analysis	AJT	Yes	Yes
42	Mathijssen	2005	Netherlands	Case-control	6-7-9	Injury	Odds ratio	Lab analysis	None	No	No
43	Tamblyn et al.	2005	Canada	Cohort	6	Injury	Odds ratio	Prescriptions	ADGIW	No	No
44	Wadsworth et al.	2005	Great Britain	Sample survey	4	Injury	Odds ratio	Self report	ACDEGHJQ	No	No
45	Hemmelgarn et al.	2006	Canada	Case-control	12	Injury	Odds ratio	Prescriptions	AGRW	No	No
46	Sagberg	2006	Norway	Culpability	4	Mostly PDO	Odds ratio	Self report	AM	No	No
47	Bramness et al.	2007	Norway	Cohort (registry)	3-6-12	Injury	Relative risk	Prescriptions	AG	No	No
48	Engeland et al.	2007	Norway	Cohort (registry)	3-6-9-11-12	Injury	Relative risk	Prescriptions	AG	No	No
49	Hebert	2007	Canada	Case-control	6	Injury	Odds ratio	Prescriptions	ADGIW	No	No
50	Mann et al.	2007	Canada	Sample survey	7	Injury	Odds ratio	Self report	AEGNOW	Yes	Yes
51	Bramness et al.	2008	Norway	Cohort (registry)	4	Injury	Relative risk	Prescriptions	AG	No	No
52	Fergusson et al.	2008	New Zealand	Sample survey	7	Mostly PDO	Relative risk	Self report	BJM	Yes	Yes
53	Gustavsen et al.	2008	Norway	Cohort (registry)	6-10	Injury	Relative risk	Prescriptions	AG	No	No
54	Hours et al.	2008	France	Culpability	4-6-11	Injury	Odds ratio	Self report	AJW	No	No

55	Rapoport et al.	2008	Canada	Case-crossover	4-6	Mostly PDO	Odds ratio	Prescriptions	AEGIMOPR	No
56	Vingilis and Wilk	2008	Canada	Sample survey	2-4-6-9	Injury	Odds ratio	Self report	QAGJJPQ	Yes
57	Bachs et al.	2009	Norway	Cohort (registry)	9	Injury	Relative risk	Prescriptions	AGHY	Yes
58	Gibson et al.	2009	Great Britain	Case-crossover	2-4-5-6-9-10	Injury	Relative risk	Prescriptions	AEGIMOPR	Yes
59	Majdzadeh et al.	2009	Iran	Case-crossover	9	Injury	Relative risk	Lab analysis	AEGIMOPR	No
60	Richer et al.	2009	Canada	Sample survey	7	Mostly PDO	Odds ratio	Self report	ABCJM	No
61	Woratanarat et al.	2009	Thailand	Case-control	1-4-5-7-9	Injury	Odds ratio	Lab analysis	None	No
62	Orrtols et al.	2010	France	Cohort (registry)	2-5-12	Injury	Odds ratio	Prescriptions	ADGJNTW	No
63	Pulido et al.	2010	Spain	Sample survey	7-8	Injury	Odds ratio	Self report	ADEGJMPW	Yes
64	Yang et al.	2011	Taiwan	Case-crossover	6-10	Injury	Odds ratio	Prescriptions	D	Yes
65	Gjerde et al.	2011	Norway	Case-control	1-6-7-9-10	Fatal	Odds ratio	Lab analysis	AGTY	No
66	Orrtols et al.	2011	France	Cohort (registry)	6-10-12	Injury	Odds ratio	Prescriptions	ADGJTW	Yes

7. Measure of drug use. Three indicators of drug use have been applied: self-reported use, records of prescriptions, and results of laboratory analyses.
8. Confounders controlled. Potentially confounding factors were identified by letters. A total of 24 potentially confounding factors were coded, see [Table 1](#).
9. Dose-response pattern assessed. This refers to whether a study tested for a dose-response relationship between the dose taken of a drug and its effect on accident risk.
10. Dose-response pattern found. This refers to whether a study found a dose-response relationship between a drug and the risk of accident involvement.

These variables are listed in [Table 1](#).

### 2.3. Main characteristics of available studies

A total of 66 studies were included in the systematic review and meta-analysis. [Table 2](#) lists these studies. Most of the studies are recent. 47 of the studies have been published between 2000 and 2011. The 66 studies contain a total of 264 estimates of the risk of accident involvement associated with the use of drugs. The most common study design is the case-control design, which was used in 20 studies. This design normally involves comparing a sample of accident victims treated at a medical facility to a group of drivers not involved in accidents with respect to various risk factors of interest. Sample surveys, i.e. questionnaires mailed to a sample of the population were used in 12 studies. A cohort design, which includes both prospective and retrospective studies, was applied in 15 studies. Fourteen studies were culpability studies, i.e. studies relying on the induced exposure approach ([Chandraratna and Stamatiadis, 2009](#)), comparing a group of drivers involved in accidents at fault to a group of drivers involved in accidents not-at-fault. The remaining five studies were case-crossover studies. A case-crossover study is a study in which the same subjects serve both as cases and controls. Thus, a person would be a case when using a certain drug and a control when not using it. To save space, a further description of the study designs will not be given in this paper.

Thirty studies assessed the effect on accident risk of a single drug. Thirty-six studies assessed the effects of more than one drug, although these drugs were not necessarily used in combination at the same time. No study assessed the effects of more than six of the drugs identified in this review. An advantage of trying to assess the effects of multiple drugs is that it is then, in principle, possible to control for exposure to another drug when assessing the effects of a specific drug. This, however, is not possible when several drugs are used at the same time. In such cases, an estimate of risk can only show the combined effects of the drugs that were used together, not the specific effect of any one of these drugs. When deciding which results to include from studies reporting multiple results, results that referred to use of a single drug were included, whereas results that referred to combined use of many drugs were not included. As an example, from the study by [Gjerde et al. \(2011\)](#), two estimates of accident risk were given for benzodiazepines, diazepam, zopiclone, cannabis and amphetamine. For these drugs the estimates of risk that stated “only benzodiazepines”, “only diazepam”, and so on were included, whereas those that did not state explicitly that the estimate of risk applied to the use of a single drug only were not included. Unfortunately, not all studies state explicitly that the estimate of risk applied to a single drug only, hence some estimates may refer to the combined use of more than one drug.

A majority of the studies (44) assessed the association between the use of drugs and involvement in injury accidents. Ten studies assessed the risk of fatal accidents and twelve studies assessed the risk of property damage only accidents. Nearly all studies (54) applied the odds ratio of accident involvement as the estimator of

**Table 3**  
Studies not included in meta-analysis.

Study number	Authors	Year	Country	Design	Reason for not including study in meta-analysis
1	MacPherson et al.	1984	United States	Sample survey	Standard errors of estimates of risk are not reported
2	Beylich et al.	1994	Norway	Cohort	Estimates of risk are hypothetical and imprecise; standard errors are not stated
3	Marowitz	1995	United States	Cohort	Standard errors of estimates of risk are not stated
4	Meulemans et al.	1998	Belgium	Not clear	Study report was not retrieved
5	Thomas	1998	Canada	Review	Study is a literature review and does not contain original estimates of risk
6	Bates and Blakely	1999	New Zealand	Review	Study is a literature review and does not contain original estimates of risk
7	Río and Alvarez	2000	Spain	Cohort	Study does not contain any estimates of risk
8	Zador et al.	2000	United States	Case-control	Study deals only with alcohol
9	Longo et al.	2001	Australia	Culpability	Standard errors of estimates of risk given only in a difficult-to-read figure
10	Río et al.	2002	Spain	Cohort	Study does not contain any estimates of risk
11	Vernon et al.	2002	United States	Case-control	Study does not deal with risk associated with drug use
12	Lardelli-Claret et al.	2003	Spain	Case-control	Study does not deal with risk associated with drug use
13	Keall et al.	2004	New Zealand	Case-control	Study deals only with alcohol
14	Ramaekers et al.	2004	Netherlands	Review	Study is a literature review and does not contain original estimates of risk
15	Cunradi et al.	2005	United States	Cohort	Type of drug on which estimates of risk are based is not stated
16	Lagarde et al.	2005	France	Cohort	Study does not deal with risk associated with drug use
17	Smink et al.	2005	Netherlands	Cohort	Study deals with injury severity only, not risk of accident involvement
18	Oyefeso et al.	2006	Great Britain	Cohort (registry)	Definition of risk not relevant for the purpose of this study
19	Sheridan et al.	2006	New Zealand	Review	Study is a literature review and does not contain original estimates of risk
20	Alvarez and Fierro	2007	Spain	Cohort	Study does not deal with risk associated with drug use
21	Bédard et al.	2007	Canada	Case-control	Study does not use accident involvement as dependent variable
22	Baldock	2008	Australia	Review	Study is a literature review and does not contain original estimates of risk
23	Dubois et al.	2008	Canada	Culpability	Study does not use accident involvement as dependent variable
24	Far et al.	2008	Spain	Sample survey	Type of drug used while driving is not stated, only type of drug used in general consumption
25	Hingson et al.	2008	United States	Sample survey	Type of drug on which estimates of risk are based is not stated
26	Lenguerrand et al.	2008	France	Case-control	Duplicates a paper included (paper 34 on the list in Table 2 above)
27	Blomberg et al.	2009	United States	Case-control	Study deals only with alcohol
28	Davey and Freeman	2009	Australia	Cohort	Study presents exposure only; no estimates of risk
29	Lia et al.	2009	Norway	Review	Study is a literature review and does not contain original estimates of risk
30	Orriols et al.	2009	France	Review	Study is a literature review and does not contain original estimates of risk
31	Pasnin et al.	2009	Norway	Case series	Study contains only a case series, no control group to enable risks to be estimated
32	Rapoport	2009	Canada	Review	Study is a literature review and does not contain original estimates of risk
33	Smink	2010	Netherlands	Review	Study is a literature review and does not contain original estimates of risk
34	Dubois et al.	2010	Canada	Cohort (registry)	Study does not use accident involvement as dependent variable
35	Dassanayake et al.	2011	Australia	Review	Study is a literature review and does not contain original estimates of risk
36	Asbridge et al.	2012	Canada	Review	Study is a literature review and does not contain original estimates of risk

risk. In the studies that permitted a comparison of the odds ratio and relative risk as estimators of accident risk, there was only a small difference between them. In the meta-analysis all estimators of risk (odds ratio, relative risk and standardized incidence ratio) have therefore been treated as equivalent.

Twenty studies relied on self reports of drug use. Obviously, such reports are likely to be inaccurate with respect both to the amount and time of drug use. Twenty-six studies relied on data regarding prescriptions. Prescriptions are usually specific with respect to the dose to be taken and the duration of the use of a drug. Patient compliance with prescribed use is, however, always an issue. Twenty studies assessed drug use in terms of the results of laboratory analyses, usually analyses of a sample of blood or saliva. This is clearly the most reliable method for determining whether a drug was used when driving.

Studies vary greatly with respect to how many potentially confounding factors they have controlled for. Twenty-three studies evaluated the presence of a dose-response relationship between the dose taken of a drug and the size of the increase in accident risk; twenty-two of these studies confirmed a dose-response relationship, one did not. The other 43 studies did not probe for a dose-response relationship.

Thirty-six studies were neither included in the systematic review nor in the meta-analysis. The reason for omitting these studies was in all cases related to the possibility of including them in the meta-analysis. Some studies could in principle have been included in a systematic review, but excluded from meta-analysis. Table 3 lists the studies that were excluded from the systematic review

and the meta-analysis and states for each study the reason for its exclusion.

The reasons for excluding studies were many, but three reasons were the most important: (1) The study dealt with a different topic, such as the risk associated with alcohol; (2) The study did not report sufficient information to be included in meta-analysis; (3) The study was a review, i.e. a secondary source not reporting original results of research.

#### 2.4. Study quality assessment

It is clear that the studies that could be included in the meta-analysis are very different in a number of important respects. It was therefore decided to summarize study characteristics in terms of a numerical measure of study quality. While assessing study quality is certainly not an exact science (Elvik, 2008, 2011), it is widely regarded as a useful part of meta-analysis (Borenstein et al., 2009). The quality score was based on four study characteristics:

1. How drug use was measured. A distinction was made between five methods of determining drug use. Listed in order from the most reliable to the least reliable, these were: (a) Laboratory analysis of blood samples; (b) Laboratory analysis of saliva samples or a mixture of blood and saliva; (c) Laboratory analysis of urine samples or a mixture of urine and other body fluids; (d) Prescribed dose of a drug according to prescriptions given by physicians; (e) Self-reported drug use.

2. How accident severity was specified. A distinction was made between three levels (fatal, injury, property damage only), and a study rated as best if it included estimates of risk for all levels of accident severity.
3. Control for confounding factors. A checklist was made of nine important potentially confounding factors and studies rated according to how many of these factors they controlled for. Up to two additional points could be earned if a study controlled for other potentially confounding factors in addition to the nine that were listed.
4. Confirmation of the presence of a dose-response relationship between the dose taken of a drug and its effect on accident risk.

These variables were selected because they are consistently reported in studies, thus avoiding the problem of basing quality scores on missing data. Table 4 shows how studies were scored according to these characteristics.

Control for confounding represented 55% of the maximum score (11 out of 20 points) and was thus regarded as by far the most important element of study quality. Quality scores were stated on a scale ranging from 0 to 1. Fig. 1 shows the quality scores of the 264 estimates of risk in chronological order.

As can be seen from Fig. 1, no estimate scored higher for study quality than 0.65. The majority of estimates scored less than 0.50, which is the midpoint of the scale. A tendency can be seen for study quality to improve over time. The main reason why so many studies score comparatively low for quality is poor control for potentially confounding variables. No study scored more than 7 points for control for confounding factors. The maximum score was 11.

### 3. Meta-analysis

#### 3.1. Study inclusion criteria and statistical weighting

Estimates of the risk of accident involvement associated with the use of drugs were included in the meta-analysis if the standard error of the estimate was stated or could be derived. Each estimate of risk was assigned a statistical weight which was inversely proportional to its sampling variance (standard error squared). Most estimates of risk were odds ratios, which were converted to log odds ratios in order to apply the normal distribution for statistical testing and estimation of confidence intervals. The statistical weight assigned to each estimate of risk was defined as follows:

$$w_i = \frac{1}{v_i}$$

Variance of logarithm of odds ratio : 
$$v_i = \frac{1}{A} + \frac{1}{B} + \frac{1}{C} + \frac{1}{D}$$

A, B, C, and D are the four numbers that enter the calculation of the odds ratio. In case relative risk was used to measure accident involvement, variance was estimated as:

$$\text{Variance of logarithm of relative risk} = \frac{1}{A} + \frac{1}{B} - \frac{1}{A+C} - \frac{1}{B+D}$$

In studies not stating the numbers used to estimate the odds ratio or relative risk, the statistical weight was derived from the 95% confidence interval for the estimate of risk as follows:

$$\text{Statistical weight} = \frac{1}{((\ln(\text{upper } 95\%) - \ln(\text{lower } 95\%))/3.92)^2}$$

All these statistical weights are fixed-effects weights, i.e. they account only for the sampling variance of each estimate of risk (Borenstein et al., 2009). When there is systematic variation between estimates of risk, a random-effects model of meta-analysis should be used. To determine if estimates of risk vary systematically

(i.e. more than random sampling variation), the following test statistic is computed:

$$Q = \sum_{i=1}^g w_i y_i^2 - \frac{(\sum_{i=1}^g w_i y_i)^2}{\sum_{i=1}^g w_i}$$

where  $y_i$  is the logarithm of estimate of risk  $i$  and  $w_i$  is the fixed-effects weight of estimate  $i$ . This test statistic has a Chi-square distribution with  $g - 1$  degrees of freedom, where  $g$  is the number of estimates of risk that have been combined. If this test statistic is statistically significant, a random effects model of meta-analysis is more adequate than a fixed effects model. In a random effects model, the statistical weights are modified to include a component reflecting the systematic variation of estimates of risk between studies. This component is estimated as follows (Shadish and Haddock, 1994):

$$\tau^2 = \frac{Q - (g - 1)}{C}$$

$Q$  is the test statistic described above,  $g$  is the number of estimates and  $C$  is the following estimator:

$$C = \sum_{i=1}^g w_i - \left[ \frac{\sum_{i=1}^g w_i^2}{\sum_{i=1}^g w_i} \right]$$

The variance of each result now becomes:

$$v_i^* = \tau^2 + v_i$$

The corresponding statistical weight becomes the inverse of the variance. The weighted mean estimate of risk is

$$\bar{y} = \exp \left( \frac{\sum_{i=1}^g w_i y_i}{\sum_{i=1}^g w_i} \right)$$

Exp is the exponential function (that is 2.71828 raised to the power of the expression in parenthesis),  $y_i$  is the logarithm of each estimate of risk and  $w_i$  is the statistical weight (fixed-effects or random-effects) of each estimate of effect. A 95% confidence interval for the weighted mean estimate of risk is obtained according to the following expression: 95% confidence interval (upper/lower limit) =  $\exp \left[ \left( \frac{\sum_{i=1}^g w_i y_i}{\sum_{i=1}^g w_i} \right) \pm 1.96 \cdot 1 / \sqrt{\sum_{i=1}^g w_i} \right]$

The weights in this expression are either the fixed effects weights or the random effects weights, depending on the model of analysis adopted.

#### 3.2. Exploratory analysis

To prepare for meta-analysis, a funnel plot of all estimates of the risk of accident involvement associated with the use of drugs while driving was prepared. In total, the 66 studies included in the meta-analysis contained 264 estimates of risk. Fig. 2 shows the funnel plot. The scales used for the axes are as recommended by Sterne and Egger (2001).

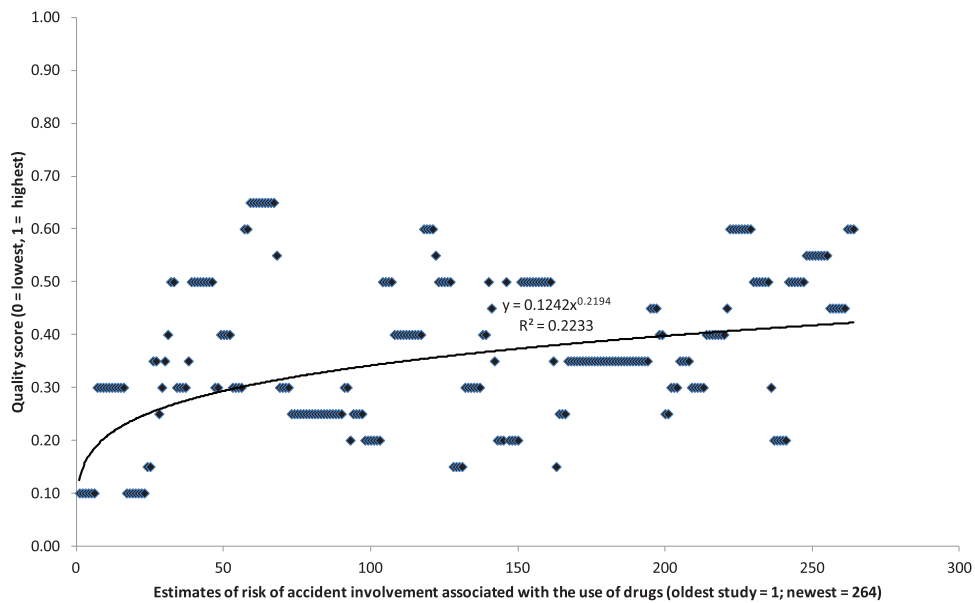
The horizontal axis shows the logarithm of the estimate of risk; positive values indicate an increase of risk, negative values indicate a reduction of risk. The vertical axis shows the standard error of each estimate of risk. The scale has been inverted, so that estimates that have a small standard error are located at the top of the diagram.

Ideally speaking, the outer contours of the data points should resemble a funnel turned upside down. Contours have been indicated in Fig. 2; some data points are located outside the contour lines, suggesting either the presence of outlying data points or large heterogeneity in estimates of risk. Nevertheless, it is evident that

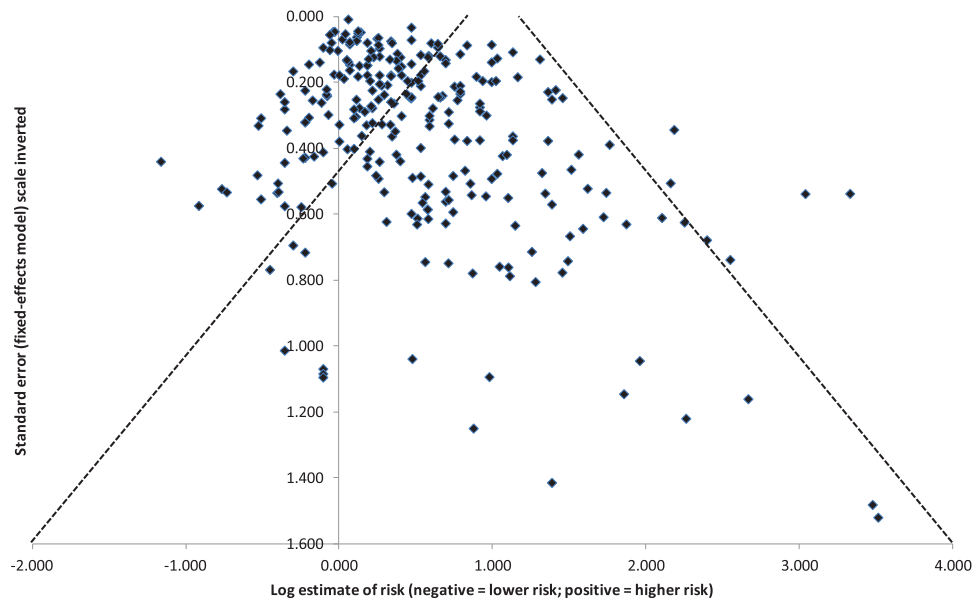
**Table 4**  
Study quality assessment.

Study characteristic	Scores assigned	Maximum possible score
Measure of drug use	5 = laboratory analysis of blood samples for all subjects (cases and controls); 4 = laboratory analysis of samples of saliva or mix of blood and saliva; 3 = laboratory analysis of samples of urine or mix of urine and other body fluids; 2 = prescriptions; 1 = self report	5 (25% of total score)
Specification of accident severity	2 = at least two levels of accident or injury severity included in the same study; 1 = accidents at a specific level of severity (fatal, injury, property damage) included; 0 = a mix of injury accidents and property damage accidents included	2 (10% of total score)
Control for confounding factors	9 = if all the following potentially confounding factors are controlled for: Age, gender, km driven, drug use history, dose of drug, use of other drugs, use of alcohol, health status (co-morbidity), place of residence 2 = additional points if multiple other potentially confounding factors are controlled for 1 = additional point if one other potentially confounding factor is controlled for	11 (55% of total score)
Test of dose-response	2 = tested and found; 1 = tested but not found; 0 = not tested or not relevant	2 (10% of total score)

**Scoring of studies**  
Points counted and divided by maximum possible score (20 = 5 + 2 + 11 + 2). Expressed as relative score, e.g. 12/20 = 0.60



**Fig. 1.** Quality scores of 264 estimates of risk associated with the use of drugs while driving.



**Fig. 2.** Funnel plot of all estimates of relative risk associated with the use of drugs while driving.

**Table 5**

Design of meta-analysis with respect to model of analysis (fixed-effects versus random-effects) and test for publication bias (by means of the trim-and-fill technique).

Drug	Accident severity	Number of estimates	Test for heterogeneity	Model of analysis	Trim-and-fill analysis	Data points added
Amphetamine	Fatal	8	Positive	Random effects (RE)	Performed	3 (FE); 1 (RE)
	Injury	2	Not applicable	Fixed effects (FE)	Not performed	0
	Property damage	1	Not applicable	Fixed effects	Not performed	0
Analgesics	Injury	8	Positive	Random effects	Performed	2 (FE); 2 (RE)
	Anti-asthmatics	6	Negative	Fixed effects	Performed	1 (FE)
Anti-depressives	Injury	20	Positive	Random effects	Performed	1 (FE); 2 (RE)
	Property damage	5	Positive	Random effects	Performed	0
Anti-histamines	Injury	7	Negative	Fixed effects	Performed	0
Benzodiazepines	Fatal	10	Positive	Random effects	Performed	0
	Injury	51	Positive	Random effects	Performed	34 (FE); 26 (RE)
	Property damage	4	Negative	Fixed effects	Not performed	0
Cannabis	Fatal	10	Positive	Random effects	Performed	0 (FE); 1 (RE)
	Injury	15	Positive	Random effects	Performed	1 (FE); 2 (RE)
	Property damage	17	Positive	Random effects	Performed	14 (FE); 7 (RE)
Cocaine	Fatal	4	Positive	Random effects	Not performed	0
	Injury	3	Positive	Random effects	Not performed	0
	Property damage	4	Positive	Random effects	Not performed	0
Opiates	Fatal	7	Positive	Random effects	Performed	5 (FE); 2 (RE)
	Injury	18	Positive	Random effects	Performed	3 (FE); 1 (RE)
	Property damage	1	Not applicable	Fixed effects	Not performed	0
Penicillin	Injury	5	Positive	Random effects	Performed	0
Zopiclone	Fatal	1	Not applicable	Fixed effects	Not performed	0
	Injury	4	Positive	Random effects	Not performed	0
	Property damage	1	Not applicable	Fixed effects	Not performed	0

the data points located near the top of the diagram are less dispersed than those located closer to the bottom. Most of the data points indicate an increase in risk, but the left part of the diagram appears to be less populated by data points than the right, suggesting the possible presence of publication bias. Publication bias denotes the tendency not to publish studies if their findings are not statistically significant, go in the opposite direction of what was expected (e.g. indicating lower risk when drugs are used) or are otherwise regarded as difficult to interpret.

Based on Fig. 2, it was decided to continue the meta-analysis. Summary estimates of risk were developed if at least five estimates of risk were available in the original studies. All levels of accident severity were initially aggregated; subsequently different summary estimates of risk were obtained for each level of accident severity; some of these estimates were based on less than five source estimates. It was possible to obtain summary estimates of risk for eleven different drugs. When three or more estimates of risk were available, it was tested whether there was systematic between-study variation in the estimates of risk. If there was systematic variation (heterogeneity), a random-effects model of meta-analysis was adopted (Borenstein et al., 2009).

### 3.3. Testing and adjusting for publication bias

If at least five individual estimates of risk were available, a trim-and-fill analysis (Duval and Tweedie, 2000a, 2000b; Duval, 2005) was performed to test and adjust for the possible presence of publication bias. The trim-and-fill technique is based on the assumption that in the absence of publication bias, the data points in a funnel plot ought to be symmetrically distributed around the summary estimate. The technique detects the possible presence of publication bias by testing for asymmetry in the funnel plot by means of three estimators that are based on ranks. Duval and Tweedie (2000a, 2000b) label these estimators  $R$ ,  $L$  and  $Q$ ; the simpler and more widely used estimators are  $R$  and  $L$  and the testing made in this paper was confined to those estimators.

To perform a trim-and-fill analysis, estimates of risk are sorted from the lowest to the highest. A summary estimate of risk is obtained and the differences between the individual estimates of risk and the summary estimate are computed. These differences are then ranked from the smallest to the largest. Ranks are signed. Thus, any estimate of risk lower than the mean gets a negative rank. Any estimate higher than the mean gets a positive rank. The estimator  $R$  is based on the length of the rightmost number of ranks associated with positive effects, i.e. the number of positive ranks larger than the absolute value of any of the negative ranks. Denoting this length with  $\gamma$ , the estimator is defined by  $R_0 = \gamma - 1$ . The second estimator is based on the sum of ranks for the positive effects. Denoting the ranks by  $r_i$ , the sum of positive ranks is defined by  $T_n = \sum_{r_i > 0} r_i$ , an estimator of the number of missing studies is defined by:  $L_0 = \frac{4T_n - n(n+1)}{2n-1}$ .

A more detailed technical description of how to perform a trim-and-fill analysis is given in the publications quoted above as well as Høye and Elvik (2010).

Table 5 summarizes the design of the meta-analysis. It shows the groups that were formed and the tests performed in each group. A total of 24 groups were formed by combining type of drug and accident severity. A test for heterogeneity (systematic variation) in estimates of risk was performed for 19 groups. The test was positive in 16 cases. A trim-and-fill analysis was applied in 14 groups. It indicated publication bias in ten cases. Results are presented both with and without adjusting for publication bias.

### 3.4. Main analysis

Table 6 reports the results of analysis. The risk associated with the use of drugs is stated in terms of a summary odds ratio. The summary odds ratio in each cell of Table 6 is based on between 1 and 51 individual estimates. Estimates that are statistically significant at the 5% level are shown in bold.

Summary estimates of risk based on less than five studies must be regarded as highly uncertain. The largest number of estimates



**Table 6**  
Summary estimates of relative risk of accident involvement associated with the use of various drugs. Based on meta-analysis.

Drug	Accident severity	Number of estimates	Best estimate of odds ratio <sup>a</sup>	95% confidence interval	Best estimate adjusted for publication bias <sup>a</sup>	95% confidence interval
Amphetamine	Fatal	8	<b>5.61</b>	(2.74, 11.49)	<b>5.17</b>	(2.56, 10.42)
	Injury	2	<b>6.19</b>	(3.46, 11.06)	<b>6.19</b>	(3.46, 11.06)
	Property damage	1	<b>8.67</b>	(3.23, 23.32)	<b>8.67</b>	(3.23, 23.32)
Analgesics	Injury	8	1.06	(0.92, 1.21)	1.02	(0.89, 1.16)
	Anti-asthmatics	6	<b>1.33</b>	(1.09, 1.62)	<b>1.31</b>	(1.07, 1.59)
Anti-depressives	Injury	20	<b>1.39</b>	(1.17, 1.70)	<b>1.35</b>	(1.11, 1.65)
	Property damage	5	1.28	(0.90, 1.80)	1.28	(0.90, 1.80)
Anti-histamines	Injury	7	<b>1.12</b>	(1.02, 1.22)	<b>1.12</b>	(1.02, 1.22)
Benzodiazepines	Fatal	10	<b>2.30</b>	(1.59, 3.32)	<b>2.30</b>	(1.59, 3.32)
	Injury	51	<b>1.65</b>	(1.49, 1.82)	<b>1.17</b>	(1.08, 1.28)
	Property damage	4	<b>1.35</b>	(1.04, 1.76)	<b>1.35</b>	(1.04, 1.76)
Cannabis	Fatal	10	1.31	(0.91, 1.88)	1.26	(0.88, 1.81)
	Injury	15	1.26	(0.99, 1.60)	1.10	(0.88, 1.39)
	Property damage	17	<b>1.48</b>	(1.28, 1.72)	<b>1.26</b>	(1.10, 1.44)
Cocaine	Fatal	4	<b>2.96</b>	(1.18, 7.38)	<b>2.96</b>	(1.18, 7.38)
	Injury	3	1.66	(0.91, 3.02)	1.66	(0.91, 3.02)
	Property damage	4	1.44	(0.93, 2.23)	1.44	(0.93, 2.23)
Opiates	Fatal	7	<b>2.13</b>	(1.23, 3.72)	<b>1.68</b>	(1.01, 2.81)
	Injury	18	<b>1.94</b>	(1.51, 2.50)	<b>1.91</b>	(1.48, 2.45)
	Property damage	1	<b>4.76</b>	(2.10, 10.80)	<b>4.76</b>	(2.10, 10.80)
Penicillin	Injury	5	1.12	(0.91, 1.39)	1.12	(0.91, 1.39)
Zopiclone	Fatal	1	2.60	(0.89, 7.56)	2.60	(0.89, 7.56)
	Injury	4	1.42	(0.87, 2.31)	1.42	(0.87, 2.31)
	Property damage	1	<b>4.00</b>	(1.31, 12.21)	<b>4.00</b>	(1.31, 12.21)

<sup>a</sup> Estimates shown in bold are statistically significant at the 5% level.

of risk was found for benzodiazepines. There were 65 estimates of risk in total, of which 10 for fatal accidents, 51 for injury accidents and 4 for property damage only accidents. All summary estimates indicate an increase in the odds ratio of accident involvement associated with using benzodiazepines. The increase in accident risk displays a severity gradient; the increase in risk is largest for fatal accidents, smaller for injury accidents and still smaller for property damage only accidents.

The trim-and fill analysis indicated the presence of substantial publication bias in the estimates of the risk of injury accident associated with using benzodiazepines. Twenty-six new data points were added according to the random-effects analysis. Fig. 3 shows these data points in addition to the original 51 data points.

Adjusting for publication bias by means of the trim-and-fill method reduced the summary odds ratio for involvement in injury accidents from 1.65 to 1.17. The adjusted estimate remains statistically significant at the 5% level.

The second largest number of estimates of risk (42) refers to the use of cannabis. The summary odds ratio indicates that the risk of becoming involved in an accident at any level of severity increases moderately (by about 25–50%) when using cannabis. Evidence of publication bias was found in summary estimates of risk at all levels of accident severity. Adjusting for publication bias lowered all summary estimates of risk. Fig. 4 shows the new data points added by the trim-and-fill analysis of estimates of risk referring to property damage only accidents.

Adjusting for publication bias reduced the summary estimate of the odds ratio of becoming involved in a property damage only accident when using cannabis from 1.48 to 1.26. The adjusted estimate was, however, statistically significant at the 5% level.

As far as the other drugs are concerned, a severity gradient with respect to the increase in risk is seen for cocaine. However, the confidence intervals of the odds ratios for injury accidents and property-damage-only accidents overlap almost completely, which indicates that the small difference in the summary estimates

of risk is not statistically significant. For opiates and zopiclone, the pattern is irregular. There is a somewhat greater increase in the risk of a fatal accident than in the risk of an injury accident, but then again a larger increase in the risk of a property-damage-only accident. For both these drugs, however, the differences between fatal accidents and injury accidents with respect to summary estimates of risk are not statistically significant. For amphetamine, an adverse pattern is observed: risk increases more for injury accidents and property damage accidents than for fatal accidents. Again, it should be noted that this trend is not statistically significant.

Some summary estimates of risk are not statistically significant at the 5% level. This applies to the risks associated with analgesics and penicillin. The summary estimate of the risk of property damage only accidents associated with the use of anti-depressives also failed to reach statistical significance.

By and large, the increase in the risk of accident involvement associated with the use of drugs must be regarded as modest. This applies particularly to some of the medicinal drugs. Thus, the odds ratio for accident involvement is 1.06 for analgesics, 1.33 for anti-asthmatics, 1.28–1.39 for anti-depressives, and 1.12 for penicillin. Fifteen of the summary estimates indicate less than a doubling of risk. Compared to the huge increase in accident risk associated with alcohol, as well as the high accident rate among young drivers (Elvik, 2010), the increases in risk associated with the use of drugs are surprisingly small. It should be noted, however, the several of the summary estimates of risk presented in Table 6 are highly uncertain. Thus, nine of the twenty-four summary estimates of risk in Table 6 were not statistically significant at the 5% level.

### 3.5. Sensitivity analysis

The results of a meta-analysis partly depend on analytic choices made by the analyst (Elvik, 2005). It is important to assess the sensitivity of results of meta-analysis with respect to these choices.

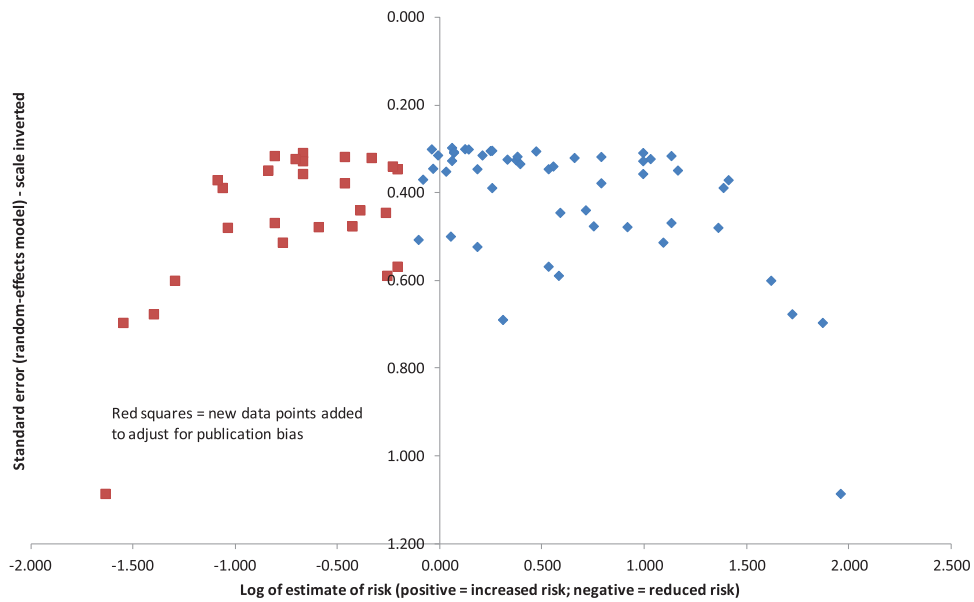


Fig. 3. Funnel plot of estimates of risk associated with use of benzodiazepines – adjusted for publication bias (random-effects model).

The sensitivity of summary estimates of risk has been tested with respect to:

1. How drug use was measured (self report, prescription, laboratory analysis).
2. Study quality.
3. The possible presence of outlying data points.

In the summary estimates of risk presented in Table 6, all estimates were combined, irrespective of how the use of a drug was measured. One may suspect, however, that the imprecision associated with self reported use of drugs, and to some extent use inferred from prescription data might “water down” estimates of risk. The only objective evidence of drug use comes from laboratory analyses of body fluids, which show both the type of drug used and dose present in the body.

A comparison was made of estimates of the odds ratio of accident involvement based on self reported drug use, drug use as known from prescriptions and drug use as inferred from laboratory analyses. To make the comparison as stringent as possible, it was based only on injury accidents and the odds ratio estimator of risk. With these restrictions, the different measures of drug use could only be compared for analgesics, anti-depressives, benzodiazepines, cannabis and cocaine. The results are reported in Table 7.

There is a weak tendency for estimates of risk based on drug use determined by means of laboratory analysis to be higher than estimates of risk based on self reported drug use. The differences are small and the confidence intervals surrounding estimates of risk are very wide. Still, it cannot be ruled out that the increase in accident risk associated with the use of drugs has been slightly underestimated by not relying exclusively on studies that determined drug use by means of laboratory analysis.

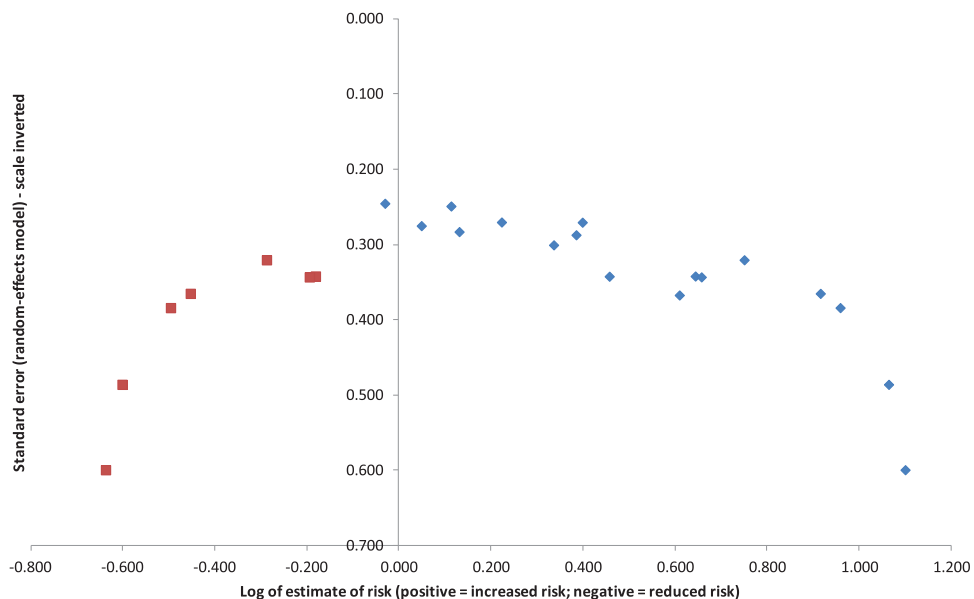


Fig. 4. Funnel plot of estimates of risk associated with use of cannabis – adjusted for publication bias (random-effects model).

**Table 7**  
Comparison of estimates of risk based on different measures of drug use.

Drug	Odds ratio of involvement in injury accident based on three measures of drug use					
	Self reported drug use		Drug use based on prescriptions		Drug use determined by laboratory analysis	
	Best estimate	95% confidence interval	Best estimate	95% confidence interval	Best estimate	95% confidence interval
Analgesics	1.30	(0.92, 1.84)	1.14	(0.91, 1.44)		
Anti-depressives	1.99	(1.28, 3.08)	1.10	(0.77, 1.59)	3.10	(0.54, 17.75)
Benzodiazepines	1.64	(0.96, 2.78)	1.37	(1.20, 1.56)	1.96	(1.34, 2.87)
Cannabis	1.31	(0.80, 2.15)			1.16	(0.79, 1.71)
Cocaine	1.56	(0.79, 3.08)			2.04	(0.58, 7.13)

On the other hand, other sources of error may pull in a different direction. In particular, poor studies tend to be associated with exaggerated estimates of risk, attributable above all to poor control for potentially confounding variables. Houwing et al. (2009) show that poor control for confounding variables in case-control studies is associated with highly misleading estimates of risk, often considerably exaggerating the risk associated with the use of a drug. To test if a similar tendency can be found in the studies included in the meta-analysis, weighted regression analyses were run for all cases in which summary estimates of risk were based on at least five individual estimates. Each individual estimate was assigned its fixed- or random-effect statistical weight, and regressions run with study quality score as independent variable and estimate of risk as dependent variable. The following functions were fitted to the scatter plots: linear, logarithmic, inverse, power, exponential and quadratic. The results are presented in Table 8.

Five of the six functions have a single parameter and will therefore not have a turning point. The quadratic function has two parameters, allowing for one turning point. In the majority of cases, a quadratic function fitted the data best, but the function was rejected as nonsensical in most of these cases. The quadratic functions usually implied negative estimates of risk for studies scoring either high or low for study quality. This is logically impossible, and strongly suggests that the function fitted best simply because it had an additional parameter compared to the single-parameter functions. However, the quadratic functions were accepted if they did not imply negative estimates of risk. To illustrate the relationships found, fitted estimates of risk were calculated for studies scoring 0.20, 0.50 and 0.80 on the quality scale (which ranged from 0 to 1). Due to the small variation of quality scores for studies of the risk associated with the use of penicillin (four studies scored 0.35, the fifth scored 0.30), no meaningful relationship between study quality and the estimate of risk could be found.

As can be seen from Table 8, there is in many cases a tendency for estimates of risk to be higher in poor studies than in good

studies. This pattern is not universal, however. Cases can also be found in which there is a positive relationship between study quality and estimate of risk. However, in the majority of cases, high study quality appears to be associated with lower estimates of risk.

Finally, the presence of outlying estimates of risk was assessed. This assessment was made by successively omitting one estimate of risk at a time and re-estimating the summary estimate of risk based on the remaining  $N - 1$  individual estimates. If the estimate based on  $N - 1$  individual estimates stayed inside the 95% confidence interval of the summary estimate of risk based on all individual estimates, no individual estimate was classified as outlying. The possible presence of outlying estimates of risk was only tested if there were at least five estimates.

Only one outlying estimate of risk was found. It referred to studies evaluating the risk of fatal accident associated with the use of benzodiazepines. The 95% confidence interval for studies that have evaluated the relationship between use of benzodiazepines and risk of becoming involved in a fatal accident ranges from 1.59 to 3.32. When one of the estimates in the study of Brault et al. (2004) was omitted, the summary estimate of risk dropped from 2.30 (based on  $N$  estimates) to 1.58 (based on  $N - 1$  estimates). This single estimate (3.90) therefore exerts a decisive influence on the summary estimate of risk. The estimate is above the upper 95% confidence limit, but it is not highest reported estimate of risk among the studies included, which was the estimate of 14.40 in the study of Assum (2005). The latter estimate, however, had a smaller statistical weight than the estimate presented by Brault et al. (2004).

#### 4. Discussion

Is the use of drugs while driving associated with an increase in the risk of accident involvement? That was the question that motivated the study reported in this paper. Based on available evidence, the answer to this question is yes. Summary estimates of risk were developed for eleven different drugs. For most of the drugs,

**Table 8**  
Relationship between study quality score and estimates of risk.

Drug	Accident severity	Sign of relationship between quality score and estimate of risk	Best fitting function	Assessment of best fitting function	Alternative function	Summary estimate of risk for all studies	Fitted estimate of risk for quality score of 0.2	Fitted estimate of risk for quality score of 0.5	Fitted estimate of risk for quality score of 0.8
Amphetamines	Fatal	Negative	Exponential	Accepted	None	5.61	7.02	4.71	3.16
Analgesics	Injury	Negative	Quadratic	Rejected	Exponential	1.06	1.19	1.06	0.85
Anti-asthmatics	Injury	Positive	Quadratic	Rejected	Power	1.33	1.05	1.60	1.99
Anti-depressives	Injury	Negative	Quadratic	Rejected	Exponential	1.39	2.03	1.30	0.84
Anti-depressives	PDO <sup>a</sup>	Negative	Quadratic	Rejected	Linear	1.28	1.64	1.28	0.92
Anti-histamines	Injury	Positive	Exponential	Accepted	None	1.12	0.95	1.08	1.23
Benzodiazepines	Fatal	Negative	Quadratic	Rejected	Linear	2.30	3.21	2.57	1.93
Benzodiazepines	Injury	Negative	Exponential	Accepted	None	1.65	2.88	1.43	0.71
Cannabis	Fatal	Curvilinear	Quadratic	Accepted	None	1.31	2.26	1.58	7.03
Cannabis	Injury	Positive	Quadratic	Rejected	Power	1.26	1.04	1.36	1.55
Cannabis	PDO <sup>a</sup>	Curvilinear	Quadratic	Accepted	None	1.48	1.46	3.47	12.08
Opiates	Fatal	Positive	Quadratic	Rejected	Power	2.13	1.63	2.62	3.34
Opiates	Injury	Curvilinear	Quadratic	Accepted	None	1.94	16.16	0.73	21.18

<sup>a</sup> PDO = property damage only.

it was possible to stratify estimates of risk according to accident severity. The summary estimates indicate that the odds ratio of accident involvement increases when drugs are used, but only fifteen of the estimates show a statistically significant increase in risk. The estimates are consistent in the sense that all of them indicate that accident risk increases. On the other hand, estimates of risk vary considerably and some of the variations, if taken at face value, appear difficult to explain.

There is, therefore, reason to remain sceptical to many of the findings reported in this paper. In the first place, it is not always clear that drugs were actually used while driving. Most studies provide no information regarding the situation or circumstances in which drugs were used. However, when a drug has been prescribed, it is likely that it will be taken and that its effects may be present when the user is driving. Moreover, a prescribed drug taken in an excessive dose may affect accident risk more strongly than when only the prescribed dose was taken. Laboratory analyses of blood samples provide the best evidence of drug use. Such analyses provide objective evidence that a drug was actually used and may give a fairly good indication of the dose taken of the drug. Thus, it is likely that most estimates of risk refer to driving that took place while the drug still had an effect, although it may not have been taken when the driver was behind the wheel.

In the second place, to claim that a certain risk factor is causally related to an increase in risk, one must rule out the possibility that the increase in risk was caused by one or more different risk factors. In practice, it is never possible to attain complete control for all confounding factors in observational (i.e. non-experimental) studies. Many of the studies reviewed in this paper did not control very well for confounding factors. It is likely that the estimates of risk in these studies are influenced by residual confounding, i.e. they show an increase in risk which is attributable to a set of correlated risk factors, not just the single risk factor of drug use. A tendency, albeit somewhat inconsistent, was found for well-controlled studies to report lower increases in risk than poorly controlled studies. One should, of course, take this as indicative only. Nevertheless, the evidence is not strong enough to conclude that the use of drugs is causally related to the increases in accident risk. There are fairly consistent statistical associations, but on the whole, control for potentially confounding factors remains too poor to rule out the possibility that these factors may have influenced estimates of risk.

In the third place, there is great heterogeneity in estimates of risk. This study cannot offer any explanation of this heterogeneity. Part of it may be related to study design and the quality of data and statistical analysis; part of it may be real. For most drugs, there are too few studies to compare the results obtained by means of different study designs. Such a comparison was made for benzodiazepines. The weighted mean odds ratio for accident involvement was 1.31 in case-control studies, 1.33 in culpability studies, 1.91 in cohort studies and 1.26 in case-crossover studies. With the exception of cohort studies, these estimates are very close to each other and the confidence intervals overlap considerably.

One potential source of error in meta-analysis is an undetected time trend in estimates of risk. If, over time, estimates of risk show a consistent tendency in a certain direction, failure to account for this may produce summary estimates of risk that are not representative of current knowledge. A test was run for estimates of the risk associated with benzodiazepines. Studies reporting on the risk associated with benzodiazepines span the period from 1976 to 2011. A statistically significant tendency was found for estimates of risk to increase over time (the fitted estimate of risk was 1.33 for the year 1976 and 1.72 for the year 2011). For most of the drugs covered by this study, any test for a time trend would be weak because there are few data points that cover a rather short period of time. As an example, there are eleven estimates of risk for cocaine, covering the period from 1992 to 2010. This period may be too short for any trend to emerge.

Extensive testing for the possible presence of trends over time was therefore not performed.

In the fourth place, the practical implications of the findings remain largely unknown. To estimate the contribution that driving under the influence of drugs makes to accidents, it is not enough to know the risk associated with the drugs. One should also know the share of traffic that takes place under the influence of the drugs. If that share is minor, the contribution will be small. But very few roadside studies have been made to determine how common it is to drive after taking drugs.

## 5. Conclusions

The main conclusions of the research reported in this paper can be summarized as follows:

1. A meta-analysis has been performed of 66 studies reporting a total of 264 estimates of the risk of accident involvement associated with the use of drugs while driving.
2. Summary estimates of risk were developed for eleven different drugs. All these estimates indicate that the use of drugs is associated with an increase in the odds ratio of becoming involved in an accident.
3. The increase in accident risk associated with the use of a drug is in most cases fairly modest; a majority of estimates indicate that the increase in risk is less than 100% (i.e. less than a doubling of the risk).
4. The trim-and-fill test indicates the presence of publication bias for some drugs. Adjusting for publication bias lowers the estimates of risk associated with the use of drugs.
5. Many studies are of modest quality, in particular with respect to the control for potentially confounding factors. A numerical index of study quality was developed; it was found that studies scoring high on this index sometimes reported lower estimates of risk than studies scoring low on the index for study quality.
6. The associations between the use of drugs and accident risk presented in this paper cannot be interpreted as causal relationship. There is a need for more research, embodying better control of confounding factors than past studies and more careful attention to how drug use is measured, preferably relying on laboratory analyses.

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Dear Members of the Senate Law & Justice Committee,

Thank you very much for scheduling this hearing and taking time out of your very busy calendar to consider issues related to the legalization of marijuana. I am honored to be able to speak with you today and help shed light on the many critical policy issues that must be thoughtfully addressed as Pennsylvania considers ending marijuana prohibition.

My family relocated from New Jersey to Denver, Colorado in 2012. Having graduated from Brooklyn Law School and serving as a bill drafter in New Jersey's Office of Legislative Services, I was very fortunate to find work in public policy at Colorado's House Majority Office for the 2013 session. After working on various other policy priorities, I was placed in charge of supporting the implementation of adult-use marijuana legalization and helped the legislature adopt the first in history adult-use marijuana statutes. Once session ended, I shifted to the Marijuana Enforcement Division and supported the regulatory agency's effort to create another first in history – a comprehensive set of regulations to oversee every aspect of a commercial adult-use marijuana market.

Since leaving public service, I have worked as an attorney with the law firm Vicente Sederberg and, today, am a partner in our sister public affairs firm VS Strategies. Over the years, I have advised governments, businesses, campaigns, and industry associations on the complex best-practices of cannabis regulation. Our firm has worked on just about every single aspect of the regulatory infrastructure, such as taxes, licensing, social equity, packaging and labeling, and testing. We've also helped advance public policy on social issues, such as record sealing, and public safety, such as DUID.

I would be happy to answer any questions that you have about any issues related to legalization, including those listed below or just about anything else one of the members finds important. To get us rolling, I've outlined a few thoughts on some of the committee's priority issues to get our conversation started:

- **DUID Laws** – This is one of the most complicated areas of public policy, as well as one of the most critical aspects of marijuana legalization. Many states have adopted a standard around 5 nanograms of THC, which Colorado considers a permissible inference that the driver was impaired but not a per se standard. Since THC can stay in someone's blood stream long after use and any impairment, we are working with our client Cognivue to support studies on their FDA approved technology to assess cognitive impairment in order to provide a clearer standard for highway safety.

- Taxes – There are a variety of issues that must be considered when establishing the amount of tax to be applied to marijuana products. Obviously, there needs to be enough revenue to cover all of the costs of regulation and fund some critical policy priorities for the state. However, taxation must not be too high that it makes regulated marijuana uncompetitive with an entrenched illicit market. It is also critical to note that marijuana taxes are regressive by nature, imposing a more significant burden on lower income persons and therefore, can have stronger negative economic impact.
  
- Test Procedures – Traditional consumer goods are required to comply with good manufacturing practices and overseen by a combination of federal and state regulators. In contrast, marijuana is only overseen by state regulations and states have elected to require compliance with a mandatory third-party testing program to help bridge the gap without the traditional infrastructure in place. In general, marijuana statutes should direct the primary regulatory agency to develop a mandatory testing program that covers potential contaminants and cannabinoid content. It should also expressly authorize products to be remediated and incentive licensees to invest in facility controls to ensure clean product.
  
- Regulatory Agency – Over the years, we have seen many states grapple with the right agency or agencies to regulate marijuana. This provided some clear lessons learned and identified two best practices:
  - A single lead agency should be placed in charge of regulating marijuana with other relevant agencies providing their expertise in support.
  - The lead agency should be the same or structurally similar to the state agencies that handle other highly regulated industries, such as alcohol, tobacco, or gaming.
  
- Licensing – It will likely take one to three years (or more) from passage of legislation until there is an active market in Pennsylvania that can displace illicit market activity. In addition to adopting regulations, a business will need to navigate the licensing process, local permitting like any other facility (building and fire departments), and then actually cultivate a crop. During this process, cannabis consumers will continue to patronize the illicit market and result in continuing arrests. Policy makers should adopt policies that can safely and legitimately accelerate the licensing process, while providing meaningful opportunities for new entrants to create a diverse industry.



**Testimony for Public Hearing on Adult-Use Cannabis in Pennsylvania**  
**Before the Law & Justice Committee, Pennsylvania State Senate**

**Jeremiah Mosteller, Senior Policy Analyst**

**Americans for Prosperity**

**Monday, February 28, 2022**

Thank you, Chair Regan, Minority Chair Brewster, and members of the Law & Justice Committee for allowing me to contribute to the Commonwealth's important conversations about legalizing adult-use cannabis. My name is Jeremiah Mosteller and I serve as a Senior Policy Analyst at Americans for Prosperity where I focus on criminal justice and cannabis regulation.

Americans for Prosperity is a grassroots organization dedicated to outreach, education, and advocacy on long-term solutions to the country's biggest problems that prevent people from realizing their full potential. Today, both an individual's having a harmful relationship with controlled substances and our society's response to addiction and substance use are barriers that stand in many people's way.

***A Failed Approach Preventing Increased Public Safety***

We approach these issues from an anti-prohibition perspective and do not advocate for the use of cannabis. We know from our work in communities across the country that substance use, particularly habitual use, can create internal barriers to people achieving their full potential while implicating public safety concerns such as impaired driving, property crime, use by children, and child neglect. But we also know from experience, data, and research that marijuana prohibition and enforcement have proven ineffective and act as a socially destructive "front door" to the criminal justice system.

While data is lacking in this area, it is estimated that the Commonwealth spends somewhere between \$46 million and \$180 million in taxpayer money each year to enforce cannabis prohibition.<sup>1</sup> More than 92,000 Pennsylvanians have been arrested for cannabis offenses in the past 5 years.<sup>2</sup> What have been the outcomes of this investment of taxpayer money over the past five decades?

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<sup>1</sup> Chris Goldstein, *Millennials bear the brunt of Pa. marijuana arrests*, The Inquirer (2018), [www.philly.com/philly/business/cannabis/millennials-bear-the-brunt-of-pa-marijuana-arrests-20180216.html](http://www.philly.com/philly/business/cannabis/millennials-bear-the-brunt-of-pa-marijuana-arrests-20180216.html); Jeffrey Miron, *The Budgetary Effects of Ending Drug Prohibition*, Cato Institute (2018), <https://www.cato.org/tax-budget-bulletin/budgetary-effects-ending-drug-prohibition>.

<sup>2</sup> Federal Bureau of Investigation, *Crime Data Explorer: Arrest – Pennsylvania*, Federal Bureau of Investigation (2021), <https://crime-data-explorer.fr.cloud.gov/pages/explorer/crime/arrest>.

- Trends in cannabis use show no consistent response to these efforts and the prevalence of cannabis use has increased among adults irrespective of these enforcement activities.<sup>3</sup>
- The black market for cannabis has continued to thrive in Pennsylvania fueling other associated violent and non-violent criminal activities that significantly impact public safety.
- Law enforcement agencies have shifted more and more resources away from their core mission of solving and preventing property and violent crime and toward drug enforcement efforts. Police now arrest someone as a suspect in a historically low percentage of violent (35.7%) and property (16.4%) crimes – leaving too many victims without justice and jeopardizing public safety.<sup>4</sup>

Prohibition is a failed approach to limiting cannabis use that is neither making us safer nor reducing the use of cannabis, but it is devastating thousands of lives across the Commonwealth each year.

We believe it is time for a different approach.

### ***Properly Structuring a Marijuana Market so All Can Access and Thrive***

Unlike many other advocates you may hear from as these conversations continue, we have no financial interest in the future market or are funded by those with a financial interest. While our main goal is to end what we believe is a failed and destructive approach to cannabis, we are working across the country to ensure that states that want to adopt either a medical or adult-use cannabis market do so in a manner that most effectively allows legal businesses to compete with the black market and ensures small businesses can thrive.

We are utilizing our team’s years of experience working on criminal justice, health care, regulatory, and many other issues to provide state leaders with guidance on how to establish a market that achieves four key goals:

- Allows innovation and research to thrive so we can deal with the social cost of marijuana, like dependence and impaired driving. Current criminalization prevents researchers from studying the positives and negatives of marijuana use and identifying solutions to these social costs.

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<sup>3</sup> John E. Schulenberg, et al., *Monitoring The Future: College Students & Adults Ages 19–60*, The University of Michigan Institute for Social Research (2021), available at <https://nida.nih.gov/drug-topics/trends-statistics/monitoring-future> (see Tables 5-1 through 5-5); See also Lloyd D. Johnston, et al., *Monitoring The Future Key Findings on Adolescent Drug Use*, The University of Michigan Institute for Social Research (2022), available at <https://nida.nih.gov/drug-topics/trends-statistics/monitoring-future> (see Figure 2).

<sup>4</sup> The F.B.I. does not release annual clearance rates per state and instead uses regions. Pennsylvania is included in the “Middle Atlantic” region with New Jersey and New York. See Federal Bureau of Investigation, *Table 26: Percent of Offenses Cleared by Arrest or Exceptional Means by Geographic Region and Division, 2020*, Federal Bureau of Investigation (2021), available at <https://crime-data-explorer.fr.cloud.gov/pages/downloads>.

The Pennsylvania Uniform Crime Reporting (UCR) Program has failed to provide updated clearance rate data since 2018 but that report showed similarly low clearance rates that were declining. See Pennsylvania State Police, *Crime In Pennsylvania Annual Uniform Crime Report*, Pennsylvania State Police (2019), available at <https://www.ucr.pa.gov/PAUCRSPUBLIC/CrimePublication/CrimePublicationReports>.

- Does not create a market where a handful of strong companies run the industry and small entrepreneurs face unnecessary barriers to access. The regulatory framework states establish should limit barriers to entry to those with a clear nexus to public health and safety and provide non-restrictive occupational and business licensing procedures.
- Imposes a total tax burden– federal, state, and local combined – that does not incentivize the continuation of gray or black markets by making them more easily accessible or profitable than legal businesses.
- Ensure individuals formerly involved in black- or grey-market cannabis operations and the criminal justice system have an opportunity to secure a true second chance so they can positively contribute to their communities and achieve their full potential.

### ***Key Lessons Learned from Other States***

#### **#1 - Prevent a California-like Crisis Through Intentional Taxation**

One of the biggest potential benefits of adult-use cannabis legalization is its potential to undermine the revenue of cartels and gangs by reducing the demand for black market products and in turn reducing the amount of violent crime experienced in the communities where these organizations currently operate. For this goal to be achieved though, states must establish a regulatory structure and tax rates that allow the legal market to compete with providers that will never comply with the law. Consumers will continue to purchase products from their legacy providers if it can save them substantial sums of money.<sup>5</sup>

The experience of California presents a clear warning for the Keystone State. Voters there approved a measure to establish an adult-use cannabis market more than five years ago, but the black market has continued to thrive given the state’s overburdensome regulations and high tax rates.<sup>6</sup> The best data available shows that \$8.7 billion worth of products are still purchased on the black market and that potentially 75% of the market is still controlled by unlicensed dealers.<sup>7</sup> This situation has resulted in leaders in some of the least tax-friendly localities suspending their local taxes in hopes that this will allow legal operators to more effectively compete with the black market.<sup>8</sup>

<sup>5</sup> Geoff Lawrence and Spence Purnell, *Marijuana Taxation and Black Market Crowd-Out*, Reason Foundation (2020), <https://reason.org/wp-content/uploads/marijuana-taxation-black-market-crowd-out.pdf> (“As demonstrated by alcohol and cigarettes, excessive taxation can influence consumers’ decisions to patronize the black market.”)

<sup>6</sup> The state imposes a 7.25% state and up to 3.5% local sales tax on consumers, a 15% state excise tax on all retail sales, and a significant cultivation tax on every plant farmers harvest from their fields or greenhouses. See Cal. Code Regs. Tit. 18, § 3700 (2021); See also California Department of Tax and Fee Administration, *Tax Rates – Special Taxes and Fees*, California Department of Tax and Fee Administration (2022), <https://www.cdtfa.ca.gov/taxes-and-fees/tax-rates-stfd.htm>.

<sup>7</sup> Tom Adams, et al., *California: Lessons from the World’s Largest Cannabis Market*, arcview Market Research (2020), [https://bdsa.com/wp-content/uploads/2019/08/2019\\_BDS\\_California\\_CIB\\_Exec\\_Summ\\_Final\\_With\\_A.pdf](https://bdsa.com/wp-content/uploads/2019/08/2019_BDS_California_CIB_Exec_Summ_Final_With_A.pdf); See also Los Angeles Times Editorial Board, *Californians overwhelmingly supported legalizing marijuana. Why is it still a mess?*, Los Angeles Times (2021), <https://www.latimes.com/opinion/story/2021-12-26/editorial-californians-overwhelmingly-supported-legalizing-marijuana-so-why-is-it-still-a-mess-five-years-later>; Alexander Nieves, *California’s legal weed industry can’t compete with illicit market*, Politico (2021), <https://www.politico.com/news/2021/10/23/california-legal-illicit-weed-market-516868>.

<sup>8</sup> KPIX 5, *San Francisco Suspends Cannabis Tax To Combat Illegal Marijuana Sales*, CBS SF Bay Area (2021), <https://sanfrancisco.cbslocal.com/2021/12/01/san-francisco-suspends-cannabis-tax-to-combat-illegal-marijuana-sales/>.

Other states with equally excessive or complicated tax regimes have similarly seen their black markets continue to thrive and dominate.<sup>9</sup>

Conversely, Michigan chose to impose a more reasonable and less complicated tax burden on its market.<sup>10</sup> Data from 2020 – the state’s first with a legal market – shows that it collected over \$31 million in tax revenue from excise taxes alone and that the legal providers have already been able to capture more than 60% of the market share within the state.<sup>11</sup>

It appears that Pennsylvania is poised to follow the example of Michigan rather than California. The current leading proposal in the Commonwealth – S.B. 473 – includes a 16% combined sales and excise tax rate that should position the future legal market to effectively compete with the black market. We would urge you to consider a phase-in approach to both taxes so that the legal market will be given time to properly establish itself against the black market since it already has an established market advantage.

## #2 - Stop Oligopolistic Control of the Markets Through Robust Competition

Reporting from other states reveals how rushed and improperly structured cannabis licensing schemes can result in entire state markets being controlled by one or a few large companies.<sup>12</sup> Reporting on Pennsylvania’s medical cannabis market already proves this is a real concern and shows how large companies have been able to dominate the market.<sup>13</sup> Pennsylvania should not follow these other states by establishing a market where only a handful of strong companies run the industry and small businesses are barred from bringing innovative products to the market.

A few steps the Commonwealth can take to ensure robust competition and a level playing field for all companies include:

- Avoid unnecessary and arbitrary statutory limitations on the number of businesses that will be able to operate in the new market.
- Include a provision that allows the number of licensed businesses to grow over time as the market demand grows.

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<sup>9</sup> See e.g. Natalie Fertig, “Talk About Clusterf---: Why Legal Weed Didn’t Kill Oregon’s Black Market,” Politico (2022), <https://www.politico.com/news/magazine/2022/01/14/oregon-marijuana-legalization-black-market-enforcement-527012>; Martin Kaste, *Despite Legalization, Marijuana Black Market Hides In Plain Sight*, NPR (2018), <https://www.npr.org/2018/05/16/610579599/despite-legalization-marijuana-black-market-hides-in-plain-sight>.

<sup>10</sup> The state imposed a 10% state excise tax and a delayed 6% sales tax. See Mich. Code § 333.27963 (2021); See also David Lyden & Jacob Johnson, *Michigan Based Cannabis Legal Group Breaks Down Recreational Marijuana Taxes*, 9&10 News (2019), <https://www.9and10news.com/2019/12/09/michigan-based-cannabis-legal-group-breaks-down-recreational-marijuana-taxes/>.

<sup>11</sup> Michigan Department of Treasury, *Treasury: First Adult-Use Marijuana Payments Distributed to Michigan Municipalities, Counties, State of Michigan* (2021), [https://www.michigan.gov/treasury/0,4679,7-121-1755\\_1963-553542--,00.html](https://www.michigan.gov/treasury/0,4679,7-121-1755_1963-553542--,00.html); Anderson Economic Group, *Michigan Cannabis Market Growth and Size*, Anderson Economic Group (2021), <https://www.michiganema.com/wp-content/uploads/2021/08/AEG-Michigan-Cannabis-Market-Study-Briefing.pdf>.

<sup>12</sup> See e.g. Izzy Kapnick, “Walgreens of Weed”: How Pot Law’s Seedy Start Created Florida’s Cannabis Oligopoly, Miami New Times (2021), <https://www.miaminewtimes.com/marijuana/marijuana-law-florida-cannabis-oligopoly-13317664>; Jeff Smith, *Florida’s medical cannabis industry has only one truly dominant player*, MJBizDaily (2019), <https://mjbizdaily.com/floridas-medical-cannabis-industry-only-one-dominant-player/>.

<sup>13</sup> Sam Wood, *Big firms find loophole, skirt Pennsylvania medical marijuana laws with corporate sleight of hand*, The Morning Call (2019), <https://www.mcall.com/news/pennsylvania/mc-nws-pa-medical-marijuana-big-firms-loophole-20190604-rvwbjedqz5d3dkmom2kzwggjj4-story.html>.

- Provide all businesses with a level playing field as to the required application process and the number of permits they can secure regardless of their involvement in other current industries.
- Prohibit any licensee – specifically those in the current medical market – from securing a “head start” that will allow them to dominate the new adult-use market before other competitors have an opportunity to join.

Adopting these recommendations will equip Pennsylvania to avoid the corruption scandals involving government officials in other jurisdictions and ensure large out-of-state companies are not able to fully dominate the adult-use market.

### #3 - Ensure Proper Fiscal Accountability and Transparency of New Tax Revenue

In 2018, a report from the Auditor General’s office estimated that the legalization of cannabis could provide more than \$581 million in tax revenue for the state in the first year a market is established.<sup>14</sup> While experts strongly caution against relying on such revenue projections, it is clear that the establishment of an adult-use cannabis market will present a financial benefit for the Commonwealth’s state and local governments.<sup>15</sup> All Pennsylvanians should be able to benefit from these new revenues through improved public services or a reduced income or property tax burden.

Many other states have made the imprudent decision to automatically allocate all cannabis tax revenues to particular programs, funds, or purposes. We fully agree that programs providing drug treatment, job training, reentry support, workforce development, and small business support are important community investments. Our sister organization – Stand Together Foundation – has invested in more than 200 such organizations.<sup>16</sup>

The problem with establishing “autopilot” spending of this new revenue is that today’s prudent programs are tomorrow’s failed experiments. It is also highly likely that any projections on the funding necessary for these purposes will likely result in programs being underfunded and/or overfunded in the near future. The needs of Pennsylvania’s citizens fluctuate year over year and this form of government appropriations will tie the hands of future General Assemblies. Subjecting this new spending and revenue to the same rules as other fiscal decisions in the state will allow the General Assembly to properly reallocate the state’s fiscal priorities in ways that we cannot predict today.

We recommend that the General Assembly either not include such types of automatic spending of the new cannabis revenue or incorporate a reasonable time limit on the

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<sup>14</sup> Pennsylvania Department of the Auditor General, *Regulating and Taxing Marijuana*, Pennsylvania Department of the Auditor General (2018), <https://www.paauditor.gov/press-releases/auditor-general-depasquale-says-state-could-reap-581-million-annually-by-regulating-taxing-marijuana> (Note: This revenue projection was based on an imprudent 35-37% combined tax rate.).

<sup>15</sup> See Jeff Chapman, et al., *Forecasts Hazy for State Marijuana Revenue*, Pew Charitable Trusts (2019), <https://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2019/08/forecasts-hazy-for-state-marijuana-revenue>; Spence Purnell & Allie Howell, *Market Size Estimates For Legalized Marijuana*, Reason Foundation (2019), <https://reason.org/policy-brief/market-size-estimates-for-legalized-marijuana/>.

<sup>16</sup> Stand Together Foundation, *Catalyst Directory*, Stand Together Foundation (2022), <https://standtogetherfoundation.org/catalysts/> (including organizations like Back on My Feet [Philadelphia], Black Men Heal [Ardmore], Safe Families for Children [multiple locations include Harrisburg] and Trade Institute of Pittsburgh).

length of automatic appropriation so the General Assembly can reevaluate what is needed in the near future. The General Assembly can still decide to appropriate this new revenue to the same purpose but requiring the use of the traditional appropriations process will provide vital flexibility, transparency, and accountability for how these new funds are used.

#### #4 – Ensure Everyone Receives a Second Chance

As noted above, more than 90,000 Pennsylvanians have been arrested for cannabis offenses in recent years.<sup>17</sup> If the Commonwealth decides that possession and distribution of cannabis should now be legal, this should be reflected both in how we apply our laws going forward and how we provide relief for those who have previously been arrested, convicted, and sentenced for cannabis offenses.

Some states have taken a piecemeal approach by legalizing adult-use cannabis and then later providing one or more forms of relief to those previously convicted of non-violent cannabis offenses.<sup>18</sup> Other states – like Montana and New Mexico – have adopted comprehensive statutes that deal with both issues simultaneously.<sup>19</sup>

Any lack of action in this area would leave thousands unnecessarily burdened by the weight of a criminal record that would not be imposed today, forcing them to face lifelong barriers to employment, education, and housing. We would recommend that the General Assembly consider three different types of opportunities for a second chance:

1. Full retroactive relief for any current charges, convictions, or sentences related to non-violent cannabis offenses where no related convictions or charges exist.
2. The opportunity to secure a resentencing hearing in court for those with charges and convictions for both cannabis offenses and other crimes.
3. Clean slate eligibility for anyone with past non-violent cannabis convictions.

### ***Other Important Issues to Consider***

#### Outdoor Grow

When most Americans traditionally think of farming, they think of fields of grain, corn, or tobacco. The cannabis industry operates very differently and the best data available shows that a small percentage of legal cannabis cultivators utilize a traditional, outdoor grow process similar to other agricultural products.<sup>20</sup> Fourteen out of the seventeen states with an implemented adult-use market have allowed outdoor cultivation of

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<sup>17</sup> Federal Bureau of Investigation, *Crime Data Explorer: Arrest – Pennsylvania*, Federal Bureau of Investigation (2021), <https://crime-data-explorer.fr.cloud.gov/pages/explorer/crime/arrest>.

<sup>18</sup> See e.g., Colorado [S.B. 13-283 (2013) (legalization); H.B. 17-1266 (2017) (providing expungement for misdemeanor cannabis offenses); HB. 20-1424 (2020) (providing mass pardon ability to Governor); H.B. 21-1090 (2021) (providing expungement for certain felony cannabis offenses)]; California [Prop. 64 (2016) (legalization); A.B. 1793 (2018) (resentencing and sealing of records)].

<sup>19</sup> H.B. 701, 2021 Legis., 2021 Reg. Sess. (Mont. 2021); S.B. 2, 55<sup>th</sup> Legis., 2021 Spec. Sess. (N.M. 2021) (adopted simultaneously with H.B. 2 which established regulatory structure).

<sup>20</sup> Cannabis Business Times, *State of the Cannabis Cultivation Industry Report*, Cannabis Business Times (2021), <https://www.cannabisbusinesstimes.com/article/special-report-2021-state-of-the-cannabis-cultivation-industry-report/> (showing that only 35% of responding companies utilize outdoor grow methods and only 11% rely solely on outdoor grow).

cannabis in addition to indoor cultivation.<sup>21</sup> The trade-offs those states have needed to weigh when considering indoor and outdoor grow methods are power consumption and environmental impact versus potential theft or diversion of products.<sup>22</sup>

The Commonwealth should have a critical conversation about this issue with experts who can speak to the environmental impacts of both methods, the potential strain placed on the power grid of indoor grow, and efforts these other states have undertaken to ensure safe outdoor growth operations. It is not an all-or-nothing proposition and many states who have recently established adult-use cannabis markets have taken specific efforts to ensure outdoor grow operations have the necessary security measures in place.

### Employer Drug Testing

The legalization of medical and adult-use cannabis in states across the country has created a complicated scenario for many employers that would regularly drug test employees as they attempt to navigate whether these policy changes mean that they should treat cannabis the same as alcohol or properly prescribed pharmaceuticals.<sup>23</sup> Some large employers have merely decided to not engage in such testing anymore given either the ambiguity or tight labor market.<sup>24</sup> Most states have decided to leave decisions about basing hiring or retention decisions on a positive drug test for non-medical cannabis to employers.<sup>25</sup> Only New Jersey, New York, and Nevada have passed legislation that restricts the consideration of such tests by employers.<sup>26</sup> Regardless of the decision members of the General Assembly make on how to handle this topic, it is vitally important that they provide employers with complete certainty and clarity about the policies that will comply with the Commonwealth's laws.

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<sup>21</sup> States allowing outdoor growing: Alaska, Arizona, California, Colorado, Connecticut, Maine, Massachusetts, Michigan, Nevada, New Jersey, New Mexico, Oregon, Vermont, and Washington. See 3 A.A.C. § 306.430 (2022); A.A.C. § R9-18-312 (2022); Cal. Bus. & Prof. Code § 26061 (2022); Colo. Rev. Stat. § 44-10-602 (2022); Conn. Gen. Stat. § 21a (2022); M.R.S. § 501(7) (2022); 925 C.M.R. § 500.050 (2022); Mich. Admin. Code R. § 420.206 (2022); N.R.S. § 678D.400 (2022); N.J. Admin. Code § 17:30-10.3 (2022); N.M.A.C. § 16.8.2.10 (2022); O.R.C. § 475C.077 (2022); 7 V.S.A. § 861(19) (2022); W.A.C. § 314-55-075 (2022); States not allowing outdoor growing: Montana and Illinois. See Mont. Code § 16-12-223 (2022); 410 ILCS § 705/10-(b)(2) (2022). States where a decision is TBD: New York (pending publication of regulations).

<sup>22</sup> See Beth Warren, Marijuana wars: Violent Mexican drug cartels turn Northern California into 'The Wild West', USA Today (2021), <https://www.usatoday.com/in-depth/news/nation/2021/12/19/mexican-drug-cartels-move-in-on-californias-shadow-marijuana-industry/8960873002/>; Jason Quinn & Hailey Summers, *Growing cannabis indoors produces a lot of greenhouse gases – just how much depends on where it's grown*, The Conversation (2021), <https://theconversation.com/growing-cannabis-indoors-produces-a-lot-of-greenhouse-gases-just-how-much-depends-on-where-its-grown-156486>; Colin A. Young, Indoor cannabis grow centers responsible for 10% of industrial electricity consumption in Massachusetts, Mass Live (2021), <https://www.masslive.com/cannabis/2021/06/indoor-cannabis-grow-centers-responsible-for-10-of-industrial-electricity-consumption-in-massachusetts.html>; See also Zhonghua Zheng, et al., *A narrative review on environmental impacts of cannabis cultivation*, J. Cannabis Res. (2021), <https://jcanabisresearch.biomedcentral.com/articles/10.1186/s42238-021-00090-0>.

<sup>23</sup> Lisa Nagele-Piazza, *Workplace Drug Testing: Can Employers Still Screen for Marijuana?*, SHRM (2020), <https://www.shrm.org/resourcesandtools/legal-and-compliance/state-and-local-updates/pages/can-employers-still-test-for-marijuana.aspx>.

<sup>24</sup> Annie Palmer, *Amazon says workers and applicants fired or barred during marijuana screening are now eligible for employment*, CNBC (2021), <https://www.cnbc.com/2021/09/21/amazon-will-lobby-government-to-legalize-marijuana.html>; Julia Glum, *Companies Are So Desperate to Fill Jobs They're Getting Rid of Drug Tests*, Money (2021), <https://money.com/labor-shortage-jobs-no-drug-tests/> (noting that 9% of employers in one survey are eliminating drug tests from candidate screening).

<sup>25</sup> Note: Many states have laws barring discrimination against medical cannabis patients. See Iris Hentze, *Cannabis & Employment Laws*, NCSL (2021), <https://www.ncsl.org/research/labor-and-employment/cannabis-employment-laws.aspx>.

<sup>26</sup> New Jersey Cannabis Regulatory, Enforcement Assistance, and Marketplace Modernization Act, A. 21, 2020-2021 Legis., 2020-2021 Reg. Sess. (N.J. 2021); Marihuana Regulation and Taxation Act, S. 854A, 2021-2022 Legis., 2021 Reg. Sess. (N.Y. 2021); A.B. 132, 2019 Legis., 2019 Reg. Sess. (Nev. 2019).

## ***Conclusion***

It is clear from the outcomes – or lack thereof – of cannabis prohibition in the Commonwealth and the calls from voters that it is time for members of the General Assembly to have a conversation about the value of continuing cannabis prohibition. Please view our team as a continued resource on how to capitalize on the failures and successes of other states in building an adult-use cannabis market that both keeps Pennsylvania's and their children safe while also establishing a market that allows innovation and entrepreneurship to thrive in a free and open market. We are honored that you would include Americans for Prosperity in this conversation and look forward to supporting the Committee's future efforts on this important topic.





#### 4 Key Considerations for Cannabis Policy Reform in Pennsylvania

In recent years, leaders in Pennsylvania have responded to calls from voters to allow the [medical use of cannabis](#). The state now appears ready to explore joining the [18 other states](#) which have fully legalized the adult use of cannabis and established a newly regulated market. The Keystone State can learn from the experience of these other states by adopting a regulatory structure that most effectively allows legal businesses to compete with the black market and ensures small businesses can thrive. Voters [want cannabis reform](#) but our state's leaders should ensure it is done right.

##### **Tax Rates**

The [experience of California](#) presents a cautionary tale. More than [\\$8.7 billion](#) worth of products are still purchased on the black market and [75% of the market](#) is still controlled by unlicensed dealers. Many experts note that the tax burden is one of the factors fueling the black market, with the state imposing up to [10.75% state and local sales tax](#), [15% excise tax](#), and [significant cultivation taxes](#) on every plant harvested. This situation has resulted in some of the least tax-friendly localities [suspending local taxes](#) to help legal operators more effectively compete with the black market.

**DO:** Impose a total tax burden – federal, state, and local combined – that is low enough to incentivize consumers to purchase products in the legal market. This will disrupt the profits of illicit providers and reduce the violence associated with the black market.

**DON'T:** Impose an overburdensome tax structure that [incentivizes the continuation of gray or black markets](#) by making them more easily accessible or profitable.

##### **Licensing and Consumer Choice**

[Reporting](#) from [Pennsylvania](#) and [other states](#) reveals how improperly structured cannabis licensing schemes can result in an entire state market being controlled by a few large companies. Arbitrary or permanent limitations on the number of licenses a state issues make it difficult for new entrepreneurs and innovative products to challenge current competitors. The establishment of these ceiling on the number of firms that can join the new market frequently have no basis in how many a state market can sustain and ultimately [result in serious corruption](#) among the government officials tasked with selecting the limited number of licensees. Pennsylvania is a state in search of new opportunities for economic growth. Any limits on the size of any new markets will likely be rough estimates at best and outdated by the time it is implemented.

**DO:** Provide a licensing scheme that allows robust competition from large companies, new entrepreneurs, and small businesses alike. Any ceilings placed on the number of businesses serving consumers in the new market must be able to grow as the market demand grows.

**DON'T:** Place unnecessary limitations on the number of businesses that will be able to operate in the new market and [create a breeding ground for corruption and oligopolistic power](#).

## **Fiscal Accountability and Transparency**

In 2018, a report from the Auditor General's office estimated that the legalization of cannabis could provide more than [\\$581 million](#) in tax revenue for the state in the first year a market is established.<sup>1</sup> The establishment of this new market will present a financial benefit for the state and local governments and all Pennsylvanians should be able to benefit from these new revenues through improved public services or a reduced income or property tax burden. Some other states have made the imprudent decision to automatically allocate *all* cannabis tax revenues to particular programs, funds, or purposes. Such appropriation decisions fail to remember that today's prudent programs are tomorrow's failed experiments. The needs of Pennsylvania's citizens fluctuate year over year and the flexibility we have all desired from our government during the recent pandemic must be reflected in any future forms of additional revenue.

**DO:** Ensure all citizens can benefit by subjecting any new cannabis tax revenue to the same transparent and accountable appropriations process as other sources of revenue. This will not prevent the General Assembly from deciding to make appropriations to the same purpose(s) but maintains vital flexibility.

**DON'T:** Limit the number of citizens who can benefit from new revenue by establishing "autopilot" spending of new cannabis tax revenue and tying the hands of future General Assemblies.

## **Ensure Everyone Receives a Second Chance**

Even though the state has adopted multiple pieces of cannabis and criminal justice policy reform in recent years, almost [119,000 Pennsylvanians](#) have still been arrested for cannabis offenses in the past 10 years. Many of their criminal acts would now be legal if the state is to adopt legislation creating an adult-use cannabis market. This should be reflected not only in how we apply our laws going forward but also in how we provide relief for those who have previously been arrested, convicted, and sentenced for cannabis offenses. Any lack of action in this area would leave thousands unnecessarily burdened by the weight of a criminal record that would not be imposed today, forcing them to face lifelong barriers to employment, education, and housing.

**DO:** Provide those who have previously been arrested, convicted, and sentenced for cannabis offenses the retroactive sentencing relief and the opportunity to have their criminal records sealed or expunged.

**DON'T:** Leave behind those who have been most directly impacted by the prohibition of cannabis and prevent them from accessing an opportunity to secure a true second chance at being a contributing member of their community.

Questions? Contact Grant Gulibon, Deputy State Director at [GGulibon@afphq.org](mailto:GGulibon@afphq.org)

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<sup>1</sup> Any forecast of potential tax revenue should be viewed with some skepticism given the inherent difficulties of forecasting tax revenue for these new markets. See Jeff Chapman, et al., *Forecasts Hazy for State Marijuana Revenue*, Pew Charitable Trusts (2019), <https://www.pewtrusts.org/en/research-and-analysis/issue-briefs/2019/08/forecasts-hazy-for-state-marijuana-revenue>; Spence Purnell & Allie Howell, *Market Size Estimates For Legalized Marijuana*, Reason Foundation (2019), <https://reason.org/policy-brief/market-size-estimates-for-legalized-marijuana/>.



**Memorandum**

**To:** Taylor Wamsher, Executive Director, Senate Law & Justice Committee,  
Office of Senator Mike Regan

**From:** Gary Seelhorst, SVP, Compliance & Gov't Affairs, Justice Cannabis Co.

**Date:** February 24, 2022

**Re:** Testimony for Senate Law & Justice Committee Hearing, Feb. 28, 2022

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Mr. Wansher,

The following is testimony that I wish to submit on behalf of Justice Cannabis Co, a multi-state, vertical cannabis operator and as a member of the Legislative Input Committee for the Pennsylvania Cannabis Coalition. We have operated a Grower/Processor facility as well as 3 dispensaries in PA since 2019. Justice Cannabis Co. was founded by civil rights attorneys on a commitment to delivering superior cannabis products and dispensary experiences based on principles of ingenuity and integrity.

I would like to characterize my testimony in two (2) separate categories:

1. The need to expedite Adult Use legislation in PA
2. Crafting Adult Use legislation that both generates tax revenue while enabling a nascent cannabis industry while redirecting current consumers of untaxed, untested, unregulated products to the taxed, tested, and regulated market

**Accelerating Adult Use Cannabis Legislation**

As senior employee of a multi-state, vertically integrated operator, I have the opportunity to see a great many states and see how their markets function. We have operations across all tiers of the industry, from cultivation to retail, and have witnessed firsthand the unintended roadblocks that can be created for these markets. As you know, some states are more mature in the development of their markets and how they are regulated, both in the medical market, the adult use market, and during the transition from medical to Adult Use. Some states have done this quickly and effectively, while others have succumbed to political in-fighting and massive regulatory framework, which only lengthen the process and add additional cost for the state, the operators, and, ultimately, the consumers. You do not need to look any further than your neighbors next door for examples of the latter.

Speaking of NY and NJ, they both will both have an Adult Use market up and running in the coming months. As a practical matter, this will inevitably drive both patients and personal use consumers from PA over the border to both of these states. Adult Use markets typical offer a wide spectrum of product types from different brands which usually are not all available in medical markets. This will certainly be the case with NY and NJ. Moreover, I have seen firsthand through our operations across the nation that states often take a variety of approaches to significant questions such as safety testing standards when creating a cannabis market. My experience leads me to anticipate that if PA does not fast-track Adult Use Legislation the result will be significant purchasing and consumption of New York and New Jersey cannabis products by Pennsylvanians—products that will reflect policymakers from those markets’ preferences and that will generate tax revenues for those markets and not yours. We’ve seen this dynamic in many other tri-state areas in the country. This is happening right now with Texans going into Oklahoma and New Mexico, and also with Southern Utahans going in Nevada and Arizona. It’s not a matter of “if” it will happen, but rather “when” and “to what extent” this will happen.

I can tell you that many believe this is a leading reason that New York fast-tracked their Adult Use legislation once they heard that NJ passed their ballot measure in 2020. NY didn’t want customers going over the border to buy from their closely interconnected neighbor, linked by scores of daily commuters and commuter transit options. Now, they’ve both taken their time in enabling Adult Use legislation, but that’s a discussion for a different audience...but them dragging their feet, gives PA more time to move of their Adult Use endeavors.

### **Creating Effective Adult Use Cannabis Legislation**

Now...If, in fact, you all decide to move down the path of Adult Use legislation, firstly, congratulations on making a smart decision for the Commonwealth. Secondly, I would certainly advise you to learn from some of the other states that have struggled to get their industry off the ground, which is usually from a complicated regulatory framework and over-aggressive tax structure.

Don’t get me wrong, I fully understand the importance of a well-regulated industry, complete with a robust track-and-trace system to monitor the supply chain and a rigorous lab testing framework to ensure safe, high-quality product. In fact, those are key regulations that help to set apart legal, licensed product from the illicit market. And they are crucial points of distinction with the illicit market that many Pennsylvanians who do not believe they qualify for medical cannabis are buying product from every day.

That said, when contemplating a tax structure, please consider the fact that you are writing a set of laws that will affect how quickly and effectively you will stand up an industry that is in its infancy. I cannot impress upon that enough. This is a brand new industry that comprises all of the elements that other industries need, like HR, Accounting, Real Estate, and Marketing. But there is a crucial distinction to flag here: because of ongoing Federal Prohibition and the failure of Congress to pass a stopgap fix for state-licensed cannabis businesses, §280E of the federal tax code prohibits industry participants from taking the same same tax deductions as other industries take, like utilities, insurance, rent, marketing, etc. Though it is, unfortunately, a

problem that only Congress can solve, I am happy to provide the Committee additional information about this federal tax provision and how it impacts the industry's competitiveness. And then...on top of all of those costs, some states levy massive state and local taxes as well...Which makes it really difficult to succeed in this business. In fact, very, very few cannabis businesses turn a profit. I realize that there is a "Green Rush" perception out there is a complete and total myth. The only Green Rush that is happen is in the illicit market, because they are not paying any taxes: not sales taxes or cannabis-specific excise or production taxes, not federal or state income taxes, not FICA taxes or any other taxes.

In fact, one of the best ways to help us compete against the illicit market is to keep our taxes low, especially in the near term. I can tell you that the regulated cannabis industry is proud to pay taxes, unlike our illicit market competitors. And we know we are never going to compete with the illicit market on a truly even cost playing field. It's not just a question of taxes, but also all of the additional costs that we (proudly) carry as legitimate businesses such as the employee benefits we offer and the costs we undertake to promote product safety. But until we begin to make a real dent in the illicit market, I urge you to be judicious on taxes. Then, consider raising our taxes once the industry is up and thriving.

Let's take CA as an example, which is one of the more mature states. California has created very unnecessary self-inflicted challenges for itself, which have hamstrung the industry by taxing at draconian rates across multiple points along the supply chain, and the consumers have responded by further entrenching the illicit market. In 2017, the last year of medical sales in CA...the industry generated roughly \$3B in sales. In 2018, the first year under the Adult Use regime, Total Sales went down to \$2.5B...presumably because the high taxes increased the price of the products, which pushed consumers back to their "corner guy," into the unlicensed market. It's been so bad in CA, that they are finally understand how those high taxes are affecting the market, and have proposed a bill (right now circulating in the state house, SB 1074) which would eliminate the cultivation tax which is one of two cannabis-specific taxes the state administers. Indeed, the California Legislative Analyst's Office detailed some of these challenges, and sky high taxes, in a report as recently as February 23, 2022 that I have linked [here](#). Eliminating the California cultivation tax is essential and long-overdue to prop up a failing industry, albeit a few years late. From a macro-economics perspective, this will entice more entrants into the market to produce more high-quality, safe product at a reasonable price. Additionally, companies will start to invest in the industry and start hiring again back to 2019 levels. So, I know it sounds counter-intuitive, but lowering taxes will, in turn, generate more tax revenue through increased sales as well as increases in corporate and employee income tax. But because of its delays in enacting tax reform, California is likely to face a resilient illicit market that much longer having habituated consumers to believe that cannabis products should only cost \$X, a number that reflects untaxed, untested products produced by workers with no benefits.

Lastly, I realize that many of these cannabis initiatives are sold to the public based of the amount of tax revenue it will provide to the state and city coffers. And there are very real economic benefits both direct from tax revenue and indirect from new jobs replacing "off the books" illicit market activity to limiting youth access to cannabis, something our company, industry, and I take very seriously, though, as a practical matter, there are not many (if any)

illicit market participants carding purchasers to verify age and the list could go on. But I urge you to please understand that there is an embryonic industry trying to stand itself up in the balance, and it faces a resilient competitor that has thrived across the nation when policymakers failed to take the impact of tax- and regulation-derived sticker shock for consumers into account when crafting these markets. I urge you to learn from past mistakes.

The need for taxed, tested, and regulated cannabis in Pennsylvania is clear. My hope is that I can be a resource for you to create that market to be as effective as possible in accomplishing your goals, goals that we wholeheartedly share.