2017 NORTHEAST TRANSPORTATION SAFETY CONFERENCE

Road Safety Matters - Tech, Trends & Tomorrow

October 24-25 - Cromwell CT
Toxicological Challenges
Drugged Driving

Robert B. Forney, Ph.D.
Chief Toxicologist, Lucas County Coroner
Toxicological Challenges to Drugged Driving

1 The Scope

A Perfect Storm
A Perfect Storm:

Many more drivers . . .

Many more taking Rx DRUGS . . .

Many more using MJ, heroin/fentanyl . . .

Many, many more are DRIVING IMPAIRED!
Motor vehicle traffic, poisoning, & drug poisoning (OD) death rates
United States, 1980-2010

- Motor Vehicle Traffic
- Poisoning
- Drug Poisoning (Overdose)
The Scope:  **More Elderly**

**Baby Boomers:**  The “Pig in the Python” Generation

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**U.S. Births: 1940-1980**

(Baby Boomer Generation in Red)

![Bar Graph](image)

US Census Data
Often rejected or redefined traditional values:

Feminism and the sexual revolution
Roe v Wade

Drugs for convenience

“The Pill” Birth Control
Amphetamines Diet Control
Valium Mood Control
Ritalin Child Behavior Control

Drugs for pleasure

Psychedelics: LSD, mescaline
“Turn on, tune in, drop out” (Timothy Leary)
Pot
Legalize Pot, make tobacco illegal
Cocaine & Crack, etc.
Number of Americans 65 Years of Age and Older: 1900-2050

Source: U.S. Census Bureau
Prescription Use by Age

Average number of prescriptions filled annually per person

Source: Medical Expenditures Panel Survey, 2002
The Elderly have a higher rate of fatality and injury in motor vehicle crashes per mile driven than any other age group except for teenagers.

Senior Drivers to Increase 70% Over Next 20 Years
The elderly having a higher rate of crash involvement

Reasons:

◆ age-related decrements in cognitive and physical functioning
◆ increased prevalence of medical conditions
◆ increased use of multiple medications

Aida A. LeRoy, Pharm.D. and M. Lee Morse, Multiple Medications and Vehicle Crashes: Analysis of Databases, Report DOT HS 810 858, May 2008 Available at:
Drug Users . . .

Drive!
Opportunities to observe vary

Proper opportunity, motivation and training

Law enforcement during a stop

Clinicians after a crash

Compromised opportunity

But proper motivation and training
The DRE Evaluation

1. Breath test
2. Interview
3. Preliminary exam
4. Eye exam
5. Psychophysical tests
6. Vital signs
7. Dark room
8. Muscle tone
9. Injection sites
10. Interrogation
11. Opinion
12. Tox analysis
## The Matrix

<table>
<thead>
<tr>
<th></th>
<th>Depress</th>
<th>Stims</th>
<th>Hallucin</th>
<th>PCP</th>
<th>Narcs</th>
<th>Inhalant</th>
<th>MJ</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HGN</strong></td>
<td>✔️</td>
<td></td>
<td>✔️</td>
<td></td>
<td></td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td><strong>Vert. Nystag</strong></td>
<td>✔️</td>
<td></td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td></td>
<td>✔️</td>
</tr>
<tr>
<td><strong>Lack of Converg</strong></td>
<td>✔️</td>
<td></td>
<td></td>
<td>✔️</td>
<td></td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td><strong>Pupil size</strong></td>
<td></td>
<td>Dilated</td>
<td>Dilated</td>
<td></td>
<td>Constrict</td>
<td>Dilated</td>
<td></td>
</tr>
<tr>
<td><strong>Rx to light</strong></td>
<td>Slow</td>
<td>Slow</td>
<td></td>
<td>Slow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pulse</strong></td>
<td><img src="arrow-down.png" alt="Down" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-down.png" alt="Down" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
</tr>
<tr>
<td><strong>BP</strong></td>
<td><img src="arrow-down.png" alt="Down" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-down.png" alt="Down" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-yellow.png" alt="Yellow" /></td>
</tr>
<tr>
<td><strong>Temp</strong></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td><img src="arrow-up.png" alt="Up" /></td>
<td></td>
<td><img src="arrow-down.png" alt="Down" /></td>
<td></td>
</tr>
</tbody>
</table>
Drug-Test Results of **Fatally Injured Drivers** Who Tested Positive for Drugs, 2009

- **Type Unknown**: 4%
- **Other drug**: 16%
- **Stimulant**: 18%
- **Depressant**: 16%
- **Narcotic**: 21%
- **Cannabinoid**: 25%

**Source:** White House Report, Drug Testing and Drug-Involved Driving of Fatally Injured Drivers in the United States: 2005-2009 (PDF)
Case 67 yo married, white female

SINGLE VEHICLE CRASH
VEERED OFF ROAD into a pole.
UNRESTRAINED DRIVER
HEAVY FRONT END DAMAGE
DATE/TIME: May, 11:50 A.M.

PASSING OFF-DUTY MEDICAL PROFESSIONALS ASSISTED WITH TREATMENT BEFORE EMS ARRIVED

SOME ORANGE COLOR EMESIS UPON ADMISSION
Pontomedullary junction transection

- Lateral view of brainstem
- Thalamus
- Cut edge of ascending tracts to cerebrum
- Optic tract
- Midbrain
- Pons
- Cranial nerves
- Medulla oblongata
- Cut edges of tracts leading to cerebellum
Thoracic spine completely transected at the level of the 2nd vertebra
<table>
<thead>
<tr>
<th>Toxicology</th>
<th>Postmortem Blood</th>
<th>Therapeutic Range Blood</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nordiazepam</strong> <em>(Nordaz®)</em></td>
<td>0.01 mg/L</td>
<td>0.20 – 1.80 mg/L</td>
</tr>
<tr>
<td><strong>Hydrocodone</strong> <em>(Vicodin®)</em></td>
<td>0.04 mg/L</td>
<td>0.02 – 0.05 mg/L</td>
</tr>
<tr>
<td><strong>Diphenhydramine</strong> <em>(Benedryl)</em></td>
<td><strong>0.22 mg/L</strong></td>
<td>0.025 – 0.110 mg/L</td>
</tr>
<tr>
<td><strong>Zolpidem</strong> <em>(Ambien)</em></td>
<td><strong>0.35 mg/L</strong></td>
<td>0.08 – 0.15 mg/L</td>
</tr>
</tbody>
</table>
Toxicological Challenges to Drugged Driving

The Scope

More Prescriptions
- More Elderly
- More Pain Patients
- More Depressed Patients

More Illegal Drugs
- More Users
- More Illegal Drugs
• **Recommendations** (implemented Jan 2001)
  Make pain assessment/management a priority in daily practice

Consider pain intensity the 5th Vital Sign

Vital Signs: 1  Respiratory Rate
  2  Heart Rate
  3  Blood Pressure
  4  Body Temperature

5  **Pain**

Patient Rights: a full pain work-up when pain is not easily characterized or treated
"Preventing drug abuse is an important societal goal. **But** there is consensus by law enforcement agencies, healthcare practitioners and patient advocates alike, that *it should not hinder patients' ability to receive the care they need and deserve.*"

(emphasis mine)
Changes in the Public’s Attitudes

1. Lowered tolerance for pain and discomfort

2. Low Information users “think they know enough”
   BUT who don’t know:
   - Difference between “OTC – RX – Controlled” Drugs
   - “Little is good, more is better”
   - Combination drug interactions
   - Effects of old prescriptions used by others

3. Belief that “It won’t happen to me!”

4. Susceptible to Pharmaceutical Companies Ads
Process Thinking:

**PRIMARY**

Immature

Pleasure Seeking
Pain Avoiding

“If it feels good, do it!”

Immediate Gratification

Ignores/Rejects Authorities in Making Choices

Susceptible to Pressure-Marketing/Peer Influences

**SECONDARY**

Mature

Truth Seeking
Error Avoiding

“Life is tougher if you’re stupid!”

Delayed Gratification

Recognizes/Seeks Authorities in Making Choices

Resistant to Pressure-Marketing/Peer Influences
The Central Nervous System “Reward Circuit”

The Limbic System: nucleus accumbens, ventral integmental area (VTA) and the prefrontal cortex

Dopamine:

- contained in neurons of the VTA
- is released into the nucleus accumbens and prefrontal cortex
- in response to either natural or drug stimuli
Defining Terms

**Narcotic**
1. Any drug that **induces sleep**
2. Sociolegal implication = any illegal substance
3. A substance affecting mood or behavior and sold for nonmedical purposes, especially an illegal one

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**Opioid**
1. Class of compounds (benzylisoquinoline alkaloids) that exert pharmacologic **activity at opioid receptors**.
2. Endogenous morphines (e.g. endorphins) opioid agonists (both natural & synthetic antagonists (e.g. naloxone) mixed agonist-antagonists

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**Opiate**
1. Alkaloid **extracts** of the **opium poppy**, *Papaver somniferum*
2. Morphine, codeine, thebaine, paperine

**NOTE:** Opioids are opiates, but the reverse is not always true!
Marketed Opioids

- Codeine
- Fentanyl (Durogesic)
- Hydrocodone (Vicodin)
- Hydromorphone (Dilaudid)
- Levorphanol (Levo-Dromoran)
- Meperidine (Demerol)
- Methadone (Dolophine)
- Morphine (MS-Contin)
- Oxycodone (Percocet)
- Oxymorphone (Opana)
- Propoxyphene
- Sufentanil (Sufenta)
- Tramadol (Ultram)
- Carfentanil (experimental)
- Lofentanil (experimental)
# Opiates on the Federal Controlled Drug Schedules

<table>
<thead>
<tr>
<th>Schedule</th>
<th>Opiates</th>
<th>Comment:</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td><strong>Heroin</strong></td>
<td><strong>High abuse &amp; dependence potential</strong></td>
</tr>
<tr>
<td></td>
<td>Dihydromorphinone</td>
<td>NO recognized medical use</td>
</tr>
<tr>
<td></td>
<td>Furanyl Fentanyl &amp; other analogues</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Codeine</td>
<td><strong>High abuse potential</strong></td>
</tr>
<tr>
<td></td>
<td>Morphine</td>
<td><strong>High incidence of dependence</strong></td>
</tr>
<tr>
<td></td>
<td>Fentanyl</td>
<td>Approved, highly regulated medical use</td>
</tr>
<tr>
<td></td>
<td>Meperidine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydromorphone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Methadone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocodone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oxycodone</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Buprenorphine</td>
<td>Less potential for abuse</td>
</tr>
<tr>
<td></td>
<td>Codeine compds (Tylenol No.3)</td>
<td>Moderate to low incidence of dependence.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approved regulated medical uses</td>
</tr>
<tr>
<td>IV</td>
<td>Pentazocine (Talwin)</td>
<td>Low potential for abuse</td>
</tr>
<tr>
<td></td>
<td>Propoxyphene (Darvocet)</td>
<td>Very low incidence of dependence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Approved less regulated medical uses</td>
</tr>
<tr>
<td>V</td>
<td>Opium preparations</td>
<td>Very low potential for abuse</td>
</tr>
<tr>
<td></td>
<td>Small dose codeine in cough meds</td>
<td>Lowest incidence of dependence</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OTC - least regulated medical use.</td>
</tr>
</tbody>
</table>
OPIUM

Powdered Opium (smoking)

Other Alkaloids (Laudanosine, Noscapine, Papaverine, etc.)

MORPHINE

CODEINE

HYDROCODONE (Lortab, Vicodin)

Diacetylmorphine (Heroin)

Hydromorphone (Dilaudid)

MORPHINE

THEBAINE

Oxycodone (Percocet, Oxycontin)

Buprenorphine (Subutex)

Buprenorphine+Naloxone (Suboxone)

Oxymorphone (Numorphone)
Heroin Production and Purity has Increased

Mexican heroin production has increased significantly

2002  6.8 metric tons
2011  50.0 metric tons—a more than 7-fold increase in 7 yrs.

<10% pure
2002  “Mexican Brown”

30% - 50% pure
2013
Because the heroin has higher purity, it now looks like cocaine.
"Price plummeted and [use] soared precisely when drug-related incarceration was increasing dramatically..."

90% Drug-related incarceration = Heroin, cocaine, and methamphetamine

Incarcerations skyrocketed

1980 = 42,000 to 2007 = 562,000

Heroin & Fentanyl Overdose Deaths in Cuyahoga County

As of 10/01/16

Cuyahoga County Medical Examiner
Drug Deaths in America Are Rising Faster Than Ever

2015 = 52,404 deaths
2016 = 64,000 deaths

Heroin metabolism

6-AM = indicative of heroin use.

Morphine is a metabolite, too!

Acetate remaining on 6 position

OAc = O-CH₃ – CO = Acetate
Heroin disappears rapidly  Morphine is detected longer.
Opioid Analytical Difficulties

Many labs “SCREEN” for drugs of abuse in urine. The tests lack sensitivity and specificity for all important drugs.

are done in urine and do not correlate with impairment or with recent use.
# Drug Abuse Testing

## Common Opioid Cutoff Concs.

<table>
<thead>
<tr>
<th>Opioid</th>
<th>Screening Cutoff</th>
<th>Confirm Cutoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opioids</td>
<td>50 ng/mL</td>
<td>100 ng/mL</td>
</tr>
<tr>
<td>Codeine</td>
<td></td>
<td>100 ng/mL</td>
</tr>
<tr>
<td>Morphine</td>
<td></td>
<td>100 ng/mL</td>
</tr>
<tr>
<td>Hydrocodone</td>
<td></td>
<td>100 ng/mL</td>
</tr>
<tr>
<td>Hydromorphone</td>
<td></td>
<td>100 ng/mL</td>
</tr>
</tbody>
</table>

**Typically Not Detected**

- Buprenorphine
- Oxycodone (reagent available)
- Fentanyl
- Oxymorphone
- Meperidine
- Tramadol

*Judged positive only when concentration is above “Cutoff”*
Case 20 yo single white female

History of crack cocaine abuse

Pill fragments found at scene

Partying all night with boyfriend of 2 yrs. who went to bed at 6:00 AM, leaving her watching TV

Found unresponsive on floor in living room at 5:15 PM

EMS contacted, pronounced her at 5:30 PM
She was cold.
Two Immediate Causes of Death:

**Cardiac**

- Heart Attack
- Heart stops
- Cerebral Anoxia
  Brain starved for Oxygen
- Response Not Possible
- Death is quick

**Pulmonary**

- Drug Overdose
- Breathing depressed
- Cerebral Hypoxia
  Brain Oxygen Reduced
- Response: Inc. Heart Rate & Blood Pressure
- Death is slow
- Fluid (Edema)
  Accumulates in Lung & Brain
Case 20 yo white female w Hx of alcohol, Rx drug abuse

**Autopsy Findings:**

- **Pulmonary edema and congestion**
- Visceral Pleural Petechiae
- **Cerebral edema** and cyanosis
- Fine petechial hemorrhages on face, conjunctivae and skin of upper chest
<table>
<thead>
<tr>
<th>Toxicology</th>
<th>Postmortem Blood</th>
<th>Therapeutic Range Blood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>Not Detected</td>
<td></td>
</tr>
<tr>
<td>Cocaine</td>
<td>0.37 mg/L</td>
<td>0.05 – 0.30 mg/L</td>
</tr>
<tr>
<td>Alprazolam</td>
<td>0.05 mg/L</td>
<td>0.008 – 0.200 mg/L</td>
</tr>
<tr>
<td>Diazepam</td>
<td>0.24 mg/L</td>
<td>0.1 – 1.0 mg/L</td>
</tr>
<tr>
<td>Nordiazepam</td>
<td>0.23 mg/L</td>
<td>0.2 – 1.8 mg/L</td>
</tr>
<tr>
<td>Dextromethorphan</td>
<td>0.13 mg/L</td>
<td>0.001 – 0.005 mg/L</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>0.48 mg/L</td>
<td>0.02 – 0.05 mg/L</td>
</tr>
</tbody>
</table>

Case: 20 yo white female w Hx of alcohol, Rx drug abuse
## Opioids increase the Risk of Road Trauma

<table>
<thead>
<tr>
<th>Opioid Dose</th>
<th>MEQ mg per day</th>
<th>Increased Odds of Road Trauma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Low</td>
<td>&lt;20</td>
<td>x</td>
</tr>
<tr>
<td>Low</td>
<td>20-49</td>
<td>21%</td>
</tr>
<tr>
<td>Moderate</td>
<td>50-99</td>
<td>29%</td>
</tr>
<tr>
<td>High</td>
<td>100-199</td>
<td>42%</td>
</tr>
</tbody>
</table>

5300 cases of 18-64 yr old Adults in the Ontario Drug Benefit program between April 2003 and March 2011 with road trauma and recorded Emergency Department visits matched with an equal number of controls.

Tara Gomes, MHSc; Donald A. Redelmeier, MD; David N. Juurlink, MD, PhD; Irfan A. Dhall, MD, MSc; Ximena Camacho, MM; Muhammad M. Mamdani, PharmD, MA, MPH. Opioid Dose and Risk of Road Trauma in Canada: A Population-Based Study. *JAMA Intern Med.* 2013;173(3):196-201. doi:10.1001/2013.jamainternmed.733.
Case  34 yo married, white male

SINGLE VEHICLE CRASH IN DECEMBER

HEAVY FRONT END DAMAGE

UNRESTRAINED DRIVER WITH SIDE AIRBAG DEPLOYMENT

RAN OFF ROAD THRU A RESIDENTIAL PROPERTY ENDED UP IN CREEK BED STRIKING TREE.

EST. TIME:  2200 HRS.
FOUND:  0743 HRS.  (FROST ON WINDSHIELD)
### Toxicology

<table>
<thead>
<tr>
<th>Substance</th>
<th>Postmortem Blood</th>
<th>Therapeutic Range Blood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>0.02 %</td>
<td></td>
</tr>
<tr>
<td>Alprazolam</td>
<td>0.09 mg/L</td>
<td>0.008 – 0.200 mg/L</td>
</tr>
<tr>
<td>Morphine</td>
<td>0.04 mg/L</td>
<td>0.02 – 0.05 mg/L</td>
</tr>
<tr>
<td>6 AM</td>
<td>8 ng/mL</td>
<td></td>
</tr>
<tr>
<td>Oxymorphone</td>
<td>0.025 mg/L</td>
<td>0.002 – 0.024 mg/L</td>
</tr>
</tbody>
</table>
1 Ace Bandage

2 Wash Cloth

3 Urine Bottle

4 Temp Strip
34 yo white male MVC

<table>
<thead>
<tr>
<th>Toxicology</th>
<th>Urine Bottle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>Not Detected</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>&gt;3.0 mg/L</td>
</tr>
<tr>
<td>Noroxycodone</td>
<td>&gt;3.0 mg/L</td>
</tr>
<tr>
<td>Oxymorphone</td>
<td>&gt;3.0 mg/L</td>
</tr>
</tbody>
</table>
Marijuana is the drug other than alcohol most commonly associated with impaired driving, and fatal accidents.

The cannabis plant several subspecies,

_Cannabis sativa sativa_, _Cannabis sativa indica_ and _Cannabis ruderalis_
Active constituents of *Cannabis sativa*

- Δ⁹-THC
- Δ⁸-THC
- Δ⁹-Tetrahydrocannabivarol
- CBD (Cannabidiol)
- CBN (Cannabinol)
- Cannabigerol (CBG)

O. H. Drummer, *The Forensic Pharmacology of Drugs of Abuse*, Arnold, Oxford Univ. Press (2001), Fig. 4.1, p. 180
Comparisons show lack of uniformity

<table>
<thead>
<tr>
<th>THC to CBD Conc’s</th>
<th>Cannabis <em>sativa</em></th>
<th>Cannabis <em>indica</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher</td>
<td>Higher</td>
<td>Lower</td>
</tr>
<tr>
<td>(huge variability exists within both species)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More Vivid High</td>
<td></td>
<td>More Sedating</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CB Receptor Activity</th>
<th>THC</th>
<th>CBD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial Agonist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Effect</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5-HT1A receptor (serotonin)</th>
<th>THC</th>
<th>CBD</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Should *Marijuana* be Legalized as a *Medicine*?

Answer: **ABSOLUTELY NOT!**

Marijuana is **not a single substance**

It is not possible to standardize the chemical content of a plant

---

**Cannabis sativa**

438+ different compounds

- 61 unique cannabinoids
- 103 terpenes
- 50 hydrocarbons
- 34 sugars
- 20 nitrogenous compounds
- proteins, alcohols, phenols, acids

73,786,976,294,838,206,464 combinations
Smoking is not a good vehicle for delivering medication ...
Smoking

Acutely (Immediately)

Lung Inflammation

- ↑ Sympathetic tone
- ↓ Tissue pO₂

Chronically (Long Term)

Endothelial dysfunction

- ↑ Sympathetic tone
- ↓ Mucociliary clearance
- Mucous gland hypertrophy
There are Medicines *derived from* marijuana...

**Dronabinol (Marinol ®)**
- FDA approved in 1985 for **intractable nausea associated with cancer treatment**

**Nabilone (Cesamet®):** nausea and neuropathic pain

**Sativex®:** Contains THC and cannabidiol in equal concentrations.
- Approved for the treatment of **spasticity associated with MS**
- in 27 countries outside the US
- Currently in Phase-III trials in the US for use in treating cancer pain

**Epidiolex®:** Pure cannabidiol.
- Currently being studied in the US as an **anti-epileptic**.
- Cannabidiol has also exhibited antipsychotic activity

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Marijuana Induced Persistent Cognitive Impairment

Systematic review of 105 studies showed Persistent impairment after cessation of cannabis use\(^1\)

- attention and psychomotor function, and
- learning and memory may possibly persist

Functional neuroimaging studies of regular MJ users

- use different parts of their brain than non-users to complete certain cognitive tasks\(^2\)


IMPAIRED DRIVING TRENDS FOR MARIJUANA IN WASHINGTON STATE

Legalization of recreational marijuana in WA in 2012

- Percentage change in number of cases involving drivers testing positive for THC

Source: Dr. Fiona Couper, WA State Toxicologist

* Projected 2013 numbers based on data from first half of the year
Marijuana Impaired Driving

Research done with driving simulators has demonstrated impaired performance with blood THC.

Marijuana Impaired Driving

• A review of several studies concluded that driving while intoxicated with MJ increases one's risk of being involved in a motor vehicle accident by a factor of 2-3.¹

• Psychomotor impairment associated with acute MJ intoxication appears to be more profound amongst occasional MJ smokers as compared with frequent users²


**Toxicological Challenges to Drugged Driving**

### 3 Interpretive Difficulties

Inactive drug metabolites alone persist to the time of sampling and are therefore often the targets of analyses.

\[
\Delta 9\text{-THC} \quad \rightarrow \quad 11\text{-OH-THC} \\
\text{PARENT DRUG} \quad \text{METABOLITES} \quad \text{Urine Drug Screen Target}
\]

\[
di\text{-OH-THC} \quad \rightarrow \quad 9\text{-COOH-THC} \\
\text{INACTIVE} \quad \text{ACTIVE}
\]
Mean THC, 11-OH THC & THCCOOH during smoking 3.55% THC marijuana
• Hysteresis: impairment and no impairment with both high and low plasma concs.
O. H. Drummer, *The Forensic Pharmacology of Drugs of Abuse*, Arnold, Oxford Univ. Press (2001), Fig. 4.7, p. 199
Mean THC, 11-OH THC & THC-COOH in Plasma after Smoking

![Graph showing THC, 11-OH THC, and THC-COOH concentrations over time after smoking.](image)

Thc concentrations peaked at 3.55% THC with N = 6.
Influence of Different Routes of Administration on the Concentration of THC in the Brain
Urinary excretion of total carboxy-THC in low-, moderate- and high-dose users of cannabis (adapted after Ellis et al., 1985^28)

O. H. Drummer, *The Forensic Pharmacology of Drugs of Abuse*, Arnold, Oxford Univ. Press (2001), Fig. 4.6, p. 189
Signs & Symptoms

Odor of marijuana
Conjunctival reddening
Bloodshot, watery eyes
Dilated pupils
Eyelid tremors
Disoriented
Incomplete thought processes
Marijuana debris

Increased pulse
Impaired time/distance estimation
Body tremors
Cannabis Impaired Driving

Onset: rapid smoked   Duration: High for 2 hrs, but 4-6 hrs.

Euphoria (inc. risk taking), sense of well-being, relaxation
Disorientation, lack of concentration, impaired memory
Distorted perception
Slowed reaction time and tracking
Distortion of time and distance
Flights of fragmentary thoughts
Drowsiness
Loss of coordination
Increased heart rate
Reddening of the eyes
Diminished reflexes
Drugs unlike alcohol are present in the blood in **very low** impairing concentrations.

<table>
<thead>
<tr>
<th>Drug</th>
<th>per se Limit</th>
<th>Units</th>
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<tbody>
<tr>
<td>Alcohol</td>
<td>0.08</td>
<td>gm/dL</td>
</tr>
<tr>
<td></td>
<td>= 80</td>
<td>mg/dL</td>
</tr>
<tr>
<td></td>
<td>= 80,000</td>
<td>ug/dL</td>
</tr>
<tr>
<td></td>
<td>= 80,000,000</td>
<td>ng/dL</td>
</tr>
<tr>
<td>THC</td>
<td>0.0000000005</td>
<td>gm/dL</td>
</tr>
<tr>
<td></td>
<td>= 0.000005</td>
<td>mg/dL</td>
</tr>
<tr>
<td></td>
<td>= 0.0005</td>
<td>ug/mL</td>
</tr>
<tr>
<td></td>
<td>= 5</td>
<td>ng/mL</td>
</tr>
</tbody>
</table>
nanogram/milliliter  Drug Analysis in Blood

Instrument:

Liquid Chromatograph Triple Quadripole Mass Spectrometer

ca $350,000.00
Drug Impaired Driving Deaths

SF, 16 yr old high on marijuana
Failed to stop at intersection

His blood on ceiling inside
Steering wheel with airbag deployed
<table>
<thead>
<tr>
<th>Toxicology</th>
<th>Specimen</th>
<th>Result</th>
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</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>Blood</td>
<td>Not Detected</td>
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<tr>
<td>Δ-9 THC-COOH</td>
<td>Urine</td>
<td>&gt;200 ng/mL</td>
</tr>
<tr>
<td>Δ-9 THC-COOH</td>
<td>Blood</td>
<td>Not Detected</td>
</tr>
<tr>
<td>11-OH THC</td>
<td>Blood</td>
<td>51 ng/mL</td>
</tr>
<tr>
<td>Δ-9 THC</td>
<td>Blood</td>
<td>10 ng/mL</td>
</tr>
</tbody>
</table>
Drug Impaired Driving Deaths

EK, 19 yr old female high on alcohol and marijuana

Drifted left of center line, hit semi-truck head on
Drug Impaired Driving Deaths

EK, 19 yr old female, identical twin, 5’ 2”, 110 lbs.

Purse, broken bottle, pill box on floor in front.
<table>
<thead>
<tr>
<th>Toxicology</th>
<th>Postmortem</th>
<th>Therapeutic Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>Blood</td>
<td>Blood</td>
</tr>
<tr>
<td>0.07 gm/dL</td>
<td>0.07 gm/dL</td>
<td></td>
</tr>
<tr>
<td>$\Delta$-9 THC-COOH</td>
<td>Urine</td>
<td>29 ng/mL</td>
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<td></td>
<td></td>
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</tbody>
</table>
sécurité
sans
sobriété
Keep your family SAFE