Cabin Air Quality

CLAUDE THIBEAULT, M.D.

Passenger Health Subcommittee, Air Transport Medicine Committee, Aerospace Medical Association

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Cabin Air Quality has generated considerable public and workers' concern and controversy in the last few years. To clarify the situation, AsMA requested the Passenger Health Subcommittee of the Air Transport Medicine Committee to review the situation and prepare a position statement. After identifying the various sources of confusion, we review the scientifically accepted facts in the different elements involved in Cabin Air Quality: pressurization, ventilation, contaminants, humidity and temperature. At the same time, we identify areas that need more research and make recommendations accordingly.

BACKGROUND

Cabin air quality has generated considerable concern and controversy in the last few years. Because this topic is quite technical in nature and contains many elements, it is sometimes difficult to understand and may easily create confusion. Further, the news media involvement and the adversarial status between employees and employers on the subject have added to that confusion.

To clarify the situation, AsMA requested that the Passenger Health Subcommittee of the Air Transport Medicine Committee review the situation and prepare a position statement. This review will identify the various sources of confusion and cover the different elements involved in cabin air quality, emphasizing the scientifically accepted facts and recommending areas where more research is needed.

SOURCES OF CONFUSION

Lack of Common Definition

Someone has already coined the term "sick airplane syndrome" and, like the term "sick building syndrome," it is not very helpful. Indeed, generic terms like "cabin air quality" and "sick airplane syndrome" are meaningless if not properly defined and based on objective data. This paper will attempt to clarify the different elements of cabin air quality and try to separate the myth from reality. This approach should help the practitioner confronted with a "cabin air quality" problem to concentrate on the real potential specific causes.

Equating Discomfort to Health Risk

Indeed discomfort does not automatically pose a future health risk as it is sometimes suggested. In fact, it is mechanically impossible to meet the subjective comfort level expected by cabin crew and passengers at all times based on the difference in activity alone. This does not mean that a situation creating discomfort does not deserve attention, but simply that it can be approached differently.

Comparing Aircraft to Office Buildings

Existing standards for office buildings do not automatically apply to airplanes. Further, comfort standards can be different from health standards at times. Fortunately, when the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) realized that their standards were used inappropriately, it quickly reacted by forming a new aviation subcommittee to support the development of an air quality standard specific to aircraft. AsMA applauds this decision and has already assigned a representative.

Trying to Find a Universal Cause

In some corners, environmental tobacco smoke (ETS) is blamed for everything. Yet, we find some of the same complaints in carriers who have totally smoke free flights. It is true that tobacco smoke is the single most important indoor air pollutant and **AsMA strongly supports the International Civil Aviation Organization (ICAO) resolution that all airline flights should be smoke free.** The so-called problem of cabin air quality is most likely multifactorial (hypoxia, decreased barometric pressure, crowding, inactivity, temperature control, jet lag, noise, three dimensional motion, fear, stress, individual health, alcohol consumption, etc.) and we need to look at all possible causes before discarding any.

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Address reprint requests to the Aerospace Medical Association, 320 S. Henry St., Alexandria, VA 22314-3579. Dr. Thibeault is the Senior Director, Occupational Health Services, Air Canada, Saint-Laurent, P.Q., Canada.

ELEMENTS OF CABIN AIR QUALITY

Are there one or more elements of cabin air quality that can explain symptoms presented by cabin crews and passengers? The situation is further complicated by the fact that most of the symptoms are nonspecific (headache, light headedness, fatigue, etc.).

Pressurization

Before aircraft cabins were pressurized, manufacturers reviewed the basic physiology and eventually accepted a cabin altitude limit of 8000 ft (2440 m) because it usually maintains oxygen saturation on the upper flat part of the oxygen dissociation curve for most people and is well tolerated by the average healthy individual. The fact is that *most, average,* and *healthy,* do not represent everybody and we should not be surprised that a few people run into difficulties with this relative hypoxia.

In fact, recent work by Cottrell (2), which shows that a sub-group of individuals desaturate significantly below 90%, also raises a question about the effects of this relative hypoxia.

The review of high altitude sickness in Scientific American Medicine (3), published in 1992, describes a subgroup of the population that will present symptoms at moderate altitudes of 5000–8000 ft (1525–2440 m) the exact copy of cabin altitudes.

The above evidence begs for more data on the subject and **AsMA recommends that researchers expand on the work of Cottrell to better qualify and quantify the contribution of relative hypoxia to passenger and crew health and comfort.**

Ventilation

Contrary to some popular belief, ventilation has very little to do with oxygen quantity. Humans at rest consume approximately 0.015 cfm (0.007 $L \cdot s^{-1}$) of oxygen (8) while being provided with over 4 cfm (1.9 $L \cdot s^{-1}$) in aircraft with a recirculation system. So there is more than enough oxygen for passengers and crew even at the lowest air flow selection. However, even if those aircraft that provide a low air flow selection can provide plenty of oxygen and control the contaminant level, passengers and cabin crew may sometimes require additional air flow to improve their comfort level. Low air flow selection may not directly cause the symptoms mentioned earlier but it may certainly exacerbate them. **Therefore, AsMA recommends that aircraft manufacturers and airline companies pay more attention to cabin crew and passenger comfort when preparing technical bulletins. This approach has been used with good success. The Association further recommends that the ventilation issue be reevaluated after completion of the work done by the new ASHRAE subcommittee.**

Contaminants

Chemical: The December 1989 U.S. Department of Transportation (DOT) Geomet study (5) and the June 1994 Airbus 320 report (Airbus Industries and Air Canada Engineers Report on A320. 1 July 1994; Ref. 949.2497/94.) showed that carbon monoxide (CO) and ozone (O_3) levels were well within accepted Federal Aviation Administration (FAA), Environmental Protection Agency (EPA) and American Conference of Governmental and Industrial Hygienists (ACGIH) standards. The March 1994 Consolidated Safety Services Inc. study (1) reported that carbon dioxide (CO_2) and volatile organic compounds more than met OSHA standards.

Partly because of the misuse of ASHRAE standards, carbon dioxide is very often targeted as one of the big problems. To date all studies on the subject, including the CSS study, reveal a range of CO_2 of 700 to 2300 ppm with an average of 1500 ppm. Since there is about 50,000 ppm of CO_2 in the human lungs and it takes at least 12,000 to 15,000 ppm in the inspired air to have any effect on the respiration rate, a level of 1500 ppm by itself, will **not cause any health effects (6). In any case, the carbon dioxide level will also be taken into consideration by the ASHRAE Aviation subcommittee and will further clarify the issue. Some elements of cabin air quality will also be measured by the on-going National Institute of Occupational Safety and Health (NIOSH) Working Women's Health Study.**

Biological: The in-flight symptoms that we are dealing with could not be easily explained by biological contaminants. Further, neither the CSS study (1) nor the DOT study (5) isolated any bacterial or fungal respiratory pathogens and the airborne microorganisms remained well below National Institute of Occupational Safety and Health (NIOSH) recommended levels.

In early 1996, Kenyon et al. (4) reported the results of their investigation of tuberculosis cases aboard a commercial aircraft. The factors involved in transmission were: 1) proximity, 2) level of contagiousness, and 3) duration of exposure. The ventilation system, even in the aircraft using recirculation, was not identified as a factor. Notwithstanding the above, **AsMA recommends that all aircraft with recirculated air systems be equipped with maximum efficiency High Efficiency Particulate Air (HEPA) type filters to remove any possibility of spreading biological contaminants.**

Humidity

Low relative humidity is a fact in commercial travel: 12 to 21% in the ATA study (1).

A 1992 Royal Air Force study (7) revealed that "Although low humidity caused mild symptoms such as nasal dryness, subjects' performance, mood and well-being were unaffected."

AsMA considers that the common recommendation of increased fluid intake during air travel is all that is needed to control the mild side effects of low humidity.

Temperature

The range of temperature encountered aboard a commercial airliner may, at most, create discomfort but coupled with low humidity, misuse of ventilation systems and relative hypoxia, it can certainly potentiate other problems. Since the temperature in the cabin can be easily controlled, the pilots should cooperate with the cabin attendants to maximize the comfort level in the cabin. Realizing that this is easier said than done, **AsMA strongly recommends that all responsible authorities**

(regulatory, airline, and professional associations) prepare training to foster understanding and cooperation between the flight crew and the cabin crew. AsMA further recommends that flight surgeons get actively involved in teaching flight and cabin crew the different aspects of short, medium, and long distance flying.

Finally, since a good part of this problem has been caused by mistrust, **AsMA recommends that all stakeholders (regulatory, airline, and professional associations) work together on the issue of cabin air quality because no amount of technical data alone will solve the problem.**

RECOMMENDATIONS

1. AsMA strongly supports the International Civil Aviation Organization (ICAO) recommendations that all airline flights should be smoke free.
2. AsMA recommends that researchers expand on the work of Cottrell to better qualify and quantify the contribution of relative hypoxia to passenger and crew health and comfort.
3. AsMA recommends that aircraft manufacturers and airline companies pay more attention to cabin crew and passenger comfort when preparing technical bulletins.
4. AsMA continues to support the new aviation subcommittee of ASHRAE and also the on-going Women's Health Study of NIOSH.
5. AsMA recommends that all aircraft with recirculated air systems be equipped with maximum efficiency High Efficiency Particulate Air (HEPA) type filters to remove any possibility of spreading biological contaminants.
6. AsMA considers that the common recommendation of increased fluid intake during air travel is all that is needed to control the mild side effects of low humidity.
7. AsMA strongly recommends that all responsible authorities (regulatory, airline, and professional associations) prepare training to foster understanding and cooperation between the flight crew and the cabin crew. AsMA further recommends that flight surgeons get actively involved in teaching flight and cabin crew the different aspects of short, medium, and long distance flying.
8. AsMA recommends that all stakeholders (regulatory, airline, and professional associations) work together on the issue of cabin air quality because no amount of technical data alone will solve the problem.

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