Aerotoxic Syndrome: A New Occupational Disease?

S. Michaels PhD, ATPL; J. Burdon MBBS, MD, FRACP; CV Howard MB, Chb. PhD, FRCPath.

1. Michaels Aviation Consulting, Sussex 2. Mercy Hospital, Melbourne, 3. University of Ulster. Contact: susan@susanmichaelis.com

Aim: An ecological study has been undertaken reviewing a cohort of airline crews in suspected contaminated aircraft cabin air events to determine if the reported symptoms and diagnosis are consistent with exposure to jet engine oil and engine/aircraft fluids or other factors.

Method: Two independent studies were utilized to review the circumstances and symptoms of a cohort of airline crews in a variety of reported cabin air supply related incidents. A table of symptoms has been utilized to review the reported symptoms for the studies published against the literature, chemical hazards and other potential factors. The symptoms were then referenced to the Bradford Hill criteria.

Background: Aircraft breathing/ventilation air (“bled air”) has been supplied since the 1950s to the aircraft cabin unfiltered from the engine compressor. The use of compressor pressurised air to seal the bearing chamber as well as supplying bleed air for the cabin provides a design mechanism for low level engine oil leakage into the cabin air in normal aircraft operations. In addition to low level oil leakage over the bearing chamber oil seals, higher level exposures can occur less frequently under operational factors such as seal wear or mechanical failure conditions. Hydrical and deicing fluids may also enter the aircraft breathing air supply. The fluids are exposed to very high compressor air temperatures.

The synthetic jet engine oils contain an ester base stock, Triaryl phosphates (TAP) as wear additives including Tricresyl phosphate (TCP), amine anti-oxidants, a wide range of pyrolysed breakdown products, corrosion inhibitors and proprietary substances in the oils and the fluids contain a wide range of globally harmonised GAP CLP classification hazards. These substances are being found in ad-hoc studies between 25-50% of sampled UK based aircraft. There are no detection systems fitted to aircraft to detect when the fluids enter the breathing air. A wide range of adverse effects have been reported by airline and passengers, yet there are differing views on the effects of such exposures.

Notable factors: The findings of this study ought to be addressed in light of the following factors:
1. UK Committee of Toxicology (COT) reports bleed air contamination and does cause acute effects with the effects reported, 2) TCP/TCP unlikely to be the only toxic mechanism, 3) Nociceceptor mechanism unsupported, 4) Exposure standards do not apply to the aircraft cabin environment.


http://handle.sussex.ac.uk/10339/430044

Purpose: What health effects are being reported in UK BAe 146 pilots exposed to contaminated bleed air?

Selection: Pilot database supplied by pilot unions

BAe 146 aircraft pilot health survey (UK) n =219 pilots:

- Controls: Civil and military pilot medical disqualification: Study chronic illness pilots (13%) 37-433 above controls.

Findings: Arrow are reporting acute and chronic neurological, neurobehavioural and respiratory disease consistent with exposure in normal flight operations to jet engine oils and aircraft fluids including CLP:

- Acute symptoms consistent with partner of acute and long term adverse effects and medical findings are occurring in temporal association to aircraft fume events, occurring primarily during periods of changing engine operating conditions, that are consistent with exposure to jet engine oil and hydraulic fluid leakage into the aircraft air supply.

- Previous reports of fumes on air:
  - Previous reports of fumes on aircraft: 10 (7)
  - Previous reports of fumes on aircraft: 10 (7)
  - Maintenance findings: oil: 31; oil and hydraulic fluid: 2

- Level of effect: (at time of event):
  - Inflammation and/or partial/previous: 7
  - Inflammation and/or partial/previous: 7

- Time of effect: immediate (in flight): 14; short-medium-term; 12; long-term: 2

- Number of acute symptoms reported/infection: 1-8; 10-23

- More than 1 rememberer affected: 11

- Passengers affected: 4

- Medical tests undertaken at time of event: 11

- Medical findings at time of event: 7

- Medical findings diagnosis later on: 10; 5.5

- Loss of pilot medical certificate/ability to fly: 5

- Use of oxygen (both pilots): 1; 10: 0; all crew: 0

- Delayed usage by pilots: 5

- Oxygen helped: 8

- Emergency checklist used by pilots: 2

- Air Accident Investigation Bureau report: 10

Findings: A catalogue of acute and chronic neurological, neurobehavioural and respiratory disease consistent with exposure in normal flight operations to jet engine oils and aircraft fluids including CLP.

Overview of the 13% of pilots who lost medical certificate to fly or experiencing chronic illness/deceased:

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>Controls</th>
<th>Chronic Fatigue</th>
<th>Cardiovascular</th>
<th>Neurological</th>
<th>Respiratory</th>
<th>Gastrointestinal</th>
<th>Dermatology</th>
<th>Skin</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>100%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>35%</td>
<td>30%</td>
<td>20%</td>
<td>10%</td>
<td>5%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>Controls</th>
<th>Long-term</th>
<th>Short-term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>100%</td>
<td>20%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Study B (2015) – Case Study: Analysis of 15 suspected cabin air contamination events

Purpose: Review undertaken of well documented incidents, to determine if the pattern and effects are consistent with aircraft cockpit and cabin contaminated with engine oil, hydraulic oils or deicing fluids and their pyrolysed products or other factors.

Selection: Incidents selected based upon extensive data being publicly available and reference made to some of these events in various publications.

Findings: A catalogue of acute and chronic neurological, neurobehavioural and respiratory disease consistent with exposure in normal flight operations to jet engine oils and aircraft fluids including CLP.

CONCLUSIONS:
Aircraft air supplies contaminated by engine oil and other aircraft fluids are reasonably linked to acute and chronic syndromes and findings/diagnoses creating a causal and adverse outcome. Other potential causes are sometimes suggested, however these fail to recognize the following:

1) The design mechanism allowing chronic low-level exposure to a complex mixture in normal flight along with specific incident events with confirmed leakage;
2) Effects seen are consistent with recognized hazards;
3) Acute effects affect safety;
4) Chronic effects are common.