



NMS Labs

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Robert A. Middleberg, PhD, F-ABFT, DABCC-TC, Laboratory Director

Toxicology Report

Report Issued 12/21/2021 16:11

To: **147837**
WMU School of Medicine
300 Portage Street

Kalamazoo, MI 49007

Patient Name Eller Matthew
Patient ID 211111-67
Chain 211111-67
Age 22 Y **DOB** 03/08/1999
Gender Male
Workorder 21395979

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Positive Findings:

<u>Compound</u>	<u>Result</u>	<u>Units</u>	<u>Matrix Source</u>
Caffeine	0.85	mcg/mL	001 - Femoral Blood
Cotinine	Positive	ng/mL	001 - Femoral Blood
Mitragynine	2100	ng/mL	001 - Femoral Blood
Creatinine (Vitreous Fluid)	1.05	mg/dL	003 - Vitreous Fluid
Sodium (Vitreous Fluid)	118	mmol/L	003 - Vitreous Fluid
Potassium (Vitreous Fluid)	7.53	mmol/L	003 - Vitreous Fluid
Chloride (Vitreous Fluid)	124	mmol/L	003 - Vitreous Fluid
Urea Nitrogen (Vitreous Fluid)	17.0	mg/dL	003 - Vitreous Fluid

See Detailed Findings section for additional information

Agency Case Number: W21-1383

Testing Requested:

<u>Analysis Code</u>	<u>Description</u>
0930B	Caffeine, Blood
1919FL	Electrolytes and Glucose Panel (Vitreous), Fluid (Forensic)
8042B	Postmortem, Expanded w/Vitreous Alcohol Confirmation, Blood (Forensic)
8050U	Postmortem, Urine Screen Add-On (6-MAM Quantification only) (Forensic)

Specimens Received:

<u>ID</u>	<u>Tube/Container</u>	<u>Volume/ Mass</u>	<u>Collection Date/Time</u>	<u>Matrix Source</u>	<u>Labeled As</u>
001	Gray Top Tube	8.25 mL	11/11/2021 08:30	Femoral Blood	211111-67
002	Gray Top Tube	8 mL	11/11/2021 08:30	Femoral Blood	211111-67
003	Red Top Tube	2 mL	11/11/2021 08:30	Vitreous Fluid	211111-67
004	White Plastic Container	20 mL	11/11/2021 08:30	Urine	211111-67

All sample volumes/weights are approximations.

Specimens received on 11/12/2021.

Detailed Findings:

Analysis and Comments	Result	Units	Rpt. Limit	Specimen Source	Analysis By
Caffeine	0.85	mcg/mL	0.50	001 - Femoral Blood	LC-MS/MS
Cotinine	Positive	ng/mL	200	001 - Femoral Blood	LC/TOF-MS
Mitragynine	2100	ng/mL	50	001 - Femoral Blood	LC-MS/MS
Creatinine (Vitreous Fluid)	1.05	mg/dL	0.0500	003 - Vitreous Fluid	Colorimetry
Sodium (Vitreous Fluid)	118	mmol/L	80.0	003 - Vitreous Fluid	Chemistry Analyzer
Potassium (Vitreous Fluid)	7.53	mmol/L	1.00	003 - Vitreous Fluid	Chemistry Analyzer
Chloride (Vitreous Fluid)	124	mmol/L	70.0	003 - Vitreous Fluid	Chemistry Analyzer
Glucose (Vitreous Fluid)	None Detected	mg/dL	35.0	003 - Vitreous Fluid	Chemistry Analyzer
Urea Nitrogen (Vitreous Fluid)	17.0	mg/dL	3.00	003 - Vitreous Fluid	Chemistry Analyzer

Other than the above findings, examination of the specimen(s) submitted did not reveal any positive findings of toxicological significance by procedures outlined in the accompanying Analysis Summary.

Reference Comments:

1. Caffeine - Femoral Blood:

Caffeine is a xanthine-derived central nervous system stimulant. It also produces diuresis and cardiac and respiratory stimulation. It can be readily found in such items as coffee, tea, soft drinks and chocolate. As a reference, a typical cup of coffee or tea contains between 40 to 100 mg caffeine.

Following the oral ingestion of 120 and 300 mg of caffeine, reported peak plasma concentrations of the drug averaged 3.0 mcg/mL (range, 2.0 - 4.0 mcg/mL) and 7.9 mcg/mL (range, 6.0 - 9.0 mcg/mL), respectively. A single oral dose of 500 mg produced a reported peak plasma concentration of 14 mcg/mL after 30 min.

Reported concentrations of caffeine in caffeine-related fatalities averaged 183 mcg/mL (range, 79 - 344 mcg/mL).

2. Chloride (Vitreous Fluid) - Vitreous Fluid:

Normal: 105 - 135 mmol/L

3. Cotinine (Nicotine Metabolite) - Femoral Blood:

Cotinine is a metabolite of nicotine and may be encountered in the fluids and tissues of an individual as a result of tobacco exposure.

Anabasine is a natural product occurring in tobacco, but not in pharmaceutical nicotine and a separate test for anabasine in urine can be used to distinguish tobacco from pharmaceutical nicotine use.

The reported qualitative result for this substance was based upon a single analysis only. If confirmation testing is required please contact the laboratory.

4. Creatinine (Vitreous Fluid) - Vitreous Fluid:

Normal: 0.6 - 1.3 mg/dL

Reference Comments:

5. Glucose (Vitreous Fluid) - Vitreous Fluid:

Normal: <200 mg/dL

Postmortem vitreous glucose concentrations >200 mg/dL are associated with hyperglycemia.

Since postmortem vitreous glucose concentrations decline rapidly after death both in vivo and in vitro, care should be taken in the interpretation of results. Stability of vitreous glucose for up to 30 days has been noted by NMS Labs when specimens are maintained frozen (-20°C).

6. Mitragynine (Kratom) - Femoral Blood:

Mitragynine is an alkaloid found in the plant Kratom which originates from Asia. The leaves of the plant are consumed for their stimulant and analgesic effects and these effects are attributed to mitragynine. Plant extracts are sold for their medicinal use and may be subject to abuse. Adverse effects include seizures, coma, and death. Mitragynine blood concentrations listed in fatalities ranged from 20-600 ng/mL; other substances may have also been present.

7. Potassium (Vitreous Fluid) - Vitreous Fluid:

Normal: <15 mmol/L

Quantitative results for Potassium will be affected if performed on gray top tubes since these collection tubes contain potassium oxalate.

8. Sodium (Vitreous Fluid) - Vitreous Fluid:

Normal: 135 - 150 mmol/L

Quantitative results for sodium will be affected if performed on gray top tubes since these collection tubes contain sodium fluoride.

9. Urea Nitrogen (Vitreous Fluid) - Vitreous Fluid:

Normal: 8 - 20 mg/dL

Unless alternate arrangements are made by you, the remainder of the submitted specimens will be discarded one (1) year from the date of this report; and generated data will be discarded five (5) years from the date the analyses were performed.

Workorder 21395979 was electronically signed on 12/21/2021 15:21 by:



 Brianna L. Peterson, Ph.D., F-ABFT
 Forensic Toxicologist

Analysis Summary and Reporting Limits:

All of the following tests were performed for this case. For each test, the compounds listed were included in the scope. The Reporting Limit listed for each compound represents the lowest concentration of the compound that will be reported as being positive. If the compound is listed as None Detected, it is not present above the Reporting Limit. Please refer to the Positive Findings section of the report for those compounds that were identified as being present.

Acode 0930B - Caffeine, Blood - Femoral Blood

-Analysis by High Performance Liquid Chromatography/ Tandem Mass Spectrometry (LC-MS/MS) for:

<u>Compound</u>	<u>Rpt. Limit</u>	<u>Compound</u>	<u>Rpt. Limit</u>
Caffeine	0.50 mcg/mL		

Acode 1919FL - Electrolytes and Glucose Panel (Vitreous), Fluid (Forensic) - Vitreous Fluid

Analysis Summary and Reporting Limits:

-Analysis by Chemistry Analyzer for:

<u>Compound</u>	<u>Rpt. Limit</u>	<u>Compound</u>	<u>Rpt. Limit</u>
Chloride (Vitreous Fluid)	70.0 mmol/L	Sodium (Vitreous Fluid)	80.0 mmol/L
Glucose (Vitreous Fluid)	35.0 mg/dL	Urea Nitrogen (Vitreous Fluid)	3.00 mg/dL
Potassium (Vitreous Fluid)	1.00 mmol/L		

-Analysis by Colorimetry (C) for:

<u>Compound</u>	<u>Rpt. Limit</u>	<u>Compound</u>	<u>Rpt. Limit</u>
Creatinine (Vitreous Fluid)	0.0500 mg/dL		

Acode 52495B - Mitragynine Confirmation, Blood - Femoral Blood

-Analysis by High Performance Liquid Chromatography/ Tandem Mass Spectrometry (LC-MS/MS) for:

<u>Compound</u>	<u>Rpt. Limit</u>	<u>Compound</u>	<u>Rpt. Limit</u>
Mitragynine	50 ng/mL		

Acode 8042B - Postmortem, Expanded w/Vitreous Alcohol Confirmation, Blood (Forensic) - Femoral Blood

-Analysis by Enzyme-Linked Immunosorbent Assay (ELISA) for:

<u>Compound</u>	<u>Rpt. Limit</u>	<u>Compound</u>	<u>Rpt. Limit</u>
Barbiturates	0.040 mcg/mL	Gabapentin	5.0 mcg/mL
Cannabinoids	10 ng/mL	Salicylates	120 mcg/mL

-Analysis by Headspace Gas Chromatography (GC) for:

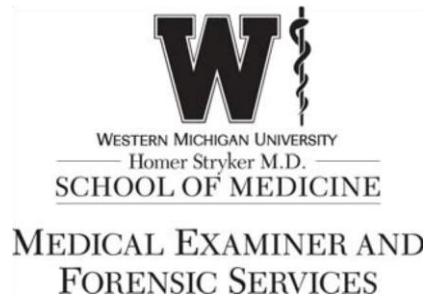
<u>Compound</u>	<u>Rpt. Limit</u>	<u>Compound</u>	<u>Rpt. Limit</u>
Acetone	5.0 mg/dL	Isopropanol	5.0 mg/dL
Ethanol	10 mg/dL	Methanol	5.0 mg/dL

-Analysis by High Performance Liquid Chromatography/Time of Flight-Mass Spectrometry (LC/TOF-MS) for: The following is a general list of analyte classes included in this screen. The detection of any specific analyte is concentration-dependent. Note, not all known analytes in each specified analyte class are included. Some specific analytes outside of these classes are also included. For a detailed list of all analytes and reporting limits included in this screen, please contact NMS Labs. Amphetamines, Anticonvulsants, Antidepressants, Antihistamines, Antipsychotic Agents, Benzodiazepines, CNS Stimulants, Cocaine and Metabolites, Hallucinogens, Hypnotosedatives, Hypoglycemics, Muscle Relaxants, Non-Steroidal Anti-Inflammatory Agents, Opiates and Opioids.

Acode 8050U - Postmortem, Urine Screen Add-On (6-MAM Quantification only) (Forensic)

-Analysis by Enzyme Immunoassay (EIA) for:

<u>Compound</u>	<u>Rpt. Limit</u>	<u>Compound</u>	<u>Rpt. Limit</u>
Amphetamines	500 ng/mL	Fentanyl / Metabolite	2.0 ng/mL
Barbiturates	0.30 mcg/mL	Methadone / Metabolite	300 ng/mL
Benzodiazepines	50 ng/mL	Opiates	300 ng/mL
Cannabinoids	50 ng/mL	Oxycodone / Oxymorphone	100 ng/mL
Cocaine / Metabolites	150 ng/mL	Phencyclidine	25 ng/mL



Decedent: **Matthew J. Eller**

Case: **W21-1383**

Sex: **Male**

Race: **White**

Age: **22 years**

Date of Birth: 03/08/1999
Date Pronounced Dead: 11/10/2021
Time Pronounced Dead: 2000 hours
Date of Exam: 11/11/2021
Time of Exam: 0730 hours
County: Muskegon
Pathologist: Joseph Prahlow, M.D.
Autopsy Procedure: Complete
Identification: Identification Tags
Persons in Attendance: Jenna Jones, Assistant
Matt Bombich, Photographer
Ben Root, Medical Student
Josh McGarry, Medical Student
Sung Jik Cha, Medical Student

Postmortem Examination Report

Cause of Death:

TOXIC EFFECTS OF MITRAGYNE

Manner of Death:

ACCIDENT



Western Michigan University Homer Stryker M.D. School of Medicine
Department of Pathology
300 Portage Street • Kalamazoo, MI • 49007
269.337.6173
med.wmich.edu

CIRCUMSTANCES:

History that the decedent stood up after playing a game of cards and then collapsed and demonstrated seizure-like activity. All resuscitative efforts failed. He had a history of kratom use.

RECEIPT OF REMAINS:

The body is received in the facility on 11/11/2021 at 0710 hours. The body is received in a secured body bag with an identification tag bearing the decedent's name and a sealing device marked with the number "2335758."

EXTERNAL EXAMINATION:

The body is identified by tags on the body bag and the right ankle. Photographs and x-rays are taken. The body is received wearing a pair of athletic shorts, a pair of boxer briefs, and a pair of socks. There is no jewelry.

The body is that of a well-developed, well-nourished, white male, whose appearance is compatible with the stated age of 22-years. His body is 73-inches long and weighs 138-pounds. The body is cold, rigor is fully developed, and the posterior lividity is partially fixed. The scalp hair is up to approximately 5-inches in length, brown, and wavy. There is emesis within the hair. The irides are hazel, and there are no petechiae of the bulbar or palpebral surfaces of the conjunctivae. There is no beard or moustache. The ears, nose, and lips are unremarkable except that the earlobes are pierced. The teeth are natural and in good condition. The neck is unremarkable. The chest is symmetrical. The abdomen is flat and unremarkable. The external genitalia, anus, and perineum are unremarkable. The penis is circumcised, and the testicles are descended into the scrotum. The extremities are well developed, symmetrical, and unremarkable. The back is unremarkable. The skin is unremarkable.

IDENTIFYING MARKS AND SCARS:

There is a tattoo of the name "Hannah" on the right triceps region.

EVIDENCE OF THERAPY:

- Oral laryngeal mask airway
- Multiple EKG pads
- Defibrillator pads
- Intravenous line, left antecubital fossa
- Bandage, left third finger

EVIDENCE OF INJURY:

There is a less than 1/8-inch superficial incised wound of the tip of the left third finger. There is a 3/16-inch in greatest dimension linear abrasion of the proximal knuckle of the left second finger. There is an approximately 1/4-inch in greatest dimension vertical linear laceration of the lower lip. There is a less than 1/8-inch crusted excoriation of the right shin. There is a less than 1-inch in greatest dimension subtle, left frontal subscalpular hemorrhage, but no other head trauma.

INTERNAL EXAMINATION:**BODY ORGAN WEIGHTS:**

Brain	1480 grams	Heart	340 grams
Right Lung	600 grams	Left Lung	500 grams
Liver	1840 grams	Spleen	230 grams
Right Kidney	150 grams	Left Kidney	170 grams

BODY CAVITIES:

The thoracic and abdominal organs are in their normal anatomic positions. The body cavities contain no adhesions or abnormal collections of fluid.

HEAD AND CENTRAL NERVOUS SYSTEM:

The scalp, subscalpular area, and skull are unremarkable except for the subtle left frontal subscalpular hemorrhage. The dura and dural sinuses are unremarkable. There are no epidural, subdural, or subarachnoid hemorrhages. The leptomeninges are thin and delicate. The cerebral hemispheres are symmetrical with an unremarkable gyral pattern; however, there is diffuse swelling. The cranial nerves and blood vessels are unremarkable. The brain is retained for Lieber neuropathological examination. The spinal cord is not examined. The pituitary gland is unremarkable.

LIEBER EXAM (from report):

The dura mater included with the specimen includes a portion of right and left calvarial dura with the superior sagittal sinus, and the falx cerebri, and dura including and adjacent to the torcula. The dura and dural sinuses are unremarkable, with no sinus thromboses, neomembranes, or mass lesions. The cerebral and cerebellar hemispheres are symmetrical with no evidence of softening or atrophy. The cortical sulci are somewhat effaced from cerebral swelling. The leptomeninges are smooth and transparent. There is no evidence of transtentorial, subfalcine, central diencephalic, or external herniation. The cerebellar tonsils are prominent, consistent with diffuse brain swelling. The blood vessels of the Circle of Willis show no atherosclerosis with no aneurysms, vascular anomalies, or malformations. The cranial nerves are present and unremarkable. Serial coronal sections of the cerebral hemispheres demonstrate well demarcated gray and white matter structures. The cortical ribbon is of normal thickness and the centrum semiovale is intact throughout, with no focal lesions. The medial temporal lobe structures including the hippocampus are bilaterally symmetric and effaced somewhat from brain swelling. There is no significant atrophy or evidence of mesial temporal sclerosis. The deep gray matter structures are anatomically intact without focal lesions. The ventricles are symmetrical with no evidence of hydrocephalus. Serial axial sections of the brainstem reveal pigmentation of the substantia nigra and locus ceruleus appropriate for age, unremarkable brainstem nuclei and white matter tracts, and no focal lesions. Midsagittal section of the cerebellar vermis and serial parasagittal sections of the cerebellar hemispheres are unremarkable. The dentate nucleus of the cerebellum is present and unremarkable.

NECK:

The soft tissues and prevertebral fascia of the neck are unremarkable. The hyoid bone and larynx are intact. The tongue is unremarkable.

CARDIOVASCULAR SYSTEM:

The intimal surface of the aorta is free of atherosclerosis. The aorta, its major branches, and the great veins are normally distributed. The pericardium, epicardium, and endocardium are smooth, glistening, and unremarkable. There are no thrombi in the atria or ventricles. The foramen ovale is closed. The coronary arterial system is right predominant and is free of atherosclerosis; however, the proximal left anterior descending coronary artery demonstrates “tunneling”. The atrial and ventricular septa are intact. The cardiac valves are unremarkable. There is slight biventricular dilatation (right greater than left). The myocardium is dark red-brown and firm, with no focal abnormalities.

RESPIRATORY SYSTEM:

The upper airway is unobstructed, but does contain small amounts of gastric contents. The laryngeal mucosa is smooth and unremarkable, without petechiae. The pleural surfaces are smooth and shiny. The pulmonary arteries contain no emboli. The major bronchi are unremarkable except for the presence of some gastric contents. Sectioning of the lungs discloses a dark red-blue, mottled, somewhat congested parenchyma.

HEPATOBIILIARY SYSTEM:

The liver is covered by a smooth, glistening capsule. The parenchyma is dark red-brown and moderately congested. The gallbladder contains no calculi. The extrahepatic biliary ducts are unremarkable.

DIGESTIVE SYSTEM:

The esophageal mucosa is gray, smooth, and unremarkable. The stomach contains 250 mL of tan semi-fluid substance. The gastric mucosa has normal rugal folds and there are no ulcers. The small and large intestines are unremarkable. The appendix is present. The pancreas is unremarkable externally and on sectioning.

GENITOURINARY SYSTEM:

The subcapsular surfaces of the kidneys are smooth and slightly lobulated. The cortices are of normal thickness. The calyces, pelves, and ureters are unremarkable. The urinary bladder contains 75 mL of clear, yellow urine. The mucosa is gray, smooth, and unremarkable. The prostate gland is unremarkable. The testicles are unremarkable.

ENDOCRINE SYSTEM:

The thyroid and adrenal glands are unremarkable externally and on sectioning.

RETICULOENDOTHELIAL SYSTEM:

The spleen is covered by a smooth, blue-gray, intact capsule. The parenchyma is dark red. The lymph nodes are unremarkable. The thymus is unremarkable.

MUSCULOSKELETAL SYSTEM:

The clavicles, ribs, sternum, pelvis, and vertebral column have no fractures. The diaphragm is intact.

MICROSCOPIC EXAMINATION:

LUNGS – Hyperexpanded alveolar spaces; bronchial mucosal hemorrhage; focal chronic bronchial inflammation.

THYROID – Variably-sized follicles; dark colloid.

ADRENAL, LIVER, THYMUS, HEART, KIDNEY, PANCREAS – Unremarkable.

BRAIN (per Lieber report) – Unremarkable adult brain.

SLIDE KEY:

A: Adrenal, liver, thymus

B: Lungs

C: Heart, kidney

D: Pancreas, thyroid

(BRAIN slides as per Lieber report)

VITREOUS ELECTROLYTES:

Sodium	118	mEq/L
Potassium	7.5	mEq/L
Chloride	124	mEq/L
Urea nitrogen	17	mg/dL
Creatinine	1.05	mg/dL
Glucose	<35	mg/dL

TOXICOLOGY:

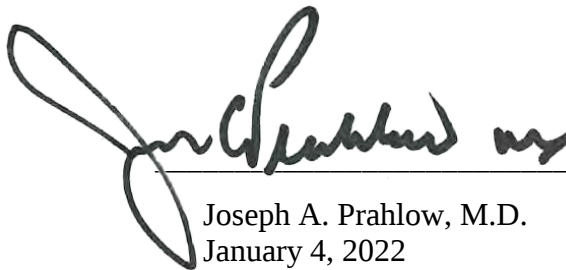
FEMORAL BLOOD -	Mitragynine -	2100 ng/mL
	Caffeine -	0.85 mcg/mL
	Cotinine -	Positive

FINAL FINDINGS:

- I. Toxic effects of mitragynine
- II. Not found: Anatomic explanation for death

CONCLUSION:

Based upon the autopsy findings and the history as available to me, it is my opinion that Matthew Eller, a 22-year-old white male, died as a result of the toxic effects of mitragynine.



Joseph A. Prahlow, M.D.
January 4, 2022