

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



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MEDICAL

Specialist's Factual Report

August 16, 2023

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A. ACCIDENT

Location: Benoit, Mississippi
Date: July 25, 2021

B. MEDICAL SPECIALIST

Specialist Turan Kayagil, MD, FACEP
National Transportation Safety Board
Washington, DC

C. DETAILS OF THE INVESTIGATION

1.0 Purpose

This investigation was performed to evaluate the pilot for potentially impairing substances and potentially impairing medical conditions.

2.0 Methods

The Federal Aviation Administration (FAA) medical case review and the pilot's autopsy and toxicology reports were reviewed. Selected investigator reports and relevant regulation and medical literature were also reviewed.

D. FACTUAL INFORMATION

1.0 FAA Medical Case Review

According to the FAA medical case review, the 55-year-old male pilot's last aviation medical examination was on December 18, 2020. At that time, he reported 13,000 total civilian flight hours. He was 73 inches tall and weighed 265 pounds. He reported no medication use and no active medical conditions. He reported a 1996 driving under the influence offense; he had received a Letter of Authorization from the FAA related to this offense. No significant issues were identified at his last aviation medical examination, and he was issued a second-class medical certificate limited by a requirement to wear lenses for distant vision and have glasses for near vision.

2.0 Autopsy

The pilot's autopsy was performed by a private forensic pathologist in North Little Rock, Arkansas, under contract with the Mississippi State Medical Examiner's Office, Pearl, Mississippi. According to the pilot's autopsy report, his cause of death was head and neck injuries. There was injury and debris in the region of the eyes; the

eye from which the vitreous fluid specimen was obtained displayed hemorrhage, while the other eye displayed hemorrhage and partial collapse. There was no evidence of blunt force or penetrating injury to the thorax or abdomen. Mild coronary artery disease was present; visual examination of the heart was otherwise unremarkable. The liver was described as enlarged and diffusely fatty. The autopsy did not identify other natural disease.

3.0 Toxicology

3.1 FAA Toxicology Results

The FAA Forensic Sciences Laboratory performed toxicological testing of postmortem specimens from the pilot.¹ Ethanol was detected at 0.189 g/dL in heart blood, 0.252 g/dL in vitreous fluid, and 0.141 g/dL in urine. N-propanol and methanol were detected at low levels in urine.² Gabapentin was detected at 948 ng/mL in heart blood, and was also present in urine. Doxepin was detected at 26 ng/mL in heart blood; urine testing was inconclusive for doxepin. The doxepin metabolite nordoxepin was detected in heart blood and urine.³ Amlodipine, carvedilol, triamterene, rosuvastatin, acetaminophen, ibuprofen, and fexofenadine were detected in heart blood and urine. The fexofenadine metabolite azacyclonol was detected in urine; heart blood testing for azacyclonol was inconclusive.

3.2 Descriptions of Detected Substances

Ethanol is a type of alcohol. It is the intoxicating alcohol in beer, wine, and liquor, and, if consumed, can impair judgment, psychomotor performance, cognition, and vigilance. Even in a small amount, ethanol can impair pilot performance, and the number and seriousness of pilot errors tends to increase with blood ethanol level.^{4,5,6}

¹ 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.

² The qualitative positive results for n-propanol and methanol indicate that neither of those substances exceeded a level of 0.0025 g/dL in urine.

³ According to an e-mail from an FAA toxicologist, the nordoxepin concentration in heart blood was lower than 6.25 ng/mL.

⁴ Federal Aviation Administration. Aeromedical factors. In: *Pilot's Handbook of Aeronautical Knowledge*. FAA H 8083 25C. Oklahoma City: United States Department of Transportation, Federal Aviation Administration, Airman Testing Standards Branch, AFS-630; 2023. https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/19_phak_ch17.pdf. Accessed August 8, 2023.

⁵ Federal Aviation Administration. Fitness for flight. In: *Aeronautical Information Manual (AIM) Basic*. Washington, DC: United States Department of Transportation, Federal Aviation Administration, Mission Support Services, Policy Directorate, AJV-P; 2023. https://www.faa.gov/air_traffic/publications/atpubs/aim_html/chap8_section_1.html. Accessed August 8, 2023.

⁶ Cook CCH. Alcohol and aviation. *Addiction*. 1997;92(5):539-555.

FAA regulation imposes strict limits on flying after consuming ethanol, including a prohibition on piloting a civil aircraft while having a blood ethanol level of 0.04 g/dL or greater.⁷

Alcohol consumption is not the only possible source of ethanol in postmortem specimens. Ethanol can sometimes be produced by microbes in a person's body after death. In the absence of trauma, postmortem ethanol production is more likely to result in low ethanol concentrations (below 0.03 g/dL) than it is to result in high ethanol concentrations. Postmortem ethanol production is made more likely by extensive trauma, which can spread microbes; in cases of extensive trauma even very high levels of ethanol may be attributable to postmortem production. Vitreous fluid and, to a lesser extent, urine, are generally better protected against the spread of microbes and therefore are generally less susceptible to postmortem ethanol production than are other specimen types.^{8,9} However, postmortem ethanol production can occur in vitreous and urine.^{9,10}

When ethanol is absorbed into circulation after ingestion, it freely distributes to body tissues in proportion to the water contents of those tissues, resulting in a relatively uniform distribution. At equilibrium, the ethanol concentrations in vitreous and newly formed urine are, on average, slightly higher than the ethanol concentration in blood. However, ratios can vary in any individual case, as can ethanol concentrations in blood collected from different sites. Also, the ethanol concentration in urine collected from the bladder does not reliably represent the ethanol concentration in newly formed urine. These factors complicate attempts to predict the blood ethanol concentration before death from ethanol concentrations measured after death. In general, an unusual distribution of ethanol concentrations across multiple specimens may indicate that ethanol formation occurred after death in some or all of the specimens.^{8,9}

N-propanol is another alcohol that can be produced by microbes in a person's body after death. Its presence in a postmortem specimen is potentially indicative of postmortem microbial activity in the specimen, but does not reliably indicate that postmortem ethanol production occurred.^{9,11} Methanol is wood alcohol; it occurs

⁷ [14 Code of Federal Regulations § 91.17](#).

⁸ Spitz WU. Forensic aspects of alcohol. In: Spitz WU, Spitz DJ, eds. *Spitz and Fisher's Medicolegal Investigation of Death: Guidelines for the Application of Pathology to Crime Investigation*. 4th ed. Springfield, IL: Charles C Thomas; 2006:1218-1229.

⁹ Kugelberg FC, Jones AW. Interpreting results of ethanol analysis in postmortem specimens: a review of the literature. *Forensic Sci Int*. 2007;165(1):10-29. doi: 10.1016/j.forsciint.2006.05.004.

¹⁰ Oshaug K, Kronstrand R, Kugelberg FC, Kristoffersen L, Mørland J, Høiseth G. Frequency of postmortem ethanol formation in blood, urine and vitreous humor - improving diagnostic accuracy with the use of ethylsulphate and putrefactive alcohols. *Forensic Sci Int*. 2022;331:111152. doi:10.1016/j.forsciint.2021.111152.

¹¹ Boumba VA, Exadactylou P, Velivasi G, Ziavrou KS, Fragkouli K, Kovatsi L. The frequency of ethanol, higher

naturally in the body at very low levels, is present in some foods and drinks, and is a solvent in a variety of industrial products.^{11,12} Low levels of n-propanol and methanol in urine are not potentially impairing.

Gabapentin is a prescription medication that can be used to treat nerve pain, certain types of seizures, and some other conditions. Gabapentin may cause sedation and dizziness and can impair coordination and performance of tasks such as driving and operating heavy machinery. The drug typically carries a warning that users may not be able to accurately assess how sleepy or impaired it makes them, and that they should not drive or operate complex machinery until they have gained enough experience to determine whether the drug impairs their ability to do so. Gabapentin also typically carries a warning that it may interact with alcohol or other sedating medications to worsen sleepiness and dizziness.^{13,14} The FAA considers gabapentin to be a “Do Not Issue/Do Not Fly” medication.¹⁵ According to the FAA medical case review for this accident, regular use of gabapentin for any reason is disqualifying for pilot medical certification. Typical treatment concentrations of gabapentin in a living person’s plasma are about 500 ng/mL to 6000 ng/mL, and the typical elimination half-life of the drug is about 5-7 hours.¹⁶ Gabapentin is generally unlikely to undergo significant postmortem redistribution.¹⁷

Doxepin is a prescription oral tricyclic antidepressant medication that may be used in the treatment of depression, anxiety, or insomnia. Topical doxepin cream is also available for short-term symptomatic treatment of certain skin conditions. Doxepin can have sedating effects, and may cause dizziness, drowsiness, and

alcohols and other low molecular weight volatiles in postmortem blood samples from unnatural deaths. *Forensic Sci Int.* 2022;341:111503. doi:10.1016/j.forsciint.2022.111503.

¹² Centers for Disease Control and Prevention. Methanol: systemic agent. The National Institute for Occupational Safety and Health Emergency Response Safety and Health Database. https://www.cdc.gov/niosh/ershdb/emergencyresponsecard_29750029.html. Updated May 12, 2011. Accessed August 8, 2023.

¹³ National Institutes of Health National Library of Medicine. Neurontin. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=ee9ad9ed-6d9f-4ee1-9d7f-cfad438df388>. Updated July 12, 2022. Accessed August 8, 2023.

¹⁴ Peterson BL. Prevalence of gabapentin in impaired driving cases in Washington State in 2003–2007. *J Anal Toxicol.* 2009;33(8):545-549. doi:10.1093/jat/33.8.545.

¹⁵ Federal Aviation Administration. Guide for aviation medical examiners: pharmaceuticals (therapeutic medications) do not issue - do not fly. Federal Aviation Administration website. https://www.faa.gov/ame_guide/pharm/dni_dnf. Updated July 10, 2023. Accessed August 8, 2023.

¹⁶ 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.

¹⁷ Hamm CE, Gary RD, McIntyre IM. Gabapentin concentrations and postmortem distribution. *Forensic Sci Int.* 2016;262:201-203. doi:10.1016/j.forsciint.2016.03.028.

confusion. It typically carries a warning against driving or operating dangerous machinery while using the drug, and a warning that effects of alcohol or other sedating medications may be heightened by the drug.^{18,19,20} The FAA considers doxepin to be a “Do Not Issue/Do Not Fly” medication.¹⁵ According to the FAA medical case review for this accident, doxepin use for any reason is disqualifying for pilot medical certification. Typical treatment concentrations of doxepin in a living person’s plasma are about 10 ng/mL to 200 ng/mL, and the typical elimination half-life of the drug is about 15-20 hours. Nordoxepin is a major active metabolite of doxepin and has a typical elimination half-life of about 33-80 hours.¹⁶ Redistribution of doxepin from heart muscle may increase the doxepin level in heart blood after death.²¹

Amlodipine is a prescription medication that can be used to treat high blood pressure and certain types of coronary artery disease.²² Carvedilol is a prescription medication that can be used to treat high blood pressure and heart failure.²³ Triamterene is a prescription medication that can be used as a diuretic (often combined with another diuretic, which was not detected in this case), including as part of treatment for high blood pressure or heart failure.^{24,25} Rosuvastatin is a prescription medication commonly used to control cholesterol and reduce

¹⁸ National Institutes of Health National Library of Medicine. Doxepin hydrochloride. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=1513c98c-e7ef-4009-b932-6757048bb86a>. Updated November 24, 2021. Accessed August 8, 2023.

¹⁹ National Institutes of Health National Library of Medicine. Doxepin. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=399866d5-3fa6-46d0-9c62-492d5997bc4f>. Updated May 16, 2023. Accessed August 8, 2023.

²⁰ National Institutes of Health National Library of Medicine. Doxepin hydrochloride cream. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=b4771ea7-c19b-4182-bb23-c1473ab583fa>. Updated May 24, 2017. Accessed August 8, 2023.

²¹ Pélissier-Alicot AL, Gaulier JM, Champsaur P, Marquet P. Mechanisms underlying postmortem redistribution of drugs: a review. *J Anal Toxicol*. 2003;27(8):533-544. doi:10.1093/jat/27.8.533.

²² National Institutes of Health National Library of Medicine. Norvasc. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=abd6a2ca-40c2-485c-bc53-db1c652505ed>. Updated April 4, 2022. Accessed August 8, 2023.

²³ National Institutes of Health National Library of Medicine. Coreg. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=c57982f2-c7da-488a-7ea9-b9609439ac68>. Updated September 15, 2017. Accessed August 8, 2023.

²⁴ National Institutes of Health National Library of Medicine. Maxide. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=e92eda49-861e-4c79-b446-ec1213151d92>. Updated April 7, 2022. Accessed August 8, 2023.

²⁵ National Institutes of Health National Library of Medicine. Triamterene. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=a09c2212-1dd5-4fbe-ad09-2a57aeabcaea>. Updated July 3, 2023. Accessed August 8, 2023.

cardiovascular risk.²⁶ Acetaminophen is a medication that is available in a wide variety of over-the-counter products as a pain and fever reducer.²⁷ Ibuprofen is an anti-inflammatory medication that is available over the counter and is commonly used to treat pain and fever.²⁸ Fexofenadine is an over-the-counter non-sedating antihistamine commonly used to relieve symptoms of seasonal and environmental allergies; azacyclonol is a fexofenadine metabolite.²⁹ Amlodipine, carvedilol, triamterene, rosuvastatin, acetaminophen, ibuprofen, and fexofenadine are not generally considered impairing.

E. SUMMARY OF MEDICAL FACTS

The 55-year-old male pilot's last aviation medical examination was on December 18, 2020. At that time, he reported no medication use and no active medical conditions. He was issued a second-class medical certificate limited by a requirement to wear lenses for distant vision and have glasses for near vision.

According to the pilot's autopsy report, his cause of death was head and neck injuries. There was injury and debris in the region of the eyes; the eye from which the vitreous fluid specimen was obtained displayed hemorrhage, while the other eye displayed hemorrhage and partial collapse. There was no evidence of blunt force or penetrating injury to the thorax or abdomen. Mild coronary artery disease was present; visual examination of the heart was otherwise unremarkable. The liver was described as enlarged and diffusely fatty. The autopsy did not identify other natural disease.

The pilot's postmortem toxicological testing detected ethanol at 0.189 g/dL in heart blood, 0.252 g/dL in vitreous fluid, and 0.141 g/dL in urine. N-propanol and methanol were detected at low levels in urine. Gabapentin was detected at 948 ng/mL in heart blood, and was also present in urine. Doxepin was detected at 26 ng/mL in heart blood; urine testing was inconclusive for doxepin. The doxepin metabolite nordoxepin was detected in heart blood and urine. No other substances were identified that were likely to have impairing effects.

²⁶ National Institutes of Health National Library of Medicine. Crestor. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=325a5d0e-9a72-4015-9fcd-1655fb504cee>. Updated July 27, 2023. Accessed August 8, 2023.

²⁷ National Institutes of Health National Library of Medicine. Tylenol Regular Strength. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=511536b2-6cbd-463e-b2db-6feec474cf6b>. Updated March 20, 2023. Accessed August 8, 2023.

²⁸ National Institutes of Health National Library of Medicine. Advil. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=5be198b8-396e-4b44-8819-e2e3b5d2ad0e>. Updated October 18, 2022. Accessed August 8, 2023.

²⁹ National Institutes of Health National Library of Medicine. Allegra Allergy. DailyMed. <https://dailymed.nlm.nih.gov/dailymed/drugInfo.cfm?setid=f061d6b1-89f7-4d5f-ac59-9c73408517c1>. Updated August 30, 2021. Accessed August 8, 2023.

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