National Transportation Safety Board
Office of Research and Engineering
Washington, DC 20594

HWY23FH008

MEDICAL

Specialist's Factual Report

February 2, 2024

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A. CRASH

Location: Goodyear, Arizona
Date: February 25, 2023
Time: Approximately 7:57 AM local time

B. MEDICAL SPECIALIST

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C. DETAILS OF THE INVESTIGATION

1.0 Purpose

This investigation was performed to evaluate the uninjured, non-commercial driver of the pickup truck (driver) for potentially impairing substances and potentially impairing medical conditions.

2.0 Methods

Reports from the 26-year-old male driver's law enforcement post-crash drug and alcohol testing were reviewed, as were records of a post-crash hospital visit that the driver requested for purposes of obtaining independent toxicology testing. Records from a Goodyear Police Department Drug Recognition Expert (DRE) who evaluated the driver were reviewed, comprising a report of the driver's systematic DRE evaluation, a supplemental report of the DRE's interview and field sobriety testing of the driver near the crash scene, and an affidavit prepared by the DRE for a search warrant to obtain the driver's blood specimen for toxicological testing. Relevant regulation and medical literature were also reviewed.

D. FACTUAL INFORMATION

1.0 Toxicology

1.1 Law Enforcement Drug and Alcohol Testing

According to a report from the Goodyear Police Department DRE, the DRE administered an alcohol breath test to the driver at approximately 10:42 AM on the crash date. No alcohol was detected.

According to the DRE report, the DRE collected a blood specimen from the driver at approximately 12:48 PM on the crash date. The Central Regional Crime Laboratory of the Arizona Department of Public Safety's Scientific Analysis Bureau tested this blood specimen for drugs.[1] According to the toxicology report, delta-9-tetrahydrocannabinol (delta-9-THC) was detected at a concentration of about 7.8 ng/mL.[2] Carboxy-delta-9-tetrahydrocannabinol (carboxy-delta-9-THC), which is an inactive metabolite of delta-9-THC, was also detected.[3]

Insufficient blood specimen remained from law enforcement testing for this medical investigation to pursue additional testing of that specimen.

1.2 Hospital Visit for Independent Toxicology Testing

After the driver's arrest, he requested to be taken to the hospital to obtain independent toxicology testing. Records from this hospital visit documented that he was evaluated in the emergency department. A urine specimen was obtained at 8:28 PM on the crash date. A urine THC screen performed on that specimen was positive. Urine amphetamine, barbiturate, benzodiazepine, cocaine, fentanyl, methadone, opiate, phencyclidine, and tricyclic screens were negative. A blood specimen collected at 9:05 PM on the crash date tested negative for ethanol. The hospital visit records documented that the driver was otherwise healthy and was a current marijuana user. No home medication use was documented.

1.3 Descriptions of Detected Substances

Delta-9-THC is the primary psychoactive chemical in marijuana and hashish, which are products derived from the cannabis plant.[4] Delta-9-THC may also be used medicinally to treat illness-associated nausea and appetite loss. Carboxy-delta-9-THC is a non-psychoactive metabolite of delta-9-THC.

Cannabis may be smoked, vaped, or ingested recreationally by users seeking mind-altering effects. Psychoactive effects of cannabis vary depending on the user, dose, and route of administration. Cannabis has a potential to adversely affect driving performance by slowing reaction time, worsening control of lane position and

[1] According to the laboratory report, a cannabinoid assay and a "Hybrid All Ions Analysis" were performed. More information about testing procedures, including a list of drugs that can be routinely identified by the Hybrid All Ions Analysis, is available from the toxicology page of the Arizona Department of Public Safety website.

[2] The laboratory report stated that the concentration was 7.8 ± 1.6 ng/mL, with the uncertainty given at a level of confidence greater than 95.45%.

[3] Carboxy-delta-9-THC was reported as "positive" without a concentration value, per the reporting procedure documented on the Arizona Department of Public Safety website.

[4] United States Drug Enforcement Administration. Marijuana. Drug Fact Sheets. https://www.dea.gov/factsheets/marijuana. Updated March 30, 2023. Accessed September 22, 2023.

following, and impairing sustained attention, route planning, decision making, and risk assessment.[5,6] In experimental driving studies, control of lateral position within a lane (a measure of drug-induced driving impairment) has been shown to be modestly worsened by acute cannabis effects.[7,8,9] After using cannabis, some drivers may attempt to compensate for impairment by driving more slowly and cautiously, but also may not accurately judge whether they are impaired.[6,10,11] Epidemiological studies indicate that acute cannabis intoxication likely moderately increases motor vehicle crash risk; while some meta-analyses estimated an approximate doubling of crash risk, a more recent meta-analysis revised the estimated relative crash risk to about 1.3.[9,12 - 15] Cannabis might also contribute to drowsiness in some individuals, through acute drug effects or interference with restful sleep. However, the

[5] Couper FJ, Logan BK. Drugs and Human Performance Fact Sheets. National Highway Traffic Safety Administration. DOT HS 809 725. April 2014 (Revised). https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/809725-drugshumanperformfs.pdf. Accessed September 22, 2023.

[6] Compton RP. Marijuana-Impaired Driving: A Report to Congress. National Highway Traffic Safety Administration. DOT HS 812 440. July 2017. https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812440-marijuana-impaired-driving-report-to-congress.pdf. Accessed September 22, 2023.

[7] Arkell TR, Vinckenbosch F, Kevin RC, Theunissen EL, McGregor IS, Ramaekers JG. Effect of cannabidiol and Δ9-tetrahydrocannabinol on driving performance: a randomized clinical trial. *JAMA*. 2020;324(21):2177-2186. doi:10.1001/jama.2020.21218.

[8] McCartney D, Arkell TR, Irwin C, McGregor IS. Determining the magnitude and duration of acute Δ9-tetrahydrocannabinol (Δ9-THC)-induced driving and cognitive impairment: a systematic and meta-analytic review. *Neurosci Biobehav Rev*. 2021;126:175-193. doi:10.1016/j.neubiorev.2021.01.003.

[9] Simmons SM, Caird JK, Sterzer F, Asbridge M. The effects of cannabis and alcohol on driving performance and driver behaviour: a systematic review and meta-analysis. *Addiction*. 2022;117(7):1843-1856. doi:10.1111/add.15770.

[10] Brooks-Russell A, Brown T, Friedman K, et al. Simulated driving performance among daily and occasional cannabis users. *Accid Anal Prev*. 2021;160:106326. doi:10.1016/j.aap.2021.106326.

[11] Marcotte TD, Umlauf A, Grelotti DJ, et al. Driving performance and cannabis users' perception of safety: a randomized clinical trial. *JAMA Psychiatry*. 2022;79(3):201-209. doi:10.1001/jamapsychiatry.2021.4037.

[12] Li MC, Brady JE, DiMaggio CJ, Lusardi AR, Tzong KY, Li G. Marijuana use and motor vehicle crashes. *Epidemiol Rev*. 2012;34(1):65-72. doi:10.1093/epirev/mxr017.

[13] Asbridge M, Hayden JA, Cartwright JL. Acute cannabis consumption and motor vehicle collision risk: systematic review of observational studies and meta-analysis. *BMJ*. 2012;344:e536. doi:10.1136/bmj.e536.

[14] Rogeberg O, Elvik R. The effects of cannabis intoxication on motor vehicle collision revisited and revised. *Addiction*. 2016;111(8):1348-1359. doi:10.1111/add.13347.

[15] Rogeberg O, Elvik R, White M. Correction to: 'The effects of cannabis intoxication on motor vehicle collision revisited and revised' (2016). *Addiction*. 2018;113(5):967-969. doi:10.1111/add.14140.

relationship between cannabis use and sleep is complex and incompletely understood.[16 – 19]

Acute impairing effects of cannabis typically last at least 1-2 hours after use, with return to baseline within about 3-7 hours, although some residual effects may persist longer, and the duration of acute effects may be increased at higher cannabis doses or when cannabis is used orally.[5,8] Frequent cannabis users often develop some tolerance to effects of cannabis, but often adjust their usage upward to compensate. Driving impairment from acute cannabis intoxication is not simply predictable from tolerance.[10,11]

When cannabis is smoked, the blood delta-9-THC concentration peaks rapidly (this peak is delayed and flattened when cannabis is consumed orally). Subsequent decline in the blood delta-9-THC concentration is initially hastened by diffusion of delta-9-THC into fatty tissues. An occasional cannabis user's blood delta-9-THC concentration may fall to a very low or undetectable level within hours after smoking, whereas a frequent cannabis user's blood delta-9-THC concentration may remain detectable for days or weeks of abstinence, while delta-9-THC sequestered in fatty tissues redistributes into blood. [5,20 – 23] During this time, as the blood delta-9-THC concentration gradually trends downward due to drug elimination, it might transiently fluctuate upwards due to other physiological factors.[24]

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[16] Gates PJ, Albertella L, Copeland J. The effects of cannabinoid administration on sleep: a systematic review of human studies. *Sleep Med Rev*. 2014;18(6):477-487. doi:10.1016/j.smrv.2014.02.005.

[17] Kaul M, Zee PC, Sahni AS. Effects of cannabinoids on sleep and their therapeutic potential for sleep disorders. *Neurotherapeutics*. 2021;18(1):217-227. doi:10.1007/s13311-021-01013-w.

[18] Kolla BP, Hayes L, Cox C, Eatwell L, Deyo-Svendsen M, Mansukhani MP. The effects of cannabinoids on sleep. *J Prim Care Community Health*. 2022;13:21501319221081277. doi:10.1177/21501319221081277.

[19] Lavender I, McGregor IS, Suraev A, Grunstein RR, Hoyos CM. Cannabinoids, insomnia, and other sleep disorders. *Chest*. 2022;162(2):452-465. doi:10.1016/j.chest.2022.04.151.

[20] Huestis MA. Human cannabinoid pharmacokinetics. *Chem Biodivers*. 2007 Aug;4(8):1770-804. doi: 10.1002/cbdv.200790152.

[21] Bergamaschi MM, Karschner EL, Goodwin RS, et al. Impact of prolonged cannabinoid excretion in chronic daily cannabis smokers' blood on per se drugged driving laws. *Clin Chem*. 2013;59(3):519-526. doi:10.1373/clinchem.2012.195503.

[22] Spindle TR, Cone EJ, Schlienz NJ, et al. Acute pharmacokinetic profile of smoked and vaporized cannabis in human blood and oral fluid. *J Anal Toxicol*. 2019;43(4):233-258. doi:10.1093/jat/bky104.

[23] Vandrey R, Herrmann ES, Mitchell JM, et al. Pharmacokinetic profile of oral cannabis in humans: blood and oral fluid disposition and relation to pharmacodynamic outcomes. *J Anal Toxicol*. 2017;41(2):83-99. doi:10.1093/jat/bkx012.

[24] Peng YW, Desapriya E, Chan H, Brubacher J. Residual blood THC levels in frequent cannabis users after over four hours of abstinence: a systematic review. *Drug Alcohol Depend*. 2020;216:108177. doi:10.1016/j.drugalcdep.2020.108177.

Forensic interpretation of a blood concentration of delta-9-THC is challenging. The complex pharmacokinetics of delta-9-THC prevent reliable back-extrapolation from a measured concentration to a concentration at a given earlier time. More fundamentally, a person's instantaneous blood concentration of delta-9-THC does not directly predict that person's impairment.[5,6] Thus, attempts at predicting impairment from measured concentrations of delta-9-THC and its metabolites often focus on estimating whether the time of last cannabis use was recent enough to indicate probability of related acute psychoactive effects.[5,25,26] Because an occasional cannabis smoker's blood delta-9-THC concentration typically will decline below 5 ng/mL within a few hours of smoking, concentrations above this value sometimes are interpreted to indicate recent cannabis use. However, a frequent cannabis user's blood delta-9-THC concentration may remain elevated above 5 ng/mL for longer periods of abstinence, beyond the period of acute impairing effects, and sometimes as long as days.[24,27,28] Peak delta-9-THC concentrations after cannabis use may be much higher, but typically undergo rapid early decline, often before forensic blood specimens can be collected.[29]

Cannabis (marijuana and hashish) is a Schedule 1 controlled substance under federal law.[4] Arizona state law permits recreational use of cannabis by individuals of age 21 years or older subject to certain restrictions, but prohibits driving while impaired to the slightest degree by cannabis or with delta-9-THC or its metabolites in blood.[30]

2.0 Drug Recognition Expert Records

The Goodyear Police Department DRE interviewed the driver and performed standardized field sobriety tests of the driver near the crash scene. The driver was

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[25] Huestis MA, Henningfield JE, Cone EJ. Blood cannabinoids. II. Models for the prediction of time of marijuana exposure from plasma concentrations of delta 9-tetrahydrocannabinol (THC) and 11-nor-9-carboxy-delta 9-tetrahydrocannabinol (THCCOOH). *J Anal Toxicol*. 1992;16(5):283-290. doi:10.1093/jat/16.5.283.

[26] Kosnett MJ, Ma M, Dooley G, et al. Blood cannabinoid molar metabolite ratios are superior to blood THC as an indicator of recent cannabis smoking. *Clin Toxicol (Phila)*. 2023;61(5):355-362. doi:10.1080/15563650.2023.2214697.

[27] Karschner EL, Schwilke EW, Lowe RH, et al. Implications of plasma delta 9-tetrahydrocannabinol, 11-hydroxy-THC, and 11-nor-9-carboxy-THC concentrations in chronic cannabis smokers. *J Anal Toxicol*. 2009;33(8):469-477. doi:10.1093/jat/33.8.469.

[28] Odell MS, Frei MY, Gerostamoulos D, Chu M, Lubman DI. Residual cannabis levels in blood, urine and oral fluid following heavy cannabis use. *Forensic Sci Int*. 2015;249:173-180. doi:10.1016/j.forsciint.2015.01.026.

[29] Jones AW, Holmgren A, Kugelberg FC. Driving under the influence of cannabis: a 10-year study of age and gender differences in the concentrations of tetrahydrocannabinol in blood. *Addiction*. 2008;103(3):452-461. doi:10.1111/j.1360-0443.2007.02091.x.

[30] See Arizona Revised Statutes Title 36 Chapter 28.2 and Title 28 Chapter 4.

subsequently arrested on charges unrelated to drug use or intoxication. He then underwent blood specimen collection and a standardized, systematic DRE drug influence evaluation while in police custody.[31] Records of the DRE drug influence evaluation document that it took place from 1:06 PM to 1:46 PM on the crash date. The DRE's opinion based on the results of the evaluation was that the driver was not articulably under the influence of any drug.

According to DRE records, the driver stated that his last use of cannabis prior to the crash had been smoking part of a blunt before 9:00 PM the night before the crash. The DRE documented that the driver stated he had been smoking cannabis for 9 years, and normally smokes when he gets home after getting off work in the afternoon. The driver denied using any medications or drugs other than cannabis. He denied having any medical problems.

E. SUMMARY OF MEDICAL FACTS

The 26-year-old male driver tested negative for alcohol on a breath test administered at 10:42 AM on the crash date and positive for delta-9-tetrahydrocannabinol (delta-9-THC) in a blood specimen collected at 12:48 PM on the crash date. Delta-9-THC is the primary psychoactive chemical in cannabis and was measured in the driver's blood specimen at a concentration of about 7.8 ng/mL. An inactive metabolite of delta-9-THC was also detected in the blood specimen but was not quantified. The driver admitted to regularly smoking cannabis for years and stated that the last time he had smoked before the crash was prior to 9 PM the previous night. A police Drug Recognition Expert (DRE) assessed the driver near the scene of the crash and later performed a DRE drug influence evaluation, which began at 1:06 PM on the crash date. The DRE's opinion based on the results of the evaluation was that the driver was not articulably under the influence of any drug.

Submitted by:

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[31] More information about the DRE drug influence evaluation is available from the website of the International Association of Chiefs of Police, including a summary of the 12-step DRE evaluation process and an article on DRE examination characteristics of cannabis impairment [Hartman RL, Richman JE, Hayes CE, Huestis MA. Drug Recognition Expert (DRE) examination characteristics of cannabis impairment. *Accid Anal Prev*. 2016;92:219-229. doi:10.1016/j.aap.2016.04.012.].