

National Transportation Safety Board

Office of Research and Engineering

Washington, DC 20594



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MEDICAL

Specialist's Factual Report

January 30, 2023

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A. ACCIDENT

Location: Danville, Virginia
Date: February 2, 2022

B. MEDICAL SPECIALIST

Specialist Turan Kayagil, MD, FACEP
National Transportation Safety Board
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C. DETAILS OF THE INVESTIGATION

1.0 Purpose

This investigation was performed to evaluate the pilot for medical conditions, the use of medications/illicit drugs, and the presence of toxins.

2.0 Methods

The Federal Aviation Administration (FAA) medical case review and the pilot's autopsy and toxicology reports were reviewed. Supplemental information related to carboxyhemoglobin testing was obtained and reviewed from the Virginia Department of Forensic Science (DFS), the FAA Forensic Sciences Laboratory, and the Commonwealth of Virginia Office of the Chief Medical Examiner (OCME). Selected National Transportation Safety Board (NTSB) 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 23-year-old male pilot had his last aviation medical examination on May 5, 2021. At that time, he reported 264 civilian flight hours. He was 69 inches tall and weighed 207 pounds. He reported no medications or medical conditions. No significant issues were identified and he was issued a first-class medical certificate limited by a requirement to wear corrective lenses.

2.0 Autopsy

The Commonwealth of Virginia Office of the Chief Medical Examiner, Western District, performed the pilot's autopsy. According to the autopsy report, the cause of

death was blunt force trauma of the head, torso, and extremities, and the manner of death was accident. No thermal injury or airway soot was described. The esophagus and the serous cavities were disrupted. The autopsy was somewhat limited by the extent of injury, with the brain unavailable for examination; within this limitation, the autopsy did not identify significant natural disease.

3.0 Toxicology

3.1 Virginia DFS Toxicology

At the request of the OCME, the Virginia DFS performed toxicological testing of postmortem pooled cavity blood from the pilot.¹ This testing detected ethanol at 0.012 g/dL. Carboxyhemoglobin was elevated at 31%.²

3.2 FAA Toxicology

The FAA Forensic Sciences Laboratory also performed toxicological testing of pooled cavity blood from the pilot.³ Ethanol was not detected.⁴ At the request of the NTSB, the FAA Forensic Science Laboratory performed separate carboxyhemoglobin measurements for all five specimens of cavity blood that had been submitted to the FAA. For three of these specimens, carboxyhemoglobin was less than 10% (reported as “not detected”).⁵ The remaining two specimens were determined to be unsuitable for measuring carboxyhemoglobin.

3.3 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,

¹ According to the Virginia DFS toxicology report, cavity blood was screened for the following drugs and/or drug classes: ethanol, methanol, acetone, isopropanol, cocaine/benzoylcegonine, opiates, oxycodone/oxymorphone, methamphetamine/methylenedioxymethamphetamine (MDMA), phencyclidine (PCP), fentanyl, methadone, barbiturates, benzodiazepines, carisoprodol/meprobamate, zolpidem, buprenorphine/norbuprenorphine, cannabinoids, diphenhydramine/cyclobenzaprine, dextromethorphan, tramadol, tricyclic antidepressants, amphetamine/methylenedioxyamphetamine (MDA)/phentermine. Carboxyhemoglobin was also measured.

² Nonsmokers normally have carboxyhemoglobin levels of less than 1-3%, while heavy smokers may have levels as high as 10-15%.

³ The FAA Forensic Sciences laboratory has the capability to test for well over 1300 substances including toxins, prescription and over-the-counter medications, and illicit drugs. Some of these substances are listed at <https://jag.cami.jccbi.gov/toxicology>.

⁴ According to an e-mail from an FAA Forensic Toxicologist, the fact that ethanol was reported as “not detected” indicates that the ethanol in the specimen was below the reporting cutoff of 0.01 g/dL.

⁵ According to the [FAA website](#), the fact that carboxyhemoglobin was reported as “not detected” indicates that carboxyhemoglobin was below the reporting cutoff of 10% in these specimens.

and vigilance.⁶ FAA regulation imposes strict limits on flying after consuming ethanol, including prohibiting pilots from flying with a blood ethanol level of 0.04 g/dL or greater.⁷ However, consumption is not the only possible source of ethanol in postmortem specimens. Ethanol can be produced by microbes in a person's body after death. Postmortem ethanol production is made more likely by extensive traumatic injury, and can cause an affected toxicological specimen to test positive for ethanol while another specimen from the same person tests negative.^{8,9}

Carboxyhemoglobin is formed when carbon monoxide binds to hemoglobin in blood, impairing the blood's ability to deliver oxygen to body tissues (hypemic hypoxia). Carbon monoxide is an odorless, tasteless, colorless, nonirritating gas that can be produced during hydrocarbon combustion. Exposure to carbon monoxide usually occurs by inhalation of smoke or exhaust fumes. Symptoms of low-level carbon monoxide exposure are nonspecific and variable, and may include headache, nausea, and tiredness. Increasing levels of exposure may become impairing or incapacitating, causing more serious neurocognitive, cardiac, and/or vision problems, progressing to death above carboxyhemoglobin levels of about 50% (or lower if other serious medical conditions co-exist), although symptoms are not simply predictable from carboxyhemoglobin levels. Nonsmokers normally have carboxyhemoglobin levels of less than 1-3%, while heavy smokers may have levels as high as 10-15%. As with other causes of tissue hypoxia, carbon monoxide poisoning may be insidious and difficult for an exposed person to recognize; there is no reliable physical sign of exposure.^{10 - 14}

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

⁷ [14 CFR § 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 Maloney GE. Carbon monoxide. In: Tintinalli JE, Ma OJ, Yealy DM, et al., eds. *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*. 9th ed. New York, NY: McGraw-Hill Education; 2020:1414-1417.

¹¹ Clardy PF, Manaker S, Perry H. Carbon monoxide poisoning. In: Post TW, ed. UpToDate. Waltham, MA: UpToDate Inc. <https://www.uptodate.com/contents/carbon-monoxide-poisoning>. Updated January 12, 2023. Accessed January 25, 2023.

¹² Spitz WU. Asphyxia. 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; 2006:783-845.

¹³ Dolinak D, Matshes EW, Lew EO. Environmental injury. In: Dolinak D, Matshes EW, Lew EO, eds. *Forensic Pathology: Principles and Practice*. Burlington, MA: Elsevier Academic Press; 2005:239-258.

¹⁴ Hampson NB, Piantadosi CA, Thom SR, Weaver LK. Practice recommendations in the diagnosis, management, and prevention of carbon monoxide poisoning. *Am J Respir Crit Care Med*. 2012;186(11):1095-1101. doi:10.1164/rccm.201207-1284CI.

3.4 Supplemental Information on Carboxyhemoglobin Testing

According to information provided by the Virginia DFS, the Virginia DFS used ultraviolet-visible (UV-VIS) spectrophotometry for carboxyhemoglobin quantitation.¹⁵ A light absorbance spectrum (over wavelengths of light from 500 nm to 650 nm) was obtained using the blood specimen. Also, two separate reductions were prepared from the specimen by treatment with sodium dithionite to reduce oxyhemoglobin and methemoglobin (which, if left unreduced, can interfere with carboxyhemoglobin quantitation). Absorbance spectra from 500 nm to 650 nm were obtained for each reduction, and the carboxyhemoglobin percentage of each reduction was calculated from light absorbance at 541 nm and 555 nm wavelengths, yielding results of 31.2% and 31.0%.

The Virginia DFS performed confirmation of elevated carboxyhemoglobin using a palladium chloride microdiffusion method. In the method, carbon monoxide is liberated from hemoglobin by the addition of sulfuric acid in a diffusion cell. Liberated carbon monoxide reduces palladium chloride in the center of the diffusion cell to metallic palladium, which has a silver appearance. The apparent intensity of the silvering change is judged by a trained observer as negative (no change, e.g., less than 10% carboxyhemoglobin), "+" (e.g., 10-20% carboxyhemoglobin), "++" (e.g., 30-50% carboxyhemoglobin), or "+++" (e.g., greater than 60% carboxyhemoglobin). In this case, the change was observed to be "++", which was consistent with the quantitative result, so the final result was reported as 31% (the rounded average of the 31.2% and 31.0% values from quantitation).

According to information provided by the FAA Forensic Sciences Laboratory, the FAA also employed UV-VIS spectrophotometry for carboxyhemoglobin quantitation, using sodium dithionite to reduce oxyhemoglobin and methemoglobin, obtaining spectra over light wavelengths from 450 nm to 700 nm, and calculating carboxyhemoglobin percentages from light absorbance at 540 nm and 579 nm wavelengths (except for two specimens that were determined to be of unsuitable quality for quantitation based on the appearance of their spectra).¹⁶

According to information provided by the OCME, the specific collection sites of the pooled cavity blood specimens were not documented. It was not practical to send the leftover portion of the specimen that had been tested by the Virginia DFS for additional carboxyhemoglobin testing, because this remaining specimen was limited to a small amount of blood that had become coagulated.

¹⁵ Details of the Virginia DFS procedures for carboxyhemoglobin determination are available from the [Toxicology Procedures Manual on the Virginia DFS website](#) (accessed January 25, 2023).

¹⁶ The basic FAA Forensic Sciences Laboratory methodology for carboxyhemoglobin determination is available from the [FAA website](#). Notably, because none of the specimens tested by the FAA yielded an elevated carboxyhemoglobin result, there was no role for confirmation testing of these specimens.

E. SUMMARY OF MEDICAL FACTS

The 23-year-old male pilot had his last aviation medical examination on May 5, 2021. At that time, he reported no medications or medical conditions. He was issued a first-class medical certificate limited by a requirement to wear corrective lenses.

According to the pilot's autopsy report, his cause of death was blunt force trauma of the head, torso, and extremities, and his manner of death was accident. No thermal injury or airway soot was described. The esophagus and the serous cavities were disrupted. The autopsy was somewhat limited by the extent of injury, with the brain unavailable for examination; within this limitation, the autopsy did not identify significant natural disease.

The Virginia Department of Forensic Science (DFS) performed toxicological testing of postmortem pooled cavity blood from the pilot. Ethanol was detected at 0.012 g/dL. Carboxyhemoglobin, a marker of carbon monoxide (CO) exposure, was elevated at 31%, as measured by spectrophotometry with confirmation by microdiffusion.

The Federal Aviation Administration (FAA) Forensic Sciences Laboratory also performed toxicological testing of pooled cavity blood from the pilot. Ethanol was not detected at a reporting threshold of 0.01 g/dL. Carboxyhemoglobin testing was performed on five specimens using spectrophotometry. For three of these specimens, carboxyhemoglobin was not detected at a reporting threshold of 10%. The remaining two specimens were unsuitable for measuring carboxyhemoglobin.

Submitted by:

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