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Response letter to the Aerospace Medical Association (AMA)

Dear Editor,

Thank you for the opportunity to respond to the letter from the Aerospace Medical Association (AMA) and others. We will correct some inaccuracies in the AMA letter and clarify some of the critical remarks made about our paper in their letter.

In their first paragraph AMA state "…*given the controversial nature of the subject matter*,,,". We are uncertain where they place this controversy. The issue of the potential for harm, caused by the inhalation of pyrolysed aircraft engine oil, was first recognised as long ago as the mid1950s. [1] There is little debate about the fact that vapour-phase lubricants, such as tricresyl phosphate (TCP) added to gas turbine engine oils are toxic – this is clearly stated on the manufacturer's labels. There is incontrovertible, well documented, evidence that passenger and crew exposure to oils via the air conditioning system occurs. [2–4] It would

appear that the main reason for mentioning controversy is to disparage the paper, rather than focus of the facts of the case.

The AMA letter criticises the design and methodology of Study A. They state, incorrectly, that the response rate was only 14%. The WHO article said "*First, in a BAe 146 aircraft pilot health survey PhD research project (study A) (8), United Kingdom pilot unions were requested to supply a list of all known United Kingdom certified BAe 146/146 Avro RJ aircraft (BAe 146) pilots. In all, 274 BAe 146 pilots (14% of the known total; 7% women) responded...*". If the AMA authors had reviewed the original publication source (Michaelis PhD [5], which is freely accessible on line), they would have understood, that of the 2002 pilots ever licensed by the UK Civil Aviation Authority (CAA), to fly the BAe 146/Avro RJ, only 274 were contactable, as the CAA refused to supply the contact details of the 2002 pilots. Therefore, as only 274 were contactable it represents a 14% **access rate.** Of the 389 names Michaelis was able to access via the unions, she was unable to contact 115 of these as she either had no contact details (50) or could not contact them using the details supplied (65). Michaelis was therefore able to contact 274 of the 389 names supplied, which equates to a 70% **response rate**. The statement made by the AMA authors of an 86% non-response rate is simply wrong.

To be clear about the details on selection or interviewer bias, it is a pity that the AMA authors did, once again, not consult the source document- a peer reviewed PhD thesis, which was summarised in a further published paper in 2011. [6] We must emphasise that the size of papers submitted to WHO Panorama is strictly limited to 3500 words and 30 references. This is the normal situation with all peer-reviewed journals. Readers have to be prepared to refer to the source texts because the limited space precludes a re-statement of all the details. However, we would emphasise that the data for Study A has passed scrutiny twice - once for the PhD examination and once for the comprehensive review performed by Public Health Panorama. This study was the most detailed to date and was comprehensively described in the source document.

The AMA authors next turned their attention to Study B. The constituent studies were not selected for the reason stated by the AMA letter, namely *'because they were consistent with hyperventilation and hypoxia'*. What we actually said was that *"the incidents were selected*

*because they were **reported to be** consistent with acute hyperventilation and hypoxia* [7] *and extensive data being available"*. There was no need to elaborate any more, as these were a number of the incidents referenced by the author (Bagshaw) supporting the hyperventilation suggestion and indeed there was extensive data available. The data was collated clearly and extensively reported in Tables 1–3. This criticism of this extended data set is regrettable and should not have been downplayed based on the limited word count available.

The listed complaints were very clearly assigned to acute and chronic categories. By ignoring the acute effects, the AMA authors appear to be trying to negate that the reported findings have clear implications for flight safety. This is an important consideration and of relevance to all crew and passengers. In a case study of just 15 incidents, noting the acute on chronic picture, the acute and long-term medical findings and diagnoses in table 2, are very noteworthy. The findings were both qualitative and quantitative.

To suggest there is no aetiological implication for the symptoms is not supportable, as Table 1 clearly shows that in 93% of the incidents, the source of the fume events was coincidental with positive identification of oil or hydraulic fluids in 13 of the 15 incidents, with 1 further event listed as possibly related to oil leakage. The effects were consistent with the literature, regulatory hazard classifications and the various hazard databases. While this is the most extensive study to date, there have been many others which show similar acute and long-term effects in association with exposure to aircraft contaminated air environments. [8–10]

What the AMA letter does not acknowledge is that, as is clearly pointed out in our study, oil leakage into the cabin air environment is inevitable and has to occur with the use of pressurised air being used to both seal the engine oil bearing chamber and supply of breathing air, a system that was designed in the 1950s. There is now an extensive supportive literature on this subject. [4,11–15]

The references quoted in the AMA letter rely upon a number of industry supported studies that all suggest that any contaminants found are at too low a concentration to be of clinical significance or linked with adverse effects. This ignores the fact that occupational exposure limits are not available for many of the substances, do not apply to the travelling public, do not apply to complex pyrolysed mixtures with physiological adverse effects due to oxygen

deficiency at elevations above 5000 feet. [16,17] Even an AMA paper in 2002 stated that *"OSHA standards (and others throughout the world) are not applicable to aircraft* cabin air". [18] The authors dismiss most other published literature as not supportive of establishing a causal or associated relationship with an environment which guarantees low-level exposure in normal flight to synthetic engine oils. Finally in this regard, it is important to note that it is well recognised that some susceptible individuals will develop symptom/disease at environmental concentrations well below industry set standards.

The authors of the letter also choose to completely ignore the evidence that we put forward about the effects of low dose repeated exposure to OPs [19] and the increased sensitivity of nerve cells to toxic insult after continual low dose pre-exposure and the effect of mixtures of OPs. [20,21] The AMA authors appear to rely on acute high dose exposure levels and responses in individual patients, thus ignoring the pattern of effects across a number of individuals. Given our knowledge of exposure to of low dose OP mixtures, it is our opinion that the Bradford Hill criteria are adequately met - we should remind the authors of the AMA letter that Bradford Hill himself stated that not all the criteria had to be met to establish causation. Therefore, we can understand why the AMA authors, coming predominantly from an occupational health standpoint, do not look upon the Bradford Hill criteria from the same perspective as we do. That said, we emphasise that viewing the problem through the prism of toxicology and an analysis of patterns of symptoms between patients is the logical way forward.

It is noteworthy that in 2002, the US National Research Council reported that that Federal Aviation Administration (FAA) does not collect health-effects data, therefore creating extreme difficulty in identifying any causal relationship between cabin air quality and the health complaints reported by crew and passengers. [22] A year earlier the Swedish Statens Haverikommission (SHK) Board of Accident Investigation recommended that an international database be set up to collect factual data after suspected cabin air contamination. In 2016 the Spanish Civil Aviation Accidents and Incidents Investigation Commission (CIAIAC) recommended that the International Civil Aviation Organization (ICAO) monitors international actions to determine real impact on human health & take safety actions as necessary. While the aviation industry has to date failed to do this, it is perhaps clear why

such information is not wanted within a specific industry, such as aviation. Our paper clearly referenced 2 sources supporting the Bradford Hill causation process, not just the one by the main author cited by the AMA. The lack of a co-ordinated reporting system collating operational and medical data clearly hampers the elucidation of any causal connection. However as our study has shown, it is time this data was collected with a clearly recognized medical protocol and disease recognition

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