Toxicology and DUID

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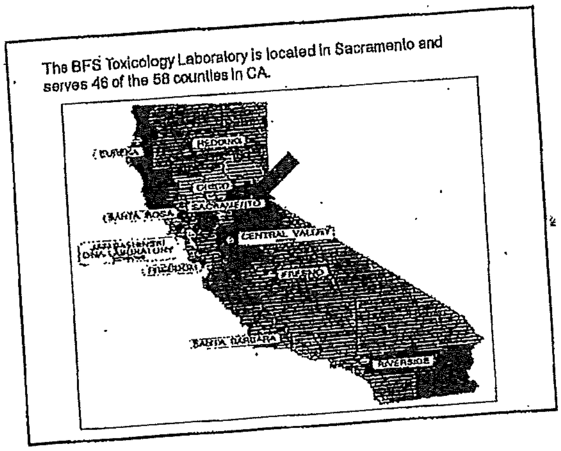

The BFS Toxicology Laboratory is located in Sacramento and serves 46 of the 58 counties in CA.

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CHICO
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SANTA ROSA
JAN BASHINSKI DNA LABORATORY
CENTRAL VALLEY
FREEDOM
FRESNO
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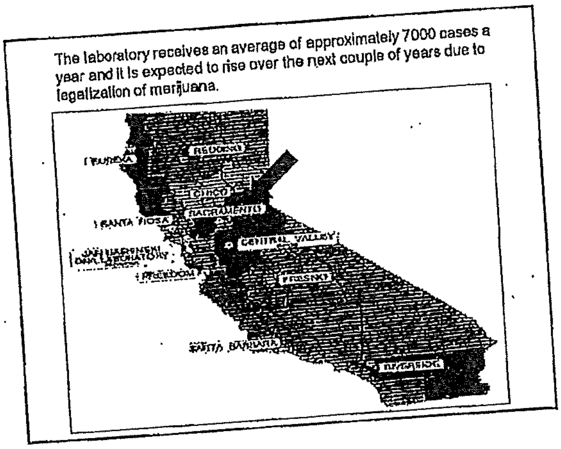

The laboratory receives an average of approximately 7000 cases a year and it is expected to rise over the next couple of years due to legalization of marijuana.

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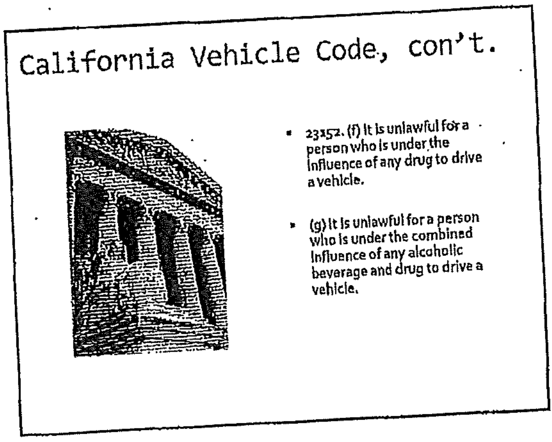
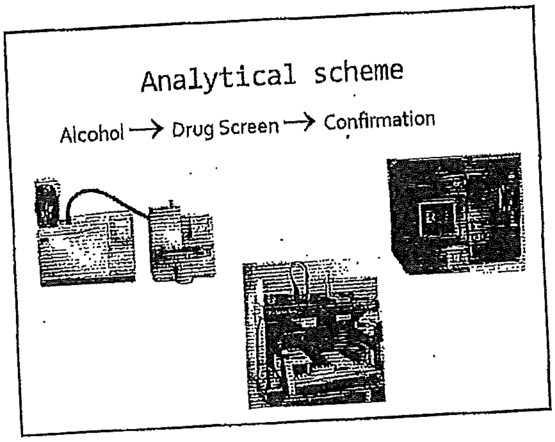


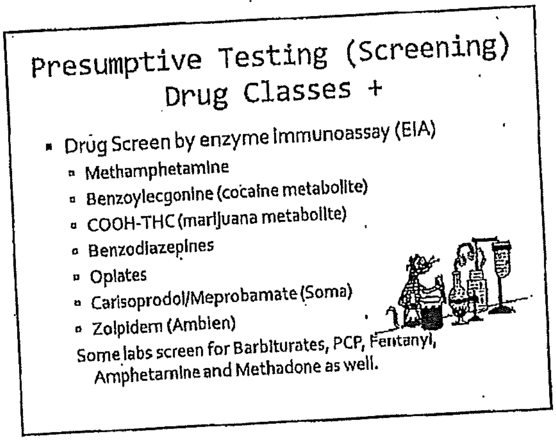
California Vehicle Code, con't.

- 23152. (f) It is unlawful for a person who is under the influence of any drug to drive a vehicle.
- (g) It is unlawful for a person who is under the combined influence of any alcoholic beverage and drug to drive a vehicle.



Analytical scheme

Alcohol → Drug Screen → Confirmation

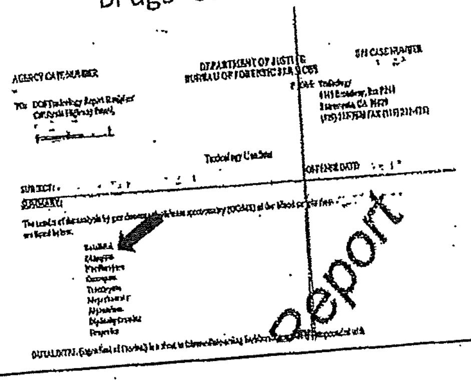


Presumptive Testing (Screening) Drug Classes +

- Drug Screen by enzyme immunoassay (EIA)
  - Methamphetamine
  - Benzoylecgonine (cocaine metabolite)
  - COOH-THC (marijuana metabolite)
  - Benzodiazepines
  - Opiates
  - Carisoprodol/Meprobamate (Soma)
  - Zolpidem (Ambien)

Some labs screen for Barbiturates, PCP, Fentanyl, Amphetamine and Methadone as well.

Drugs Confirmed



AGENCY CASE NUMBER

DEPARTMENT OF JUSTICE
BUREAU OF FORENSIC SERVICES

SUBJECT:

SUMMARY:

Report

Examples of Drugs Confirmed

CNS Depressants: Diazpam, Alprazolam, Zolpidem, Carisoprodol, Barbiturates

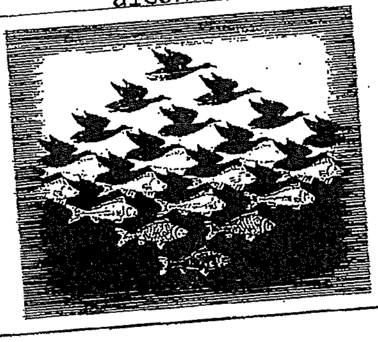
Narcotic Analgesics: Hydrocodone, Oxycodone, Morphine, Codeine, Oxymorphone, Hydromorphone, Methadone

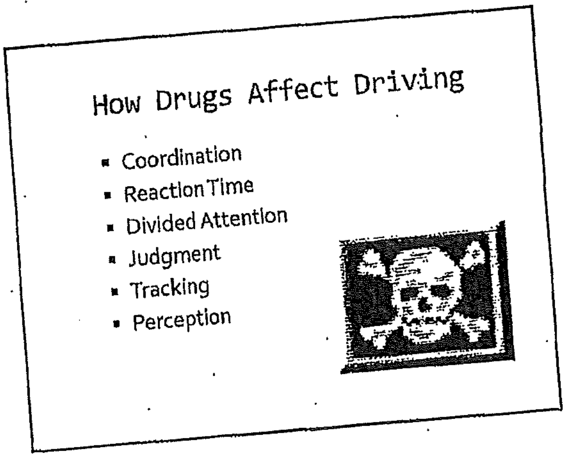
CNS Stimulants: Cocaine, Methamphetamine,

Cannabis: THC

There are too many to list here!

Look at drugs differently than alcohol



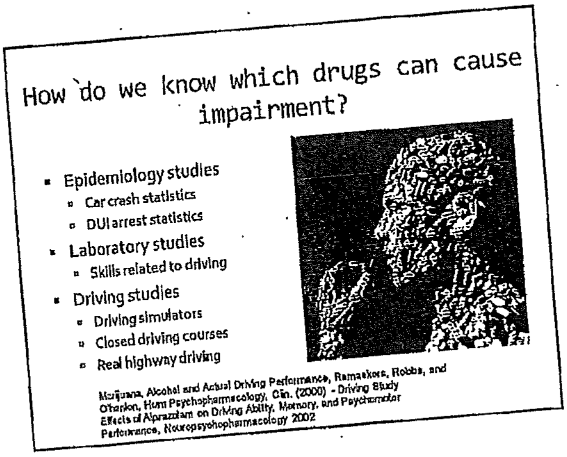


How Drugs Affect Driving

- Coordination
- Reaction Time
- Divided Attention
- Judgment
- Tracking
- Perception

Definitions

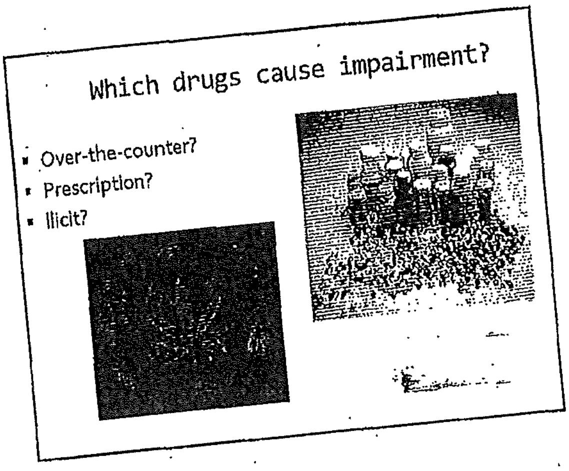
- Drug: a substance intended for use in the treatment or prevention of disease.
- Legal definition of drug: Any substance when taken into the human body impairs the ability to operate a vehicle safely.
- Influence vs. impairment



How do we know which drugs can cause impairment?

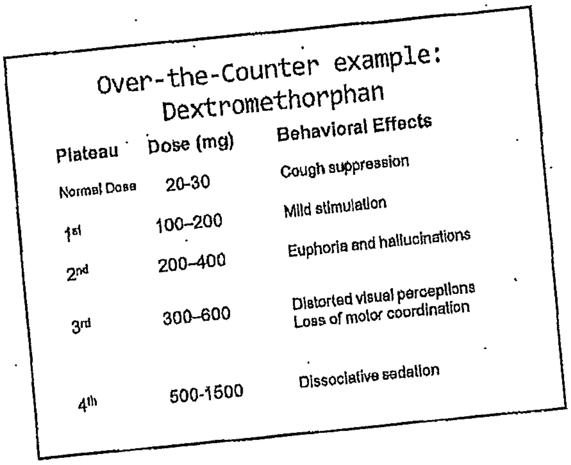
- Epidemiology studies
  - Car crash statistics
  - DUI arrest statistics
- Laboratory studies
  - Skills related to driving
- Driving studies
  - Driving simulators
  - Closed driving courses
  - Real highway driving

Marijuana, Alcohol and Actual Driving Performance, Ramaekers, Robbs, and Oterlon, Hum Psychopharmacology, Clin. (2000) - Driving Study
Effects of Alprazolam on Driving Ability, Memory, and Psychomotor Performance, Neuropsychopharmacology 2002



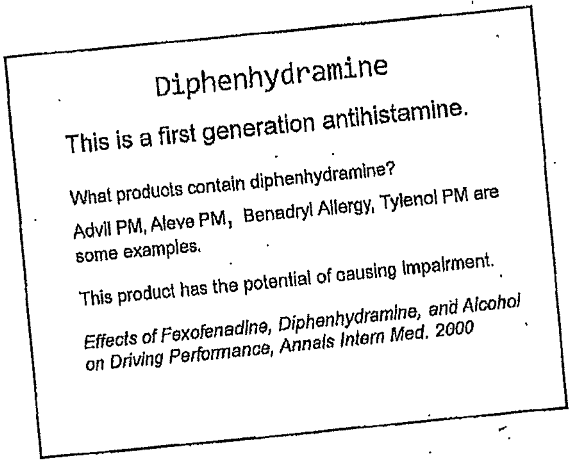
Which drugs cause impairment?

- Over-the-counter?
- Prescription?
- Ilicit?



Over-the-Counter example: Dextromethorphan

Plateau	Dose (mg)	Behavioral Effects
Normal Dose	20-30	Cough suppression
1st	100–200	Mild stimulation
2nd	200–400	Euphoria and hallucinations
3rd	300–600	Distorted visual perceptions Loss of motor coordination
4th	500-1500	Dissociative sedation



Diphenhydramine

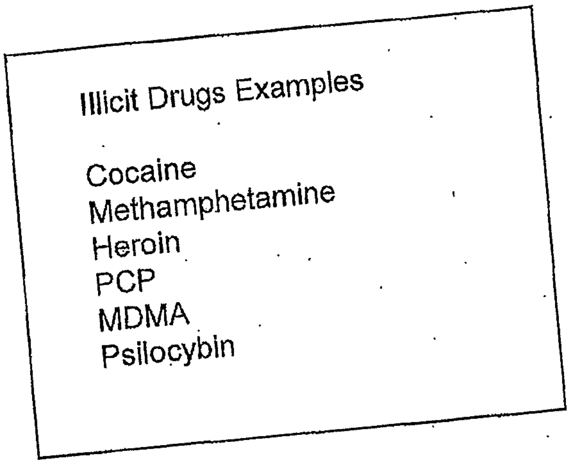
This is a first generation antihistamine.

What products contain diphenhydramine?

Advil PM, Aleve PM, Benadryl Allergy, Tylenol PM are some examples.

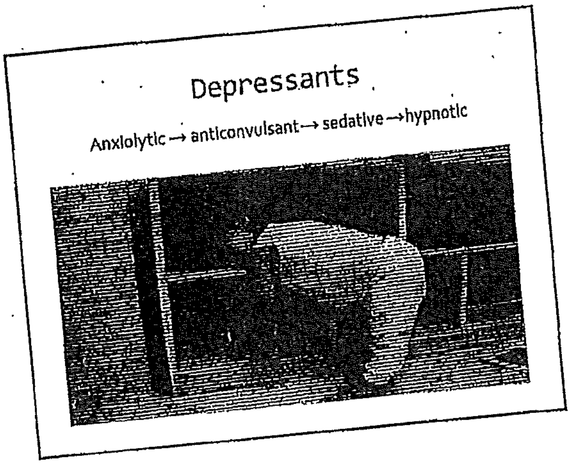
This product has the potential of causing impairment.

Effects of Fexofenadine, Diphenhydramine, and Alcohol on Driving Performance, Annals Intern Med. 2000



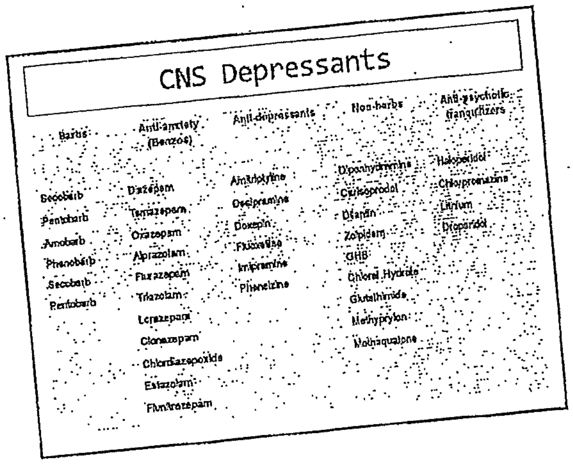
Illicit Drugs Examples

Cocaine
Methamphetamine
Heroin
PCP
MDMA
Psilocybin



Depressants

Anxiolytic → anticonvulsant → sedative → hypnotic



CNS Depressants

Barbs	Anti-anxiety (Benzos)	Anti-depressants	Non-barbs	Anti-psychotic tranquilizers
Secobarb	Diazepam	Amitriptyline	Diphenhydramine	Haloperidol
Pentobarb	Temazepam	Desipramine	Carisoprodol	Chlorpromazine
Amobarb	Oxazepam	Doxepin	Dianin	Lithium
Phenobarb	Alprazolam	Fluoxetine	Zolpidem	Droperidol
Secobarb	Flurazepam	Imipramine	GHB	
Pentobarb	Triazolam	Phenelzine	Chloral Hydrate	
	Lorazepam		Glutethimide	
	Clonazepam		Methyprylon	
	Chlordiazepoxide		Methaqualone	
	Estazolam			
	Flunitrazepam			

Why can't we predict impairment based solely on drug level?

- Many drugs detected long after the effects wear off
- No correlation between blood and urine
- Tolerance
- Route of Administration
- Dose
- Upside or downside of drug
- Variable responses to drugs

Example of a drug detected after the effects wear off

- Methamphetamine:
  - Duration of effects:
    4-8 hrs (depending on dosage).
  - Detection:
    Blood: 1-2 days (depending on dosage).
    Urine: 2-4 days

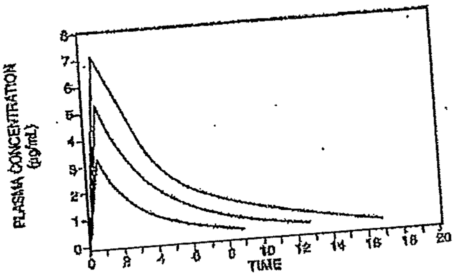
Example of lack of correlation between blood and urine

- Methamphetamine:
  - Up to 76% of a dose is excreted in acidic urine
  - As low a 2% of a dose is excreted in basic urine
- Note: This is why most forensic laboratories don't report out urine drug levels

Route of Administration for Cocaine

	Onset Effects	Duration of Effects
Smoked	5-10 sec.	15 min.
Intravenous	30-60 sec.	30 min.
Intranasal	15-30 min.	60 min.
Oral	~30 min.	hours

Dose vs. Concentration



Upside or Downside?

Example: Methamphetamine

- Early Phase:
  - Euphoria
  - Rapid speech
  - Motor restlessness
  - Poor impulse control
  - Decrease fatigue
  - ↑ HR, BP
  - Dilated pupils
- Late Phase
  - Fatigue
  - Sleepiness
  - HR, BP normal to low
  - Pupils size normal to small

Laboratory Tests

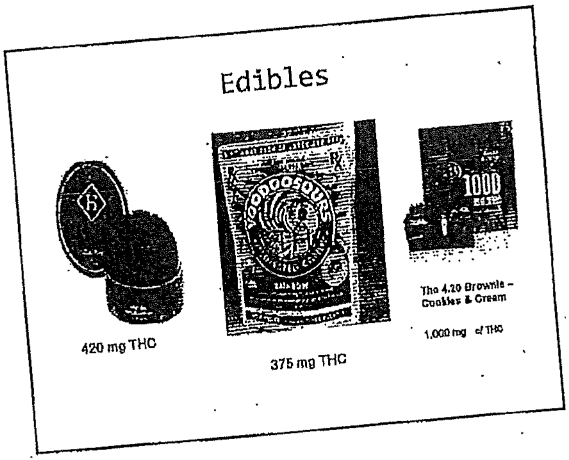
- There are 3 main cannabinoids that lab's test for.
  - 1) THC Parent = delta-9-THC (blood)
  - 2) THC active metabolite = 11-hydroxy-THC (blood)
  - 3) THC inactive metabolite = carboxy-THC (blood and or urine)

Labs are moving towards adding other cannabinoids such as CBN and CBD.

- Delta-9-THC levels can provide an estimate on how recent the use was in the case. However, it will not provide a correlation to impairment. A person can still be impaired even when levels drop below the detection limit. Conversely, a person may not be impaired even if there are measureable levels in the blood.

Marijuana Potency

- THC the psychoactive component in marijuana has increased from 4% in 1995 to 12% in 2014.
- Edibles range in concentration depending on the product.



Edibles

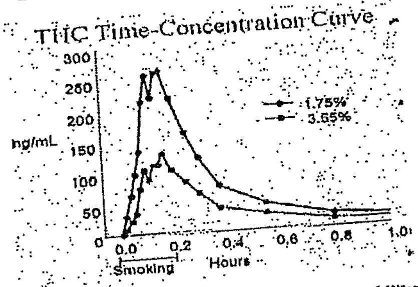
420 mg THC

375 mg THC

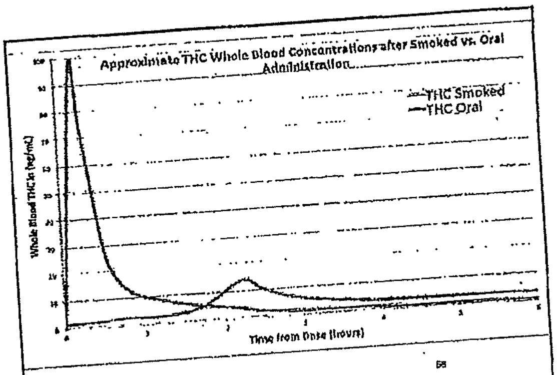
The 4.20 Brownie – Cookies & Cream

1,000 mg of THC

THC Concentration after Smoking

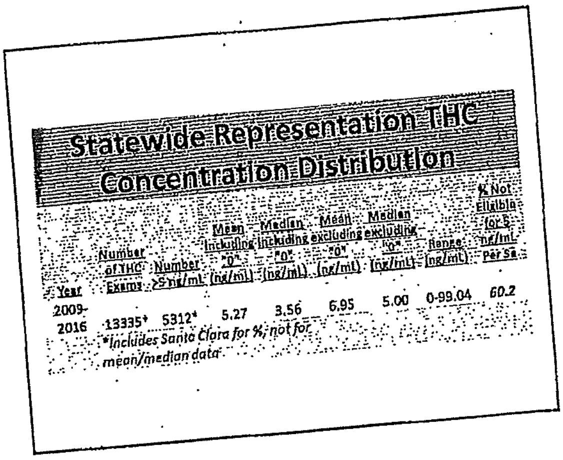


Huestis MA: Differentiating Recent Cannabis Use From Residual Cannabinoid Excretion, CAT Meeting May 5, 2012 presentation



Effect of Collection Time on Blood THC Concentrations

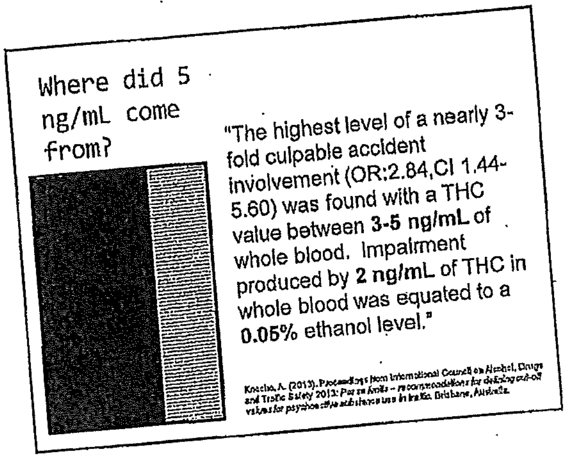
- Hartman et al 2016 *Clinical Chemistry*
- THC decreases by 73 % in first 30 minutes
- THC decreases by 90% 1.4 h post dose
- The average blood collection is 1.5-4 hours after stop/crash.
- Recommend to get blood before starting DRE.



Statewide Representation THC Concentration Distribution

Year	Number of THC Exams	Number >5 ng/mL	Mean including "0" (ng/mL)	Median including "0" (ng/mL)	Mean excluding "0" (ng/mL)	Median excluding "0" (ng/mL)	Range (ng/mL)	% Not Eligible for 5 ng/mL Per Se
2009-2016	13335*	5312*	5.27	3.56	6.95	5.00	0-99.04	60.2

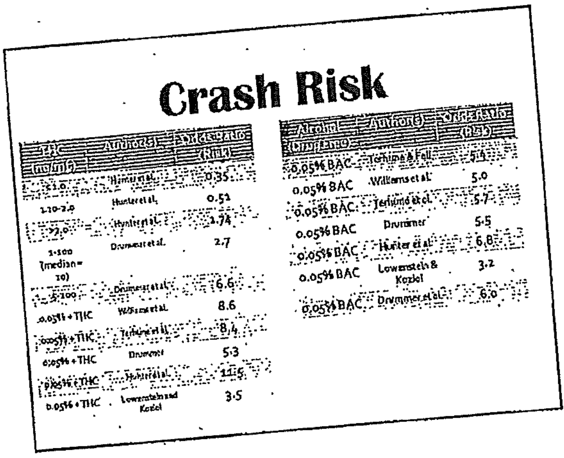
*Includes Santa Clara for %, not for mean/median data



Where did 5 ng/mL come from?

"The highest level of a nearly 3-fold culpable accident involvement (OR:2.84,CI 1.44-5.60) was found with a THC value between **3-5 ng/mL** of whole blood. Impairment produced by **2 ng/mL** of THC in whole blood was equated to a **0.05%** ethanol level."

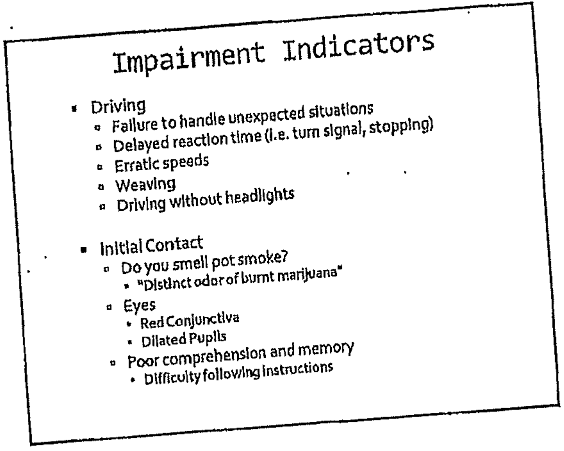
[illegible], A. (2013). Proceedings from International Council on Alcohol, Drugs and Traffic Safety 2013: *Per se limits – recommendations for defining cut-off values for psychoactive substance use in traffic.* Brisbane, Australia.



Crash Risk

THC (ng/mL)	Author(s)	Odds Ratio (Risk)
<1.0	Hartman et al.	0.35
1.10-2.0	Hunter et al.	0.51
>2.0	Hunter et al.	1.74
1-100 (median = 10)	Drummer et al.	2.7
5-100	Drummer et al.	6.6
0.05% + THC	Williams et al.	8.6
0.05% + THC	Terhune et al.	8.4
0.05% + THC	Drummer	5.3
0.05% + THC	Hunter et al.	11.5
0.05% + THC	Lowenstein and Koziol	3.5

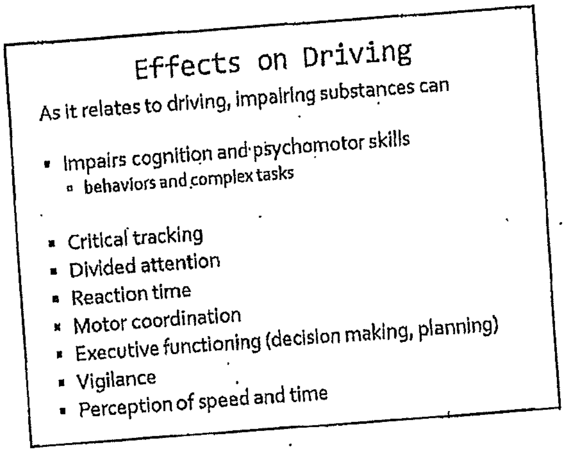
Alcohol (Drug Level)	Author(s)	Odds Ratio (Risk)
0.05% BAC	Terhune & Fell	5.4
0.05% BAC	Williams et al.	5.0
0.05% BAC	Terhune et al.	5.7
0.05% BAC	Drummer	5.5
0.05% BAC	Hunter et al.	6.8
0.05% BAC	Lowenstein & Koziol	3.2
0.05% BAC	Drummer et al.	6.0



Impairment Indicators

- Driving
  - Failure to handle unexpected situations
  - Delayed reaction time (i.e. turn signal, stopping)
  - Erratic speeds
  - Weaving
  - Driving without headlights

- Initial Contact
  - Do you smell pot smoke?
    - "Distinct odor of burnt marijuana"
  - Eyes
    - Red Conjunctiva
    - Dilated Pupils
  - Poor comprehension and memory
    - Difficulty following instructions

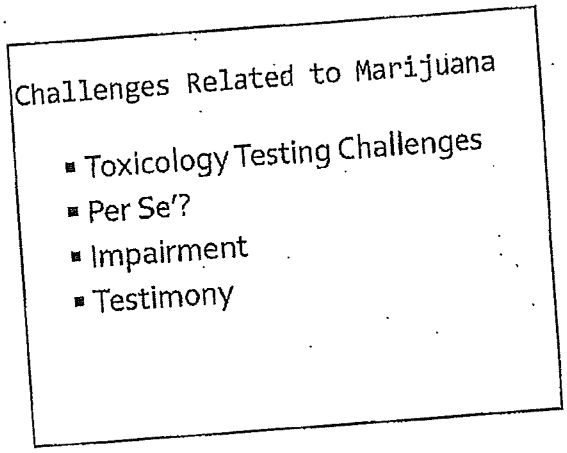


Effects on Driving

As it relates to driving, impairing substances can

- Impairs cognition and psychomotor skills
  - behaviors and complex tasks

- Critical tracking
- Divided attention
- Reaction time
- Motor coordination
- Executive functioning (decision making, planning)
- Vigilance
- Perception of speed and time



Challenges Related to Marijuana

- Toxicology Testing Challenges
- Per Se'?
- Impairment
- Testimony

Is subject Impaired? Field Sobriety Tests

- Romberg Balance
- Walk and Turn
- One Leg Stand
- Finger to Nose

Field Sobriety Tests were designed to determine:

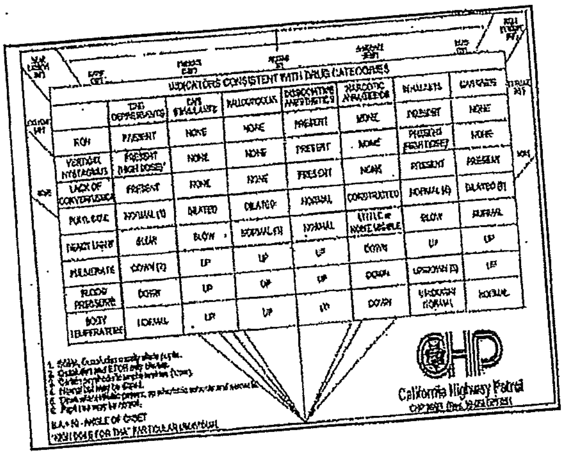
- Balance and coordination
- Short term memory
- Divided attention
- Time estimation
- Depth perception

Note: affect the ability to drive safely

Arresting Officer

Is BAC consistent with his driving and behavior?

If no: turn subject over to a DRE



INDICATORS CONSISTENT WITH DRUG CATEGORIES

	CNS DEPRESSANTS	CNS STIMULANTS	HALLUCINOGENS	DISSOCIATIVE ANESTHETICS	NARCOTIC ANALGESICS	INHALANTS	CANNABIS
HGN	PRESENT	NONE	NONE	PRESENT	NONE	PRESENT	NONE
VERTICAL NYSTAGMUS	PRESENT (HIGH DOSE)*	NONE	NONE	PRESENT	NONE	PRESENT (HIGH DOSE)*	NONE
LACK OF CONVERGENCE	PRESENT	NONE	NONE	PRESENT	NONE	PRESENT	PRESENT
PUPIL SIZE	NORMAL (1)	DILATED	DILATED	NORMAL	CONSTRICTED	NORMAL (4)	DILATED (6)
REACTION TO LIGHT	SLOW	SLOW	NORMAL (3)	NORMAL	LITTLE or NONE VISIBLE	SLOW	NORMAL
PULSE RATE	DOWN (2)	UP	UP	UP	DOWN	UP	UP
BLOOD PRESSURE	DOWN	UP	UP	UP	DOWN	UP/DOWN (5)	UP
BODY TEMPERATURE	NORMAL	UP	UP	UP	DOWN	UP/DOWN or NORMAL	NORMAL

H.A.+ N. - ANGLE OF ONSET

*HIGH DOSE FOR THAT PARTICULAR INDIVIDUAL

CHP

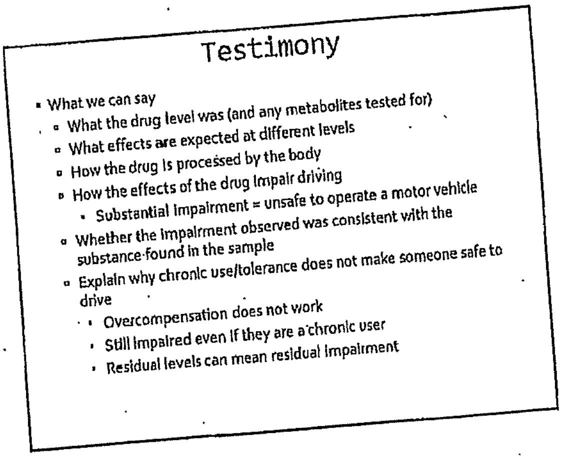
California Highway Patrol

Officer's Report

- Details
  - Bring the reader to the scene. It can be difficult to put the observation into words.
  - Gather as much information regarding subject as possible for crash even if the person is transported to hospital (i.e. behavior, vitals, speech).
  - If suspect drugs, get DRE – more information as possible – better.
- Readable
  - Any handwritten areas (i.e. face sheet of DRE Report) legible and easy to understand.

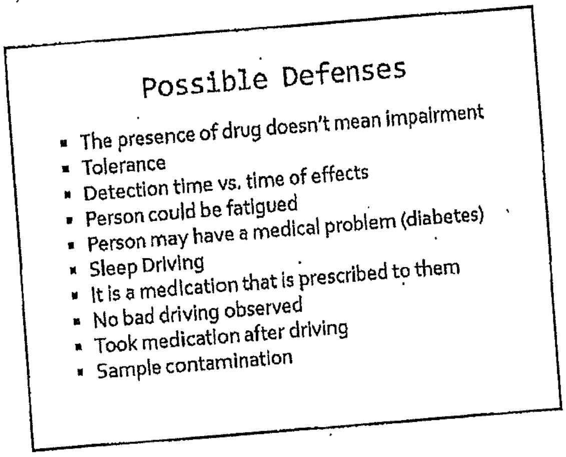
What If Tox Results Don't Match The Prediction?

- Labs can't test for everything
- Drug level below the detection limit
- Drugs with short half lives
- Is it drug effect or drug withdrawal
- Other reasons for impairment (mental/physical illness?)



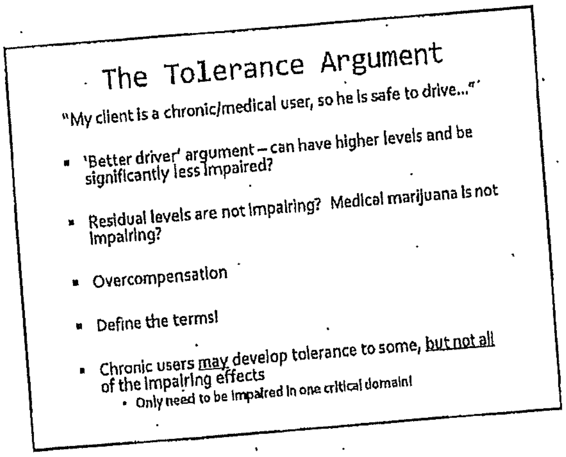
Testimony

- What we can say
  - What the drug level was (and any metabolites tested for)
  - What effects are expected at different levels
  - How the drug is processed by the body
  - How the effects of the drug impair driving
    - Substantial impairment = unsafe to operate a motor vehicle
  - Whether the impairment observed was consistent with the substance found in the sample
  - Explain why chronic use/tolerance does not make someone safe to drive
    - Overcompensation does not work
    - Still impaired even if they are a chronic user
    - Residual levels can mean residual impairment



Possible Defenses

- The presence of drug doesn't mean impairment
- Tolerance
- Detection time vs. time of effects
- Person could be fatigued
- Person may have a medical problem (diabetes)
- Sleep Driving
- It is a medication that is prescribed to them
- No bad driving observed
- Took medication after driving
- Sample contamination



The Tolerance Argument

"My client is a chronic/medical user, so he is safe to drive…"

- 'Better driver' argument – can have higher levels and be significantly less impaired?
- Residual levels are not impairing? Medical marijuana is not impairing?
- Overcompensation
- Define the terms!
- Chronic users may develop tolerance to some, but not all of the impairing effects
  - Only need to be impaired in one critical domain!

Case Study #1 continued

DRE exam:
(psychophysical tests)

Driving
Arresting Officer
DRE Evaluation

(clinical signs)

DRE prediction:

Romberg: 3" sway; eye tremors; stumbled backwards.

Walk & Turn: 13 steps 1st pass; 11 steps 2nd pass; missed heel to toe on every step; stepped off line twice; stopped walking twice.

One Leg Stand: was unable to stand.

Finger to nose: missed tip of nose every time.

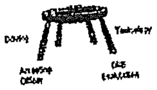
HGN, VGN, LOC, slow reaction to light; low pulse and blood pressure.

CNS Depressant

Case Study #1 continued

Toxicology Results:
(blood)

Methamphetamine 0.08 mg/L
Caffeine
Zolpidem (Ambien)

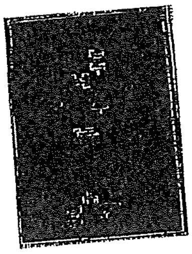

Driving
Toxicology
Arresting Officer
DRE Evaluation

Case #1

- Very poor driving
- Poor FST's
- DRE Prediction matches Tox results
- Subject admitted to taking Ambien

Missing Pieces in Case #2

- No bad driving
- No DRE
- NMS would not testify to Delta-9-THC-COOH results
- Case was dismissed



Built for Your Case

- What should be included in the hypothetical
  - Information consistent with facts in the case
  - The same information that may have been provided to the expert prior to trial
    - Different information provided to expert in court vs. prior to trial may result in a different answer on the stand then previously provided by the expert.
    - Be sure to include all that you want your expert to consider
  - Keep in mind that information such as red watery eyes, odor of marijuana, and raspy voice may be indicators of substance ingestion, NOT IMPAIRMENT.
  - If you do not consult with expert prior to trial and important subject health issues (included in police report) are not discussed with expert, the defense may bring it up in court and could change the experts opinion.

- Know your goal
  - Public Safety vs. Impairment
- Understand the time frame
  - Testing is only useful if it covers the time frame of interest
- Be aware of the limitations of interpretation
- When in doubt call an expert and retest the sample if additional testing is necessary (widen scope based on information in officers report).

Thank you

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