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

HWY23FH014

MEDICAL

Specialist's Factual Report

November 22, 2023

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A. CRASH

Location: Philadelphia, Pennsylvania
Date: June 11, 2023

B. MEDICAL SPECIALIST

Specialist: Turan Kayagil, MD, FACEP
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C. DETAILS OF THE INVESTIGATION

1.0 Purpose

This investigation was performed to evaluate the fatally injured 53-year-old male truck driver for potentially impairing substances and potentially impairing medical conditions.

2.0 Methods

Records from two commercial motor vehicle (CMV) driver medical examinations were reviewed, as were a pharmacy record and autopsy and toxicology reports. Selected National Transportation Safety Board (NTSB) investigator reports and relevant regulation and medical literature were also reviewed.

D. FACTUAL INFORMATION

1.0 Driver Medical Examinations

Records were reviewed from CMV driver medical examinations dated August 24, 2021, and October 13, 2021. According to information provided by the NTSB Human Performance Specialist for this investigation, these were the driver's most recent CMV driver medical examinations, and the October examination was completed as a pre-employment requirement set by the driver's employer. The two examinations were completed by different examiners.

Reviewed records from the August 24, 2021, examination comprised a Medical Examiner's Certificate and Medical Examination Report Form. At this examination, the driver reported a history of high blood pressure. No medication use was documented. The driver's blood pressure at the time of the examination was 142/80;

it was re-checked and was 132/80.[1] The examiner commented that the driver's blood pressure had been 150/90 the previous year. The examiner commented that the driver would benefit from blood pressure medication and was directed to see a primary care physician. No other issues were identified, and the examiner determined that the driver met physical qualification standards and was qualified for a full 2-year medical certificate without restriction.

Reviewed records from the October 13, 2021, examination comprised a Medical Examination Report Form. At this examination, the driver reported being unsure whether he had a history of high blood pressure. He answered "yes" to a question about whether his medical certificate had ever been denied or issued for less than 2 years (no details provided). He reported no medication use. The driver's blood pressure at the time of the examination was 143/90. The examiner commented that the driver's blood pressure had been slightly high at one time. No other issues were identified, and the examiner determined that the driver met physical qualification standards and was qualified for a full 2-year medical certificate without restriction.

2.0 Pharmacy Records

A record was reviewed from a pharmacy documenting prescriptions filled by the driver at that pharmacy over a 1-year period ending on the crash date. This record provided no specific evidence of ongoing medication use or use of potentially impairing medications.

3.0 Autopsy

The City of Philadelphia Office of the Medical Examiner, Philadelphia, Pennsylvania, performed the driver's autopsy. According to the driver's autopsy report, his cause of death was blunt trauma of the head and inhalation and thermal injuries, and his manner of death was accident. There was soot in the airways. The autopsy did not identify significant natural disease.

[1] Federal regulation does not specify a numeric blood pressure standard for CMV driver medical certification. According to Federal Motor Carrier Safety Administration (FMCSA) regulation, an otherwise-qualified person is physically qualified to drive a CMV if that person has no current clinical diagnosis of high blood pressure likely to interfere with the ability to operate a CMV safely. FMCSA Medical Advisory Criteria (which are advisory guidelines, not requirements) state, "Stage 1 hypertension corresponds to a systolic blood pressure of 140–159 mmHg and/or a diastolic blood pressure of 90–99 mmHg. The driver with a blood pressure in this range is at low risk for hypertension-related acute incapacitation and may be medically certified to drive for a one-year period."

4.0 Toxicology

4.1 Medical Examiner Toxicology

The City of Philadelphia Office of the Medical Examiner Forensic Toxicology Laboratory performed postmortem toxicology testing of mixed cavity blood from the driver. Carboxyhemoglobin, a marker of carbon monoxide exposure (such as may occur from smoke inhalation), was measured at 10%.[2] No other tested-for substances were detected.[3]

4.2 Federal Aviation Administration Toxicology

At the request of the NTSB, the Federal Aviation Administration (FAA) Forensic Sciences Laboratory performed toxicological testing of postmortem specimens from the driver.[4] This testing detected diphenhydramine in cavity blood and liver tissue. According to an e-mail from an FAA forensic toxicologist, the diphenhydramine concentration in the cavity blood specimen was below 25 ng/mL. Carboxyhemoglobin was not detected in cavity blood at a reporting threshold of 10%. No other tested-for substances were detected in cavity blood.

4.3 Description of Diphenhydramine

Diphenhydramine is a sedating antihistamine medication widely available over the counter in multiple sleep aids and cold and allergy products. Diphenhydramine can cause cognitive and psychomotor slowing and drowsiness. It often carries a warning that it may impair performance of tasks like driving and operating heavy

[2] Nonsmokers normally have a carboxyhemoglobin of less than 1-3%. Heavy smokers may have a carboxyhemoglobin as high as 10-15%.

[3] The laboratory report listed antihistamines among the tested-for substances but did not specify a reporting cutoff concentration for diphenhydramine.

[4] The FAA Forensic Sciences Laboratory has the capability to test for around a thousand substances including toxins, prescription and over-the-counter medications, and illicit drugs.

machinery.[5,6,7] In one driving simulator study, a single dose of diphenhydramine impaired driving ability more than a blood alcohol level of 0.1 g/dL.[8]

Typical treatment concentrations of diphenhydramine in a living person's plasma are about 25 ng/mL to 100 ng/mL, with the drug's concentration in plasma typically being about 1.3 times the concentration in whole blood. The typical elimination half-life of diphenhydramine is about 3-14 hours.[9,10] One small study of healthy adult males estimated that drowsiness may occur at plasma diphenhydramine concentrations above about 30-40 ng/mL, and mental impairment may occur at plasma diphenhydramine concentrations above about 60 ng/mL.[6,11] Diphenhydramine concentrations in postmortem cavity blood cannot be directly compared to established ranges in living individuals, because diphenhydramine has substantial potential for postmortem redistribution, and cavity blood has a potential to be diluted or contaminated by other body fluids.[12,13]

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[5] National Institutes of Health National Library of Medicine. Benadryl Allergy Liqui-Gels. DailyMed. https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=bfeae100-e2d1-4607-be3b-2d9b15cd4f7f. Updated May 17, 2023. Accessed November 22, 2023.

[6] 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 November 22, 2023.

[7] Moskowitz H, Wilkinson CJ. *Antihistamines and Driving-Related Behavior: A Review of the Evidence for Impairment*. National Highway Traffic Safety Administration. DOT HS 809 714. May 2004. https://www.nhtsa.gov/sites/nhtsa.gov/files/antihistamines20text.pdf. Accessed November 22, 2023.

[8] Weiler JM, Bloomfield JR, Woodworth GG, et al. Effects of fexofenadine, diphenhydramine, and alcohol on driving performance: a randomized, placebo-controlled trial in the Iowa Driving Simulator. *Ann Intern Med*. 2000;132(5):354-363. doi:10.7326/0003-4819-132-5-200003070-00004.

[9] Federal Aviation Administration Civil Aerospace Medical Institute. Diphenhydramine. Forensic Toxicology's WebDrugs. https://jag.cami.jccbi.gov/toxicology/DrugDetail.asp?did=50. Updated January 16, 2019. Accessed November 3, 2023.

[10] Schulz M, Schmoldt A, Andresen-Streichert H, Iwersen-Bergmann S. Revisited: therapeutic and toxic blood concentrations of more than 1,100 drugs and other xenobiotics. *Crit Care*. 2020;24(1):195. doi:10.1186/s13054-020-02915-5.

[11] Gengo F, Gabos C, Miller JK. The pharmacodynamics of diphenhydramine-induced drowsiness and changes in mental performance. *Clin Pharmacol Ther*. 1989;45(1):15-21. doi:10.1038/clpt.1989.3.

[12] Han E, Kim E, Hong H, et al. Evaluation of postmortem redistribution phenomena for commonly encountered drugs. *Forensic Sci Int*. 2012;219(1-3):265-271. doi:10.1016/j.forsciint.2012.01.016.

[13] Dinis-Oliveira RJ, Vieira DN, Magalhães T. Guidelines for collection of biological samples for clinical and forensic toxicological analysis. *Forensic Sci Res*. 2017;1(1):42-51. doi:10.1080/20961790.2016.1271098.

E. SUMMARY OF MEDICAL FACTS

The truck driver underwent commercial motor vehicle (CMV) driver medical examinations on August 24, 2021, and October 13, 2021. At the August examination, the driver reported a history of high blood pressure. No medication use was documented. The driver's blood pressure at the time of the examination was 142/80; it was re-checked and was 132/80. The examiner determined that the driver met physical qualification standards and was qualified for a full 2-year medical certificate without restriction. At the October examination, the driver reported being unsure whether he had a history of high blood pressure. He reported no medication use. The driver's blood pressure at the time of the examination was 143/90. The examiner determined that the driver met physical qualification standards and was qualified for a full 2-year medical certificate without restriction.

The City of Philadelphia Office of the Medical Examiner, Philadelphia, Pennsylvania, performed the driver's autopsy. According to the driver's autopsy report, his cause of death was blunt trauma of the head and inhalation and thermal injuries, and his manner of death was accident. There was soot in his airways. The autopsy did not identify significant natural disease. Postmortem toxicology testing of cavity blood performed by the Office of the Medical Examiner measured carboxyhemoglobin at 10% and did not detect any other tested-for substances.

At the request of the NTSB, the Federal Aviation Administration (FAA) Forensic Sciences Laboratory performed toxicological testing of postmortem specimens from the driver. This testing detected diphenhydramine in cavity blood and liver tissue. The diphenhydramine concentration in the cavity blood specimen was below 25 ng/mL. Carboxyhemoglobin was not detected in cavity blood at a reporting threshold of 10%. No other tested-for substances were detected in cavity blood.

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