Health disorders after "fume events" of aircraft crew members: facts and fiction

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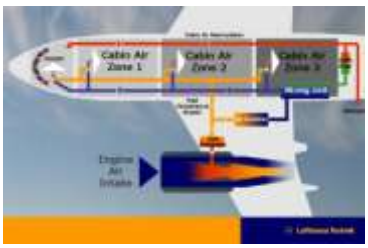
Health disorders after fume event *Background*

Cabin air contamination so called „Fume Events" (FE) are associated with various symptoms led to concerns among airline crew members, firstly described in the 1950s *(Committee of the avuiation toxicity, Aero Medical Association, Blakiston, 1953; Aerospace Medicine 41: 760-762, 1970).*

However, in the following period nor the source of this contamination with unknown substances during flight neither the clinical symptoms are systematically investigated. *Aerospace Medicine 41: 760-762, 1970; Montgomery et al. (1977): J Toxicol Clin Toxicol 11: 423-426; Rayman et al., Aviat Space Environ Med 54: 738-740; Tashkin et al., Arch Occup Environ Health 52: 117-137; Van Netten: Appl Occup Environ Hygiene 13: 733-739; Burdon et al. (2005): J Occup Health Safety. Ross et al. (2011) J BiologPhysic chem 11: 180-191; Reneman et al. (2015): Brain Imaging and Behavior.*

Though many studies are running – mostly industrial related - there is still not sufficient literature on clinical data or showing detailed data which may unravel underlying causes and context factors for the reported health complaints after this accident.

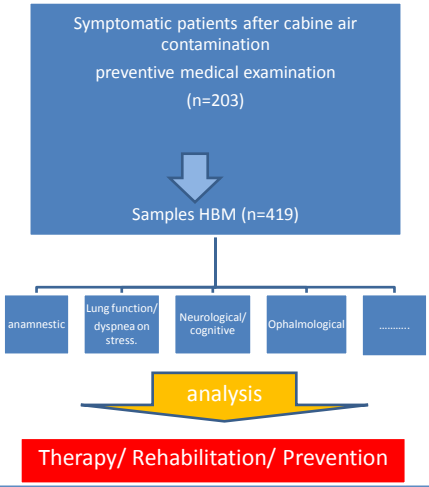


www.lufthansa-technik.com/de/cabin-air-circulation

Health disorders after fume event
Methods

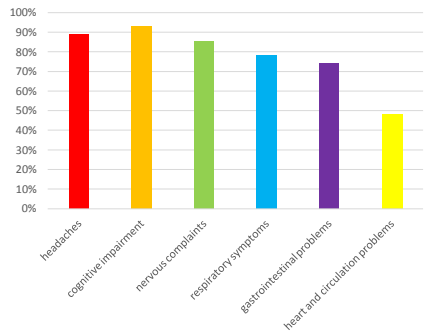
Consecutive examination in our Clinic for Occupational and Environmental Medicine

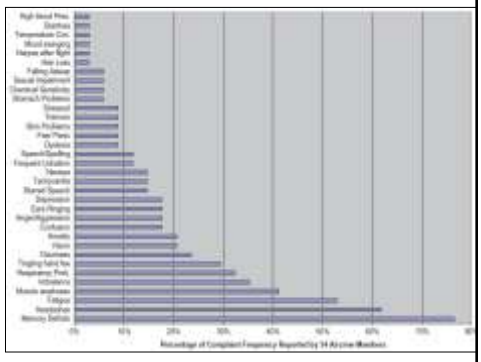
- Diagnostic function tests were applied taking into account the individual complaints
- Detection of the unknown cabin air contaminations:
  - in dependence of the diagnostic time slot blood and/or urine samples were screened for any reference
    - to organophosphates
    - and/or various VOCs.



Health disorders after fume event
Results:
frequency of symptoms

Bornemann et al: DGAUM munich 2016





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BIOLOGICAL AND HEALTH EFFECTS OF EXPOSURE TO KEROSENE-BASED JET FUELS AND PERFORMANCE ADDITIVES

Health disorders after fume event
Results:
HBM data AChE post FE

Müller and Heutelbeck, ENTOX 2015

- Biochemical effect monitoring to cover acetylcholinesterase inhibiting compounds, e.g. organophosphates
- values of the ChE check mobile® kit for the AChE activities were 26.7 - 50.9 U/g hemoglobin.
- After FE symptomatic patients' AChE activities covered a range of 37 - 50 U/g hemoglobin.

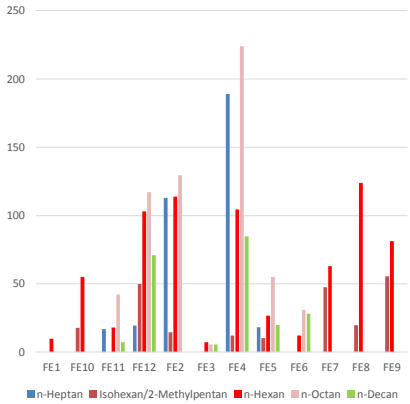
The measured AChE activities indicate a subordinate contribution of organophosphates or related compounds to the observed symptoms.

Health disorders after fume event

Results:

HBM data post FE vs. after non-exposed time (n=9)

VOC level in blood immediately (<24 hours) following FE (µg/l):



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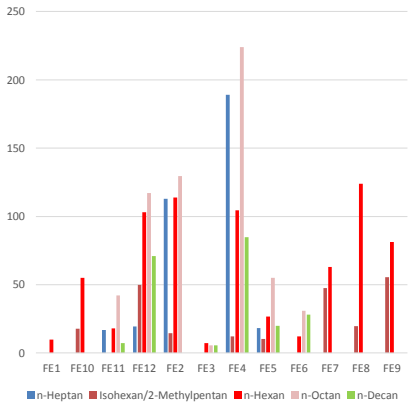
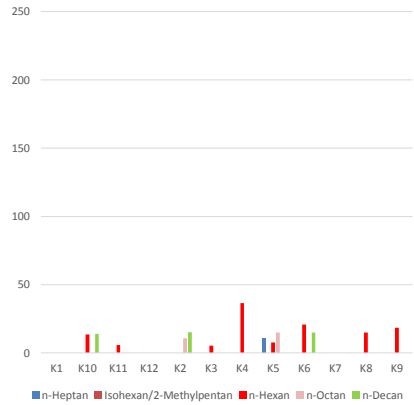
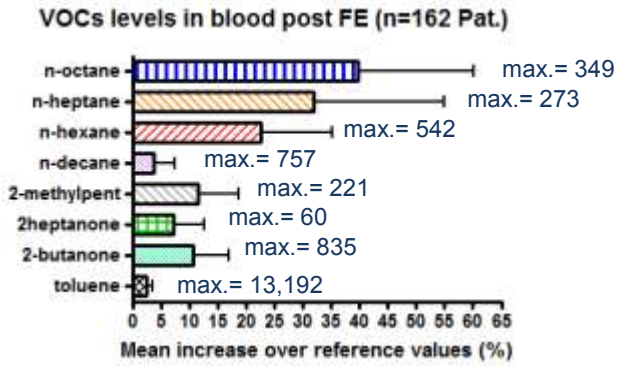


VOC level in blood several days after FE (µg/l):

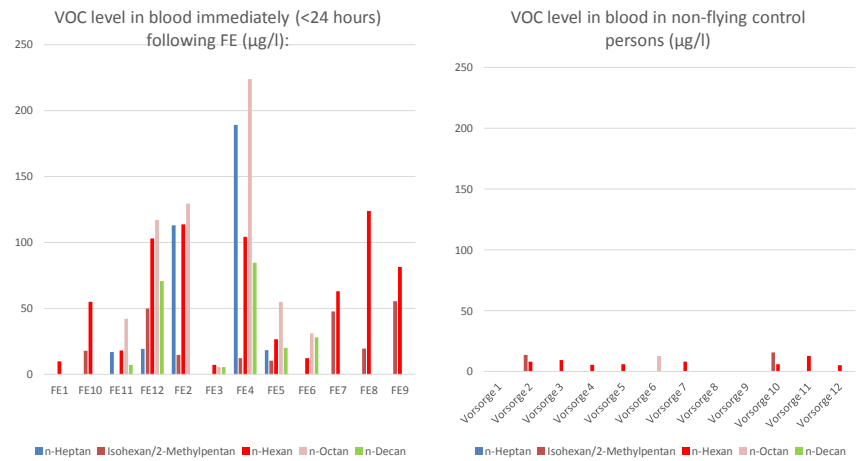


Heutelbeck, Budnik, Baur, Ramazzini Days 2016

Health disorders after fume event
Results:
HBM data VOCs post FE



Health disorders after fume event
Results:
HBM Data post FE (n=9) vs. non-flying control persons (n=12)



Health disorders after fume event

Results:

HBM Data post FE (n=9) vs. non-flying control persons (n=12)

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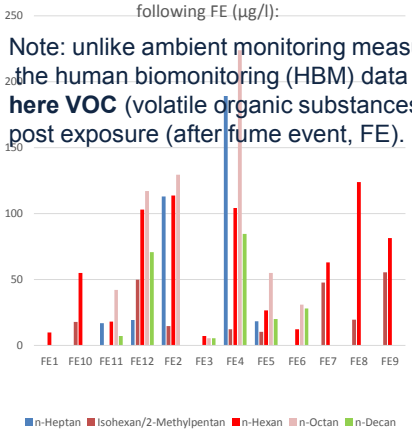
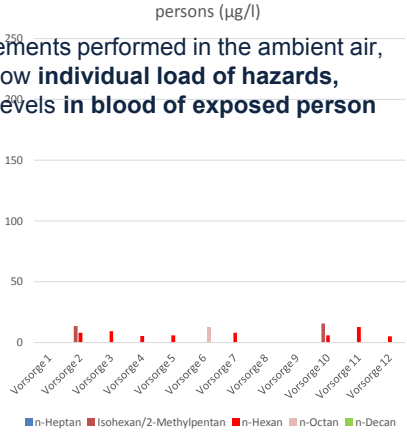


VOC level in blood in non-flying control persons (µg/l)



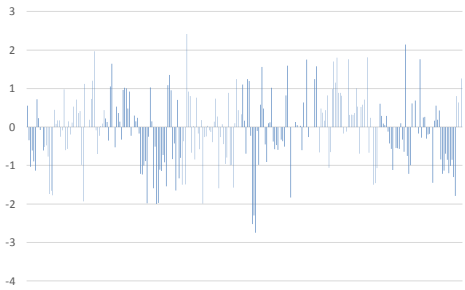
Note: unlike ambient monitoring measurements performed in the ambient air, the human biomonitoring (HBM) data show **individual load of hazards, here VOC** (volatile organic substances) levels **in blood of exposed person** post exposure (after fume event, FE).

Health disorders after fume event

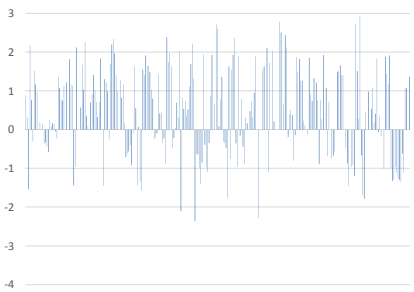
Results:

Lung function tests after FE: immediately and follow-up (n=354)

Z-Score **FEV1**



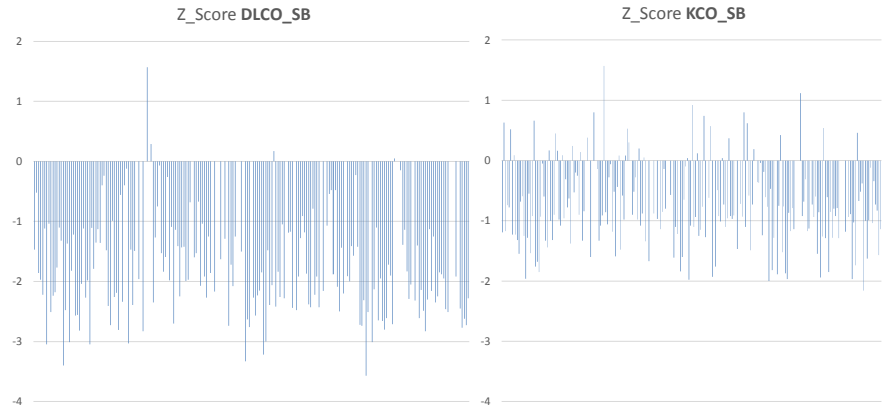
Z-Score **VC**



Health disorders after fume event

Results:

Lung function tests after FE: immediately and follow-up (n=354)



Health disorders after fume event

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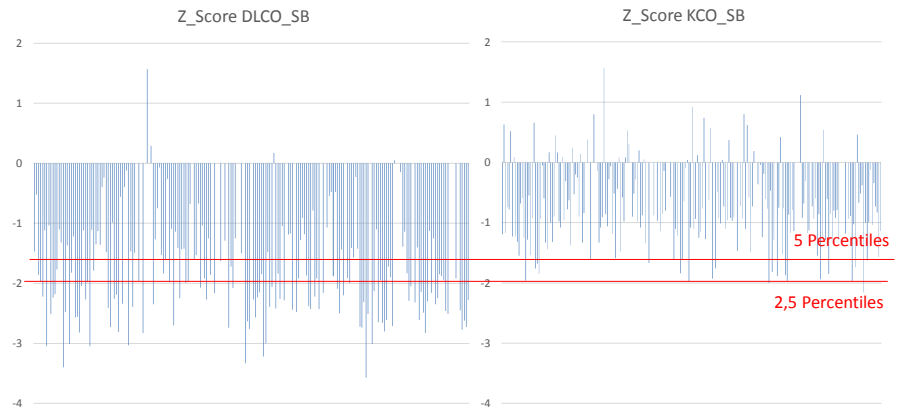

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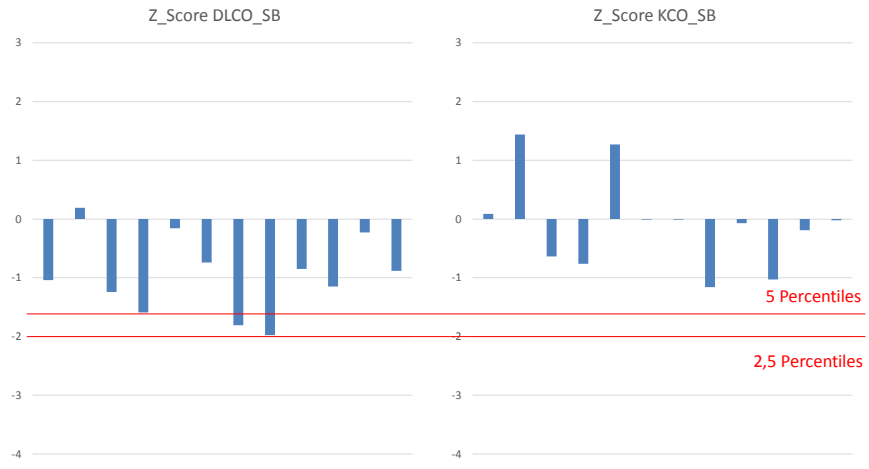
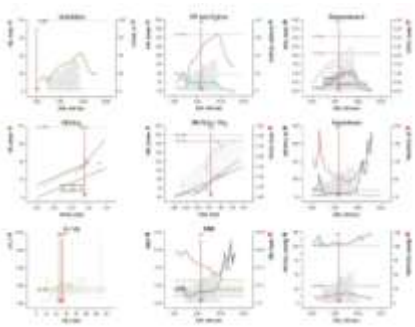
Health disorders after fume event
Results:
Lung function tests in non-flying controls (n=12)

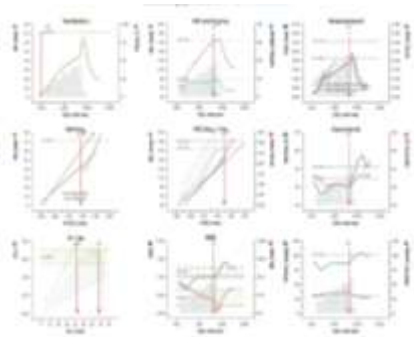


Health disorders after fume event
Results:
case history respiratory disclaims

Oxygen intake under stress
1 weeks after FE



Oxygen intake under stress
12 weeks after FE



Health disorders after fume event
Results of the interims analysis: Tests nervous complaints

More than 80% symptomatic

- Diversity of cognitive impairment, one or more symptoms were confirmed in the most cases:
  - Cognitive impairment
    - Difficulty speaking and finding words
    - Memory performance
    - Power of concentration
    - Incoordination
- Evaluation of tests strategy for nervous complaints (restless legs, muscular jerking, tingling sensations)
  - Nerve function measurement
  - neurohistology


Cognitive impairment and associated loss in brain white microstructure in aircrew members exposed to engine oil fumes

Health disorders after fume event
facts and fiction: Summary symptoms and diagnostic tests

- The symptoms associated with cabin air contamination are diverse but including mostly nervous and respiratory disclaims
  - We confirm the relevance of neurocognitive tests in measuring cognitive impairment
    - Open questions: measurement of the nervous complaints
      - Our preliminary results indicate that the use of neurophysiological or neurohistological methods can be helpful
  - Our results underline the relevance of methods monitoring the oxygen intake in the diagnostic processes in symptomatic crew members after FE
    - Open questions: Mechanism? damage at the capillary level or at alveolar membrane?
- The clinical finding are plausible in the context of the toxicological potential of VOCs which may affect the peripheral and/or central nervous system and the respiratory tract.

Health disorders after fume event *facts and fiction: Summary HBM*

- We have established methods detecting VOCs the clinical testing in symptomatic patients after cabin air contamination
  - Our clinical and toxicological results are evidence for exposure mainly to VOCs during fume events in aircrafts.
  - Most of these VOCs are not components of the general environment, but for e.g. of kerosene.
  - VOCs may affect the peripheral and/or central nervous system and the respiratory tract.
  - unlike ambient monitoring measurements performed in the ambient air, the human biomonitoring (HBM) data show individual load of hazards.
- The measured AChE activities indicate a subordinate contribution of organophosphates or related compounds to the observed symptoms.

Health disorders after fume event *facts and fiction: Conclusion*

Preliminary clinical finding ↓ HBM ↓

Further independent precise analytical and clinical investigations are urgently needed

- to evaluate more detailed the diverse clinical pictures and the causative substances and relevant context factors
- To appropriate diagnostic algorithm.
- To establish an evidence-based systematic risk assessment for good workplace safety and effective preventive measures.
- A realistic toxicological risk model has to take into consideration interindividual differences in bioactivation and detoxification as well as additive/subadditive effects of the various toxic components in cabin air.

Thank you for your attention