

CASE REPORT

Firefighting and melanoma, epidemiological and toxicological associations: a case report

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Summary The International Agency for Research on Cancer (IARC) classifies firefighting as possibly carcinogenic to humans, and polychlorinated biphenyls (PCBs) as carcinogens with sufficient evidence for development of melanoma in humans. We present a case report of a firefighter with melanoma and history of 33 years of occupational exposure. Based on the available epidemiological and toxicological evidence of association between being a firefighter and developing melanoma, melanoma was recognized by the Norwegian Labour and Welfare Service as an occupational disease in our patient. In 2017, melanoma was acknowledged as an occupational disease in only 8 out of 28 surveyed European countries. Melanoma should be considered as a possible occupational disease among firefighters with a history of relevant exposure. Further recognition of the occupational exposures leading to increased risk of melanoma is still needed for preventive purposes.

Key words Occupational health; cancer; melanoma; firefighter; PCB; epidemiology; toxicology.

Background

The International Agency for Research on Cancer (IARC) has classified working as a firefighter as *possibly carcinogenic to humans* (Group 2B) (1). Incidence of melanoma, a potentially lethal malignancy, has shown a 4-fold increase in Scandinavia with a trend of increasing male to female relative incidence (2).

This case report is a firefighter with 33 years of work exposure, diagnosed with melanoma of unknown primary site (MUP), which is more common among men than women and accounts for about 3% of melanoma cases. We explore the epidemiological and toxicological basis for an association between working as a firefighter and melanoma.

Case report

A 71-year-old non-smoking man, with fair skin, without previous medical history except for a single event of atrial fibrillation in 2000 and no history of cutaneous or other malignancies in his family, was diagnosed with melanoma in 2010 (age 61) based on histological findings from a swollen cervical lymph node, and a left lung metastasis. Both tumours were surgically removed, but

the primary tumour was not detected. Thus, the patient had MUP grade IV according to the American Joint Committee on Cancers grading system.

He later underwent surgical excision of the left parotid gland, followed by adjuvant radiotherapy, lung metastasis was removed by laparoscopy, and cerebral metastases with gamma knife followed by irradiation. He subsequently developed epileptic seizures, and currently receives palliative immunotherapy.

The firefighter worked as an active smoke diver from 1973 to 2006 (33 years), in addition to having operational responsibility for the departments' fire training. Documenting occupational exposure in retrospect is complicated, due to heterogeneity of fires and since no specific measurements of occupational exposure have been done, as they were not mandated by law at that time. He worked in an urban region with a high level of industrial activity, being involved in extinguishing numerous fires in houses, industrial buildings, waste disposal facilities, vehicles, boats, grass and heather and forest fires. Use of safety equipment was sparse during the first decades and some industrial fires from these decades were of special concern. He did not get burns resulting in scarification during his active duty. He rarely consumed alcohol. He reported frequent physical activity

Key learning points

What is already known about this subject:

- Firefighting is possibly carcinogenic to humans.
- Polychlorinated biphenyls (PCBs) are carcinogens with sufficient evidence for development of melanoma in humans.
- In 2017, melanoma was acknowledged as an occupational disease in 8 out of 28 surveyed European countries.

What this case report adds:

- A clinical assessment based on consistent epidemiological evidence of increased incidence of melanoma among firefighters and toxicological evidence of an association between PCB exposure among firefighters and melanoma risk.
- On this basis, melanoma was recognized by the Norwegian Labour and Welfare Service as an occupational disease in this patient.

What impact this may have on practice, policy or procedure:

- Recognition of melanoma as an occupational disease across Europe should be considered among firefighters with an extensive exposure for the purposes of primary, secondary and tertiary prevention.
- Quantitative exposure assessment methods for potential skin exposure to carcinogens should be developed and improved.

(in and outdoors), was never actively sunbathing and had no other exposure to UV-radiation in his leisure time.

We have concluded that he had a history of extensive exposure with regard to duration of employment, number of fires and diversity of exposure sources. This would not be the case if the patient had worked for a shorter duration or in a more rural area, with fewer fires in relation to industrial activities and in buildings as well as waste fires.

Discussion

In 2010, IARC reviewed the literature on cancer in firefighters (1). This monograph summarizes six cohort studies of varying size ($n = 2000\text{--}5000$). Four studies reporting standardized incidence ratio (SIR) of melanoma showed a moderately increased SIR ranging from 1.1 to 1.8 (1). The IARC monograph also reports a registry-based case-control study using the California Cancer Registry (OR for melanoma 1.5 95% CI: 1.33–1.70 ($n = 323$)) (1).

We extended our epidemiological basis by searching for Scandinavian studies as well as meta-analyses. In a cohort of 1080 Stockholm-based firefighters, Kullberg *et al.* found a reduced incidence of melanoma based on three observations (SIR 0.30; 95% CI: 0.06–0.88) (3). However, Pukkala *et al.* reported, in a 45 years historical prospective study of 16 422 firefighters from the Nordic Occupational Cancer study (NOCCA), an increased relative risk of melanoma (SIR 1.25; 95% CI: 1.03–1.51) (4). Furthermore, the latest Swedish follow-up of this study (8136 firefighters) showed a similar trend (SIR 1.22; 95% CI: 0.95–1.54) (5). A recent meta-analysis on incidence of cancer among firefighters reported an

association between firefighting and melanoma (SIR 1.21; 95% CI: 1.02–1.45) (6). Taken together, there is consistent epidemiological evidence of a moderately increased relative risk of melanoma among firefighters.

Sunlight, artificial UV rays and polychlorinated biphenyls (PCBs) are considered as carcinogenic agents with sufficient evidence in humans for melanoma according to IARC's list of classification by cancer sites. For melanoma, IARC classified PCBs as carcinogens with sufficient evidence in humans in 2016 (7), and it was later confirmed as an occupational carcinogen in workers exposed during manufacture of PCB capacitors; manufacture and repair of transformers; waste incineration, firefighting and recycling (8). Nevertheless, an association between PCB exposure and melanoma has been debated (9). Firefighters wear protective clothing, which provide protection against UV-radiation, thermal and chemical skin injuries. On the other hand, protective clothing may result in occlusion and trapping of toxic chemicals from smoke. Risk assessment for melanoma among firefighters should focus on their exposure to toxic gases and smoke; a heterogeneous mixture of gases and particles with varying chemical composition of carcinogens (polycyclic aromatic hydrocarbons, PCBs, benzene, etc.), and should also clarify the role of skin occlusion and interaction with other well known risk factors such as UV-light exposure.

Use of PCBs in building materials (paint, adhesives and sealing) was quite extensive in the 50s, 60s and 70s. Despite the ban on PCBs, the chemical is still present in building structures from this period, and smoke from fires in these buildings will possibly contain PCBs today. Furthermore, Scandinavian studies show that PCBs occur in smoke from waste fire, and PCBs have even been shown to be formed *de novo* during combustion of materials not containing PCBs in the first place (10–12). A study

of firefighters in Siberia indicates that firefighters are exposed to PCBs. Blood samples were drawn from active ($n = 13$) and retired firefighters ($n = 17$) and a control group ($n = 10$). PCB levels were higher among firefighters and decreased with time since retirement (13). PCBs are persistent organic pollutants with a quite wide application and will be ubiquitous in the environment. However, PCB levels in the blood of average people are declining and are often no longer detectable among the youth (14). Thus, detecting PCBs in the blood of exposed workers may be of relevance when considering risk of occupational melanoma.

Since this clinical evaluation was undertaken 13 years after the patient stopped working, unfortunately no blood samples, or other bio samples were available to evaluate individual PCB levels. However, we concluded that he had likely been exposed to PCBs, especially while extinguishing waste-, house- and industrial fires.

Melanoma has for the first time been recognized as an occupational disease among firefighters by the Norwegian Labour and Welfare Service based on the toxicological and epidemiological evidence presented here, which supports an association between extensive exposure during firefighting and melanoma (criteria for acceptance of occupational diseases in Norway is available in [supplementary material](#)). Furthermore, the lack of any personal or familiar history of cutaneous malignancy, previous sunburn incidents and a non-sun seeking behaviour support that occupational exposure may have contributed significantly to the individual risk of melanoma. The patient received economic compensation in relation to his acknowledged occupational disease.

As of 2017, melanoma was acknowledged as an occupational disease in only eight out of 28 surveyed European countries (15). Recognizing melanoma as an occupational disease for the purposes of primary, secondary and tertiary prevention is still an unmet need.

Competing interests

None declared.

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