Aerospace Medicine Toxicology

Presented to: AOCOPM Meeting
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Our Goal at CAMI: Enhance Aviation Safety

Roles of Forensic Toxicology Team at CAMI

- Toxicological research to enhance aviation safety
  - Method development
  - Prevalence of drugs in pilot populations
  - Detect trends in drug usage patterns
- Assist NTSB aviation accident investigations with analysis and interpretation.

Government Authority

- AVIATION SAFETY RESEARCH ACT OF 1988, PUBLIC LAW 100-591[H.R. 4686]
- DOT ORDER 1100.2C (1989), Chap 53, Par 53-15 ... CAMI investigate ... general aviation and air carrier accidents and searches for biomedical clinical causes of the accidents, including evidence of ... chemical abuse.
- DOT ORDER 8020.11A (1991), Chap 4, Par 170 ... CAMI conduct toxicological analyses on specimens from ... aircraft accident fatalities.

Aviation: If it occupies national air space, we take it...

AVIATION ACCIDENT INVESTIGATION

Mechanical Factors
Human Factors

SEM Analysis → Result → Interpretation → Gas/Drug Analysis

Cause → Prevention
Toxicology - the study of the harmful effects of chemicals on living organisms.

Forensic Toxicology - the application of toxicology for the purposes of the law.
- Human Performance
- Forensic Drug Testing
- Postmortem

Case History

The Scientific Method (PM Investigations)
Reducing uncertainty through experimentation

Hypothesis
Experimentation

By reducing uncertainty, we approach truth.

Case example...
- A 67 y/o pilot, 23 y/o passenger
  - Pilot: Hx of heart disease, past heart attack.
  - Takes atenolol, aspirin, losartan, simvastatin.
  - Take off, 3 miles out, request return
  - No problem was specified
  - Request granted
  - Turns back but crashes into neighborhood

Toxicology Samples Sent to CAMI
- Blood
- Vitreous
- Urine
- Bile
- Brain
- Gastric Contents
- Heart
- Kidney
- Liver
- Lung
- Muscle
- Spleen
- Powders/Pill/Paraphernalia

Toxicology Results
- 67 y/o male, pilot
  - Blood/Liver
    - Atenolol
    - Sildenafil
    - Tadalafil
    - Zopiclone
    - Methylone
    - THC/THCCOOH
- 23 y/o female
  - Blood/Liver
    - Benzoylcegonine (coca base metabolite)
    - Ecgonine methyl ester (coca base metabolite)
    - Lovamoxole
    - Methylone
    - Zolpidem
Toxicology Results

- Blue Powder
  - Amphetamine
  - Cocaine
  - Lidocaine
  - Methylene
  - Sildenafil
- White Powder
  - Cocaine
  - Lidocaine
  - Methylene

Final Conclusions

- Medical Examiner
  - Cause of Death: Blunt force injuries
  - Manner of Death: Accident
- NTSB Report
  - Rx meds: "...it is unlikely that any of these medications resulted in impairment."
  - Marijuana: "...insufficient evidence...to determine whether the pilot was impaired..."
  - "Given the level of methylone... it is likely that the pilot was impaired at the time of the accident."
  - "Contributing to the accident was the pilot's impairment from the use of illicit drugs."

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NTSB Report

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Crash While Scouting for Moose

"Contributing to the accident was the pilot's use of marijuana, which likely degraded his psychomotor ability."

<table>
<thead>
<tr>
<th>Sample</th>
<th>THC (ng/mL,g)</th>
<th>THCCOOH (ng/mL,g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung</td>
<td>204.4</td>
<td>5.5</td>
</tr>
<tr>
<td>Liver</td>
<td>87.1</td>
<td>249.5</td>
</tr>
<tr>
<td>Blood</td>
<td>9.4</td>
<td>12</td>
</tr>
<tr>
<td>Urine</td>
<td>nt*</td>
<td>14.6</td>
</tr>
</tbody>
</table>

* nt = not tested

What are we looking for?

- Fire gases
  - carbon monoxide (COHb)
  - hydrogen cyanide (CN)
- Ethanol and other volatiles
  - Also methanol, isopropanol, acetone
- Drugs
  - controlled substances
  - prescription drugs
  - nonprescription drugs

Comprehensive Analytical Strategy at CAMI

Maximizing the data to accomplish our mission

Interpretation of the results?

What about other drugs?
Another issue...

- 5 days after being reported missing in August, an airplane wreckage was found in the Sierra Blanco Mountains of New Mexico. The 56 y/o male pilot was found dead in the cockpit of the aircraft. No medications or alcohol found in the aircraft.
- At autopsy, blunt force trauma was determined to be the cause of death. A moderate amount of bodily decomposition was noted.
- Drug screens – negative; Ethanol - heart blood: 0.06 %, vitreous: 0.00%
- Source of the Ethanol?

Postmortem alcohol production – fermentation by microbes (yeast, bacteria).

Vitreous fluid is run alongside blood (when possible) to distinguish postmortem production from ingestion.

Vitreous fluid is much less susceptible to postmortem alcohol production.

Postmortem Redistribution

- False elevation of central blood specimen [heart]
- Protein-bound drug released from tissue, diffuses into blood
- Diffusion from one organ to another (e.g., lung to heart, stomach)
- Aspiration of vomitus elevates (heart, lung)
- Preferred blood for interpretation – femoral vein (peripheral site)

Postmortem Issues

- Alterations in drug concentration
- Postmortem Redistribution (PMR)
- Decreasing concentration over time
  - Cocaine
  - Olanzapine (Zyprexa)
  - Glucose
  - Ethanol production
- Tissues-only cases
- Analytical interferences due to decomposition

Case Interpretation: A Complicated Story!

Pathology/Medical

- Pharmacogenomics
- Drug interactions

Investigation/History

- Individual response variability
- Postmortem changes

Thank you for your attention!
Questions?