Commentary: Cancer in the air

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Commercial air transport is a rapidly growing business and the work of aircrews entails occupational exposure to cosmic radiation mostly in the range of 2–4 mSv/year. In 1991, the International Commission on Radiological Protection recommended an occupational exposure limit of 20 mSv/year. The actual exposure level of aircrews is thus normally well below the recommended limit. This limit is based, however, on disease occurrence in populations exposed to other types of ionizing radiation, e.g. following the Hiroshima and Nagasaki bombing. A detailed monitoring of the long-term health consequences of aircrew work is therefore well justified. The study by Haldorsen et al. reported in this issue of the International Journal of Epidemiology forms part of the monitoring activity.

Epidemiological studies of mortality and cancer incidence in aircrews have recently been reviewed. The studies fall into three categories. Firstly, proportional mortality, PMR, studies of military and commercial aircrews. Aircrew work requires health certification, and the group is subject to a strong healthy worker selection. The PMR studies may therefore be used only as a crude method of hypothesis generation. Secondly, cohort studies have been conducted of military pilots. Military pilots are, however, unlikely on average to receive the same cosmic radiation dose as commercial aircrews as they do not fly long hours in high altitudes. Thirdly, cohort studies have been conducted of commercial pilots and cabin attendants. These studies are clearly the most informative concerning long-term health effects of exposure to cosmic radiation. When it comes to assessment of the potential cancer risk, it is furthermore advantageous when these cohorts are followed for cancer incidence, as this implies more cases and more accurate diagnosis than the follow-up for cancer mortality.

At present, five cohort studies of cancer incidence in commercial air pilots have been published, two from Canada, one from Denmark, one from Iceland, and one from Norway. Two cohort studies of cabin attendants have been published from Finland and from Iceland. Data from one small cohort of retired cabin attendants from the US have been reported in letters and in a review. Selected results from a small Danish cohort of cabin attendants have been published in a letter. Haldorsen et al. in this issue of the journal report on a cohort study of Norwegian cabin attendants. Unfortunately,
observed and expected numbers of incident cancer cases have not been thoroughly reported for all cancer sites from these cohorts. Nevertheless, interesting observations emerge from the available data set. The results reported in the following come from aggregating numbers across studies reporting both the observed and expected numbers for given cancer sites (Tables 1–3).

Commercial pilots in Canada,5 Denmark, Iceland, and Norway had an overall cancer incidence close to that of men in general (obs. 517, exp. 541, standardized incidence ratio [SIR] = 0.95) (Table 1). The main reason for this average cancer risk in these initially very healthy men is an excess risk of malignant melanoma found in all cohorts (obs. 52, exp. 25.39, SIR = 2.0) and an excess risk of non-melanoma skin cancer in all three cohorts for whom this cancer site has been reported4,6,8 (obs. 93, exp. 45.65, SIR = 2.0). Both Canadian studies reported a deficit lung cancer risk and an excess prostate cancer risk not found in the Nordic cohorts. Leukaemia data were reported from one Canadian5 and the Nordic cohorts giving in total 19 observed versus 14.35 expected cases (SIR = 1.3). Data for acute myeloid...
leukaemia were reported from one Canadian cohort,5 Denmark and Iceland. Together 11 cases were observed versus 2.93 expected cases (SIR = 3.8, 95% CI: 1.9–6.7). One case was observed in the other Canadian cohort, and no case in the Norwegian cohort where the expected numbers were not reported.

Female cabin attendants in Finland, Norway, and in the small US cohort had a slightly increased overall cancer incidence compared with women in general (obs. 243, exp. 209.43, SIR = 1.2) (Table 2). As for pilots, a consistent excess risk of malignant melanoma was observed (obs. 31, exp. 15.54, SIR = 2.0). Breast cancer was in excess in Finland, Denmark, Iceland and in the small US cohort, but not in Norway. Together 105 breast cancer cases were observed versus 74.76 expected (SIR = 1.4).

Cancer incidence data for male cabin attendants have been thoroughly reported only for the Norwegian cohort (Table 3). In contrast to the two other aircrew groups, male cabin attendants had a clear excess cancer risk compared with the male national populations (obs. 56, exp. 32.75, SIR = 1.7). The Norwegian cabin attendants had an excess risk of the alcohol-related upper respiratory and gastric tract cancers and of liver cancer; together 11 observed cases versus 1.7 expected cases (SIR = 6.5). An excess risk of malignant melanoma was shared with the other aircrew groups. The Norwegian data on non-melanoma skin cancer do not include basal cell carcinoma, but the male cabin attendants had a marked excess risk of the other non-melanoma skin cancers (obs. 9, exp. 0.9, SIR = 9.9). The subtype of non-melanoma skin cancer was not reported in the Norwegian study. It is noteworthy that two cases of Kapo’si’s sarcoma were observed in the small cohort of 187 Finnish male cabin attendants.9

In total, six leukaemia cases were observed among the female and male cabin attendants versus 4.8 expected (SIR = 1.3). One case was specified to be acute myeloid leukaemia.

The monitoring of cancer incidence in commercial aircrews has so far indicated three important observations. Firstly, the excess risk of acute myeloid leukaemia in pilots. It is intriguing that a study of karyotypes in seven aircrew treated for myelodysplasia or acute myeloid leukaemia found deletion or loss of chromosome 7 in four. Similar chromosomal changes have been found in radiotherapy-induced but not in unselected cases. This observation suggests a common aetiology between the aircrew and radiotherapy-induced cases.14 Further data are clearly warranted.

Secondly, the breast cancer data are puzzling, as breast cancer is numerically by far the most important cancer in women. Overall, the data together show an SIR of 1.4. Unfortunately, it will be difficult epidemiologically to disentangle possible exposures behind this moderately elevated risk. The Finnish9 and Icelandic10 studies argued well for not attributing the excess risk to reproductive factors alone. Radiation exposure therefore remains a potential explanation, together with a possible influence from diet and alcohol, disrupted sleep-waking cycles,15 and exposure to organochlorine pesticides sprayed in cabins.12 Data on breast cancer incidence is clearly needed from other cohorts of female cabin attendants.

Thirdly, the consistent excess risk of skin cancers in aircrews has, in the literature, unambiguously been attributed to medical surveillance and/or recreational sun exposure. The high risk of non-melanoma, non-basal cell skin cancer in Norwegian male cabin attendants, and the observation of two cases of Kapo’si’s sarcoma in the small Finnish cohort indicate, however, a need for subtyping of the observed cases.

Further data to elucidate these observations will become available as two European studies are now being carried out.16 One study includes pilots and cabin attendants from ten countries with mortality as the end point, and the other includes pilots and cabin attendants from the Nordic countries with cancer incidence as the end point.

References