Challenges in the Analysis of Alcohol in Civil Aviation Accident Investigations

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Federal Aviation Administration
Civil Aerospace Medical Institute
Oklahoma City, OK

Aerospace Medical Association Meeting
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Bill Mills

I have no financial relationships to disclose.

I will not discuss off-label use and/or investigational use drugs in my presentation.
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Descriptive Statistics for U.S. Civilian Aviators
Total Number Certificates as of March 2011 is 579,912

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent Total</th>
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</thead>
<tbody>
<tr>
<td>1 DUI</td>
<td>25568</td>
</tr>
<tr>
<td>2 DUI</td>
<td>2710</td>
</tr>
<tr>
<td>3 DUI</td>
<td>440</td>
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</tbody>
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DUI = driving under the influence offense
EtOH = ethanol
Alcohol and Aircraft Accidents

- Approximately 7 to 8% of toxicology samples from fatal U.S. general aviation accidents reveal alcohol from some source
- It appears that about half of these are from antemortem ingestion

- 0.04% (40 mg/dl) FAA BAC limit
- Alcohol ingestion within 8 hrs of flight is not permitted regardless of BAC

(BAC = blood alcohol content)
Issues with Postmortem Alcohol Levels

Postmortem redistribution
- Trauma
- Blood movement
- Diffusion

H. Maeda et al. / Legal Medicine 13 (2011) 55–67
Issues with Postmortem Alcohol Levels

Postmortem production of alcohol
• Ethanol-producing microorganisms
• Time, Nutrients, Temperature

Postmortem contamination with alcohol
• Ethanol-containing fuel
• Hand cleaner, disinfectants, collection equip
Issues with Postmortem Alcohol Levels

Sample Selection

- Blood
  - cavity
  - central
  - peripheral
- Tissue
  - muscle,
  - liver,
  - brain, etc.
- Urine
- Vitreous
Supplementary Testing

- Other volatiles
  - N-propanol,
  - N-butanol
  - Acetaldehyde
  - Methanol

- Tests of antemortem ethanol metabolism
  - Urine ethyl glucuronide (>90 hrs)
  - Urine serotonin metabolite ratio (11-16 hrs)

- Don’t forget the history & scene findings
Serotonin Metabolite Ratio – Developed and Validated at CAMI

- Alcohol consumption alters the ratio of the concentration of two urinary serotonin metabolites, 5-HTOL and 5-HIAA
- Urine 5-HTOL/5-HIAA ratio > 15 indicates alcohol consumption within 11 – 16 hours prior to death
- Urine 5-HTOL/5-HIAA ratio < 15 indicates no alcohol consumption for 11 – 16 hrs prior to death
- < 1 in 10,000 chance of false positive
- Why doesn’t everyone use this test?
Case #1: May 1998  
Fatal aviation accident in remote, mountainous terrain. Pilot not recovered for more than 24 hrs.

Ethanol Testing:
Blood 93 mg/dL  
Urine 31 mg/dL  
Vitreous 3 mg/dL

Other volatiles: none detected

Serotonin metabolite ratio: 1.62

Conclusion: The ethanol present in this case was due to postmortem formation.
Case 2: April 2011

- 0320 Arrived at airport after going to a bar
- 0408 Departed without weather briefing or IFR flight plan
- 0423 Reported airport in sight (Airport 24 mi away under two broken cloud ceilings)
- 0432 Last radar contact showed left turn at 2,600 ft MSL after having overflown the destination airport

Examination of the wreckage did not reveal any pre-impact mechanical malfunctions
Toxicology testing was performed on the pilot at CAMI.

Ethanol testing:
- Blood (heart): 123 mg/dL
- Urine: 126 mg/dL
- Vitreous: 150 mg/dL

Methanol (1 mg/dL) detected in vitreous

Serotonin metabolite ratio was 480 (pmol/nmol)

Conclusion: Impairment by antemortem alcohol use