



# Health And Flight Safety Implications From Exposure To Contaminated Air In Aircraft.

**Aerospace Medical Association Meeting – Anchorage May 2011**  
Airline Transport Medical Committee Cabin Air Quality

Dr Susan Michaelis, ATPL, PhD

[www.susanmichaelis.com](http://www.susanmichaelis.com) ; [www.gcage.org](http://www.gcage.org)

susan@susanmichaelis.com

44(0) 7880 554551

# Disclosure Information

*82<sup>nd</sup> Annual Scientific Meeting*

*Dr Susan Michaelis*



I have no financial relationships to disclose.

I will not discuss off-label use and/or investigational use in my presentation.

I am here today as the Head of Research for the Global Cabin Air Quality Executive – ( GCAQE )

# Research Questions



- ✈ What health effects are being reported in crew exposed to contaminated bleed air?
- ✈ What monitoring has been undertaken, can such data be used to assess exposure impact on human health?
- ✈ How often do contaminated bleed air events occur and what are the flight safety implications?
- ✈ Have the aviation industry and Governments dealt with the contaminated bleed air issue appropriately?

# Air Quality Monitoring



General air studies	'n'	Contaminated air studies	'n'
General air studies - no fume events (38%)	20	Contaminated air studies - (62%)	33
Epidemiological studies – during monitoring (no fume event)	06	Fume event *short duration/minor	01
Epidemiological studies – Not during monitoring (no fume event)	2	Epidemiological studies – not during monitoring (no fume event)	05
Cabin air deemed acceptable (60%)	12	TCP found (48%)	16
		Oil constituents identified as source (60%)	21
		Cabin air deemed acceptable (27%)	09

- Epidemiological studies of very limited benefit
- Air deemed acceptable: strong industry affiliation



# Monitoring



- Oil studies – Extensive;
  - 1954: USAF – Toxicity of heated synthetic oils identified;
  - Study techniques – generally inadequate;
  - Analysis of results – inappropriate;
  - General air quality monitoring studies have been inappropriately widely used to suggest acceptability of cabin air;
  - Specific contaminated air studies were of mixed value; with oil identified in 60% and TCP identified in 48% of the studies;
  - Epidemiological studies are of very limited value and cannot be used to suggest air is safe.
- 
- **Studies undertaken cannot be used to suggest air quality is acceptable and not able to cause adverse effects.**

# Frequency of Events



## UK

- ✈ CAA records incomplete;
- ✈ 32% of contaminated air events involved crew impairment;
- ✈ 21% of events involved at least 1 pilot impairment;
- ✈ 10% of events involved impairment of both pilots;
- ✈ Oxygen used by 1 (both) pilots in 4% (9%) of events (transient)
- ✈ Significant flight safety events identified;
- ✈ Boeing 757: Oil fumes reported in 1% of flights at one airline.

## Global



# Frequency of Events



- ✈ Significant under-reporting and contaminated air events not rare;
- ✈ Regulatory / airline / manufacturer databases are unreliable;
- ✈ Less than 4% of events are reported;
- ✈ It is not possible to determine a reliable rate of contaminated air events – (EASA 2009);
- ✈ **Seal design fails to prevent oil leakage over the full engine operating range and seal wear provide the basis for oil leakage at lower levels. This is an inadequate design and operational feature of using bleed air;**
- ✈ Industry focus has incorrectly been placed on maintenance failures;
- ✈ Lower level synthetic oil leakage is an **expected / accepted** occurrence of the bleed air system.



# Awareness



## Extensive awareness in 1950s and 1960s

Exposure to synthetic lubricants:  
Hazardous / Toxic

Critical temp: ( $> 600^{\circ}\text{F}$ ):  
Degradation of base stock/TCP

Contamination of air was key concern:  
Design/performance

Concern of rising engine temperatures &  
toxicity – forgotten by 1970

Adverse effects in crews

## General

Industry awareness – Extensive:  
To the – present day

Engines temps routinely used above  
critical oil temps

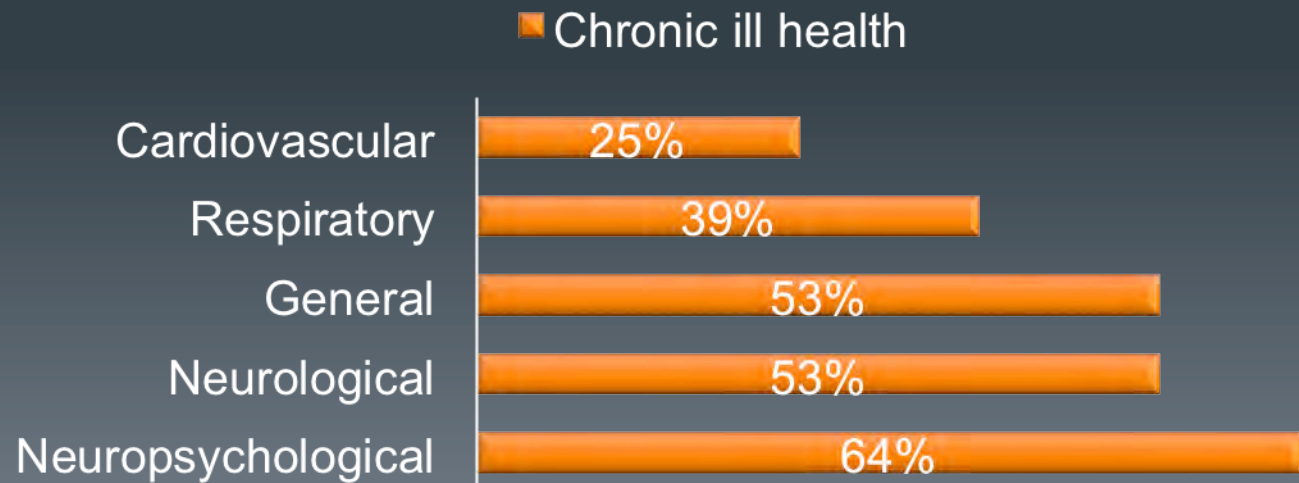
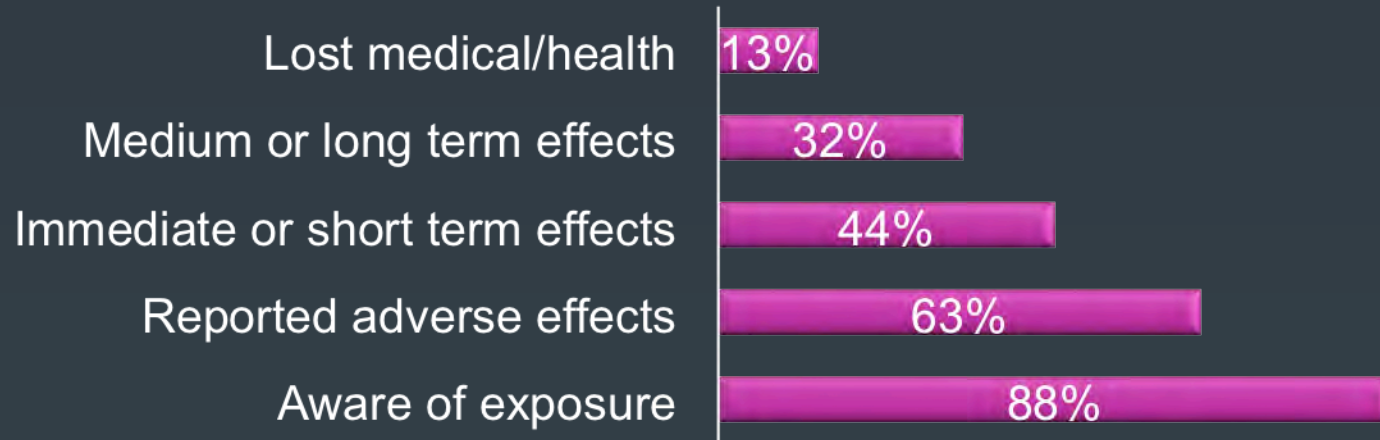
Engine compressor bleed air fails to meet  
certification and safety analysis  
requirements as occurrence  $> 10^{-5}$   
(remote)

Wide variety of regulations (oil leakage)  
fail to be met

# Health Effects



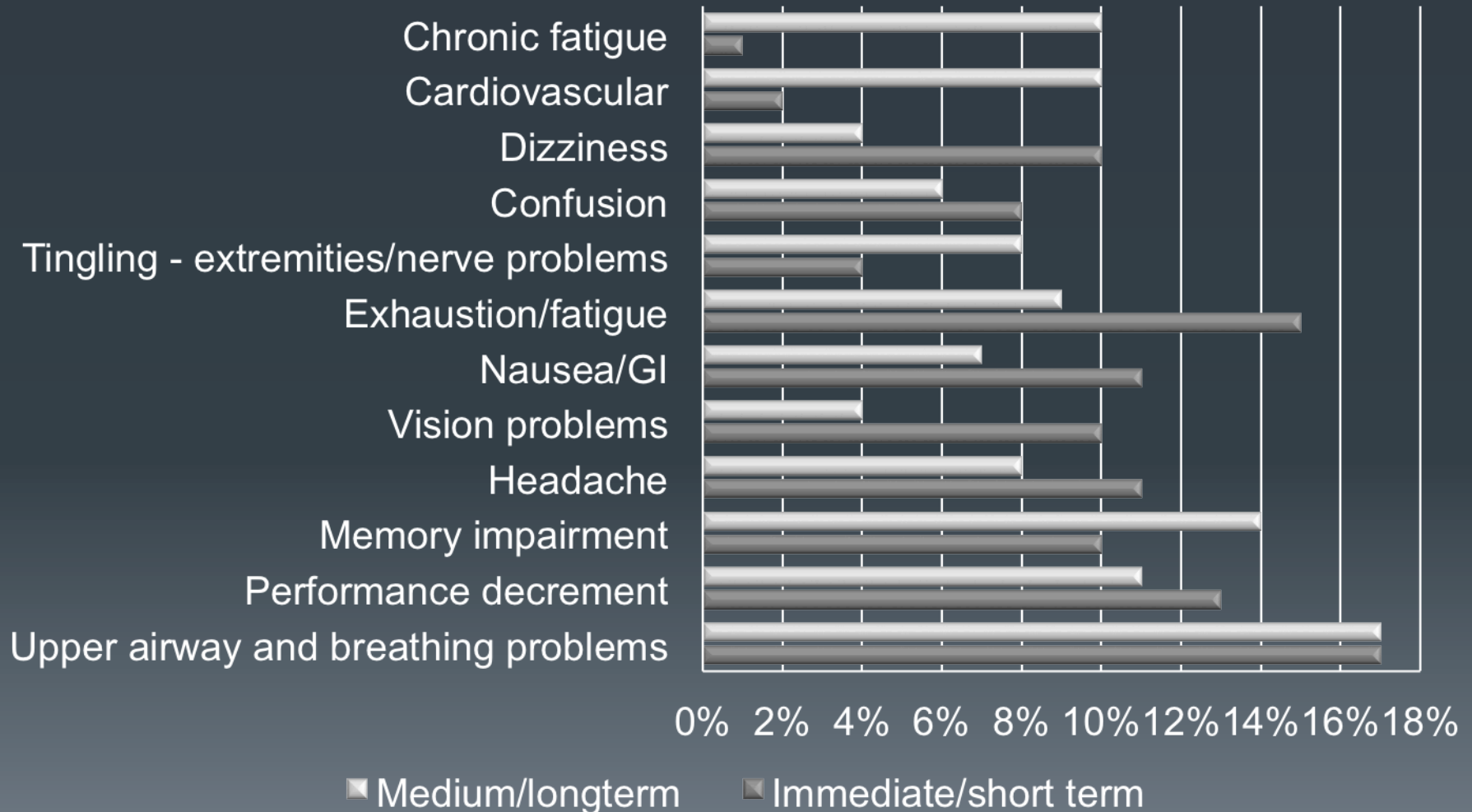
**BAe 146/RJ Adverse health effects. n=274**



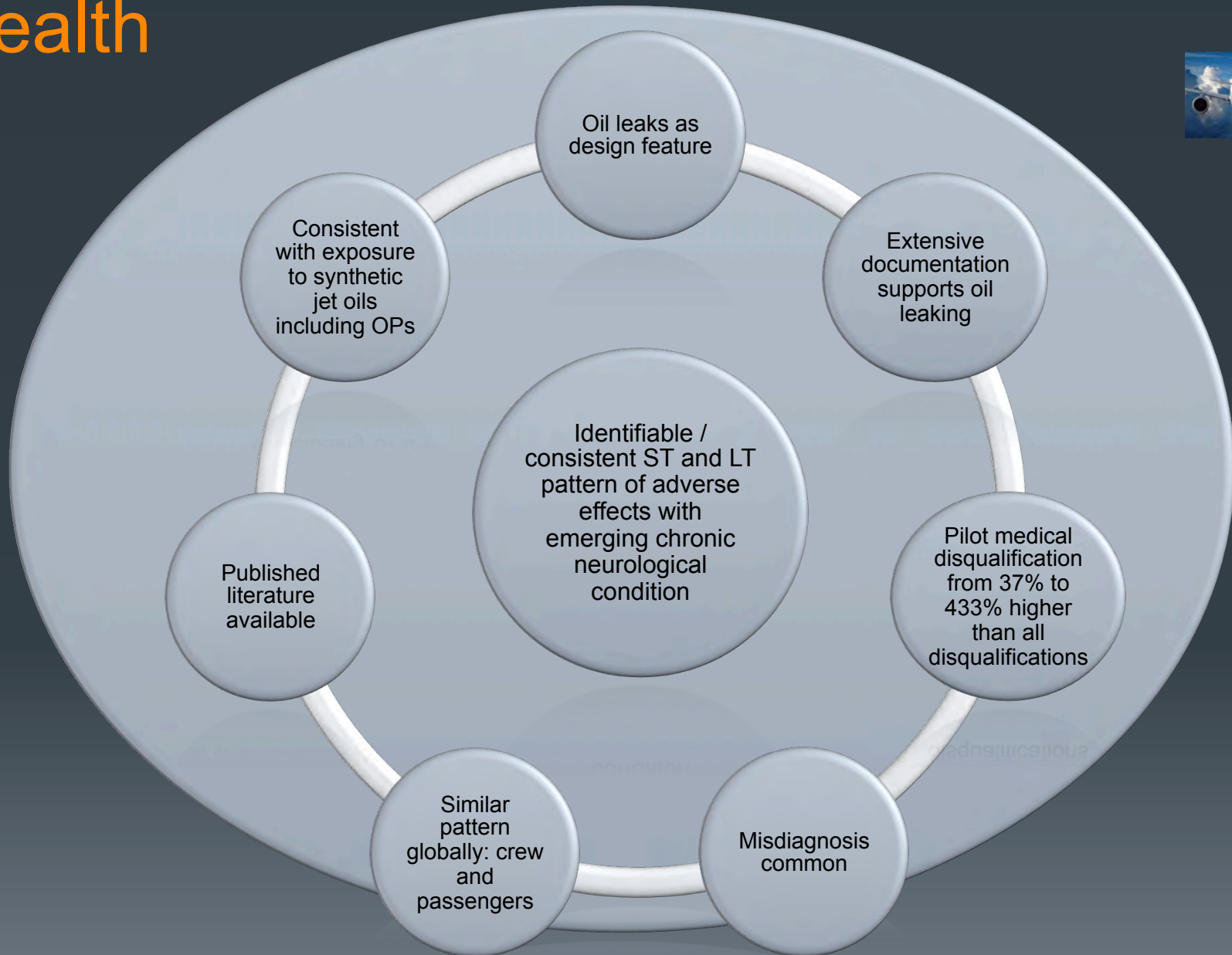
# Health Effects



## BAe 146/RJ - Health effects n=219

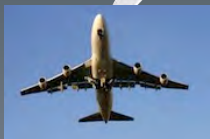
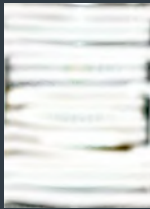


# Health





# Aerotoxic Syndrome (2000)



Studies show consistent pattern of acute and chronic symptoms/dysfunction

Causative relationship exists

Illness from a complex set of symptoms resulting from unique occupational environment

Specific symptoms can vary between people but general types of symptoms remarkably consistent.

**Term  
Aerotoxic  
Syndrome  
is valid**





# Conclusions



- ✈ Adverse effects with temporal association are evident;
- ✈ Monitoring cannot be used to say cabin air is satisfactory;
- ✈ Contaminated air is a function of design and operation of bleed air systems and therefore explains frequency;
- ✈ Awareness of issue dates back to 1950s;
- ✈ The problem remains unresolved and flight safety continues to be compromised;
- ✈ Lubricant manufacturer raises toxicity concerns with EASA;
- ✈ Solutions exist: Bleed free technology is now flying on the Boeing 787 and bleed air filtration solutions could be used.

The data from this presentation was extracted from the PhD Thesis by Susan Michaelis (2011) entitled: "Health and Flight Safety Implications from Exposure to Contaminated Air in Aircraft".

ISBN: 978-0-95-554377-7

[susanmichaelis.com](http://susanmichaelis.com)