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Acute Leukaemia in Workers Exposed to Electromagnetic Fields

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Results from a French case-control study of acute leukaemia and occupational exposure for the risk associated with exposure to electromagnetic fields (EMF) are reported. There were 185 cases and 513 controls. A significantly increased risk of acute leukaemia was observed for exposure to EMF other than that from arc welding (odds ratio = 4.04, 95% CI 1.26–12.88) which persisted after adjustment for possible confounding exposures. This study supports the hypothesis that workers exposed to some EMF have an increased risk of leukaemia.
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INTRODUCTION

SEVERAL REPORTS have suggested an association between job exposure to electromagnetic fields (EMF) and leukaemia [1, 2], especially acute myeloid leukaemia (AML). Nevertheless, most previous studies have been based on mortality or cancer registry data and only considered the job title of the most recent occupation. Three case-control studies [3–5] have used information other than census data and, except for one [5], it was not possible to control for a confounding exposure. We report results about EMF from a case control study in two French hospitals from 1984 to 1988. We examined the relation between occupational exposure and acute leukaemia.

SUBJECTS AND METHODS

The study involved 185 cases over 30-years-old, resident in France, with a first diagnosis of acute leukaemia, and 513 hospital controls matched for sex, age (within 5 years), ethnic group and usual residence. Physicians trained in industrial health administered a standardised interview to cases and controls. The questionnaire was designed to obtain information on: demography, medical history including any radiotherapy or chemotherapy, drug use, a complete description of occupational history and some assessment of environmental exposure. The occupational history was assessed in detail by a separate questionnaire for each job and included, apart from the job title and the branch of activity, recall of chemical and physical exposures including solvents, fumes, pesticides, ionising radiations and EMF, each linked with an estimation of exposure frequency and of the wearing of protection equipment. Then, after blinding of the case-control status, the job exposures over the occupational history (24 items) were reassessed by an industrial hygienist in a similar way to that used when building a job-exposure matrix [6]. When possible the hygienist coded the exposure into low (less than 5% of working time), medium (from 5 to 50%) and high (more than 50%). Only the exposures assessed by the industrial hygienist were analysed. A standard case-control analysis was used [7] and since some exposures might be correlated, adjusted odds ratios (OR) with the Mantel–Haenszel method were also calculated. Finally, to take into account simultaneously all risk factors, a logistic regression was done.

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RESULTS

No association was found between acute leukaemia and electric-arc welding (OR = 1.28, 95% CI 0.56–2.93), but a significantly increased risk of acute leukaemia was observed for other EMF exposures (7 cases vs. 5 controls; OR = 4.04, 1.26–12.88). When only medium and high exposures to EMF were considered, the risk of acute leukaemia was elevated but no longer statistically significant due to the small number of cases and controls in this category (3 cases and 3 controls; OR = 2.8, 0.6–14.1). All 7 cases (6 were men) had AML. Exposed occupations were engineers (3 cases, 2 controls) or technician (1 control) involved in electrical engineering or electronics, furnace workers (2 cases, 1 control), work near an electrolytic bath (1 case), jewellery polisher (1 control) and an X-ray technician (1 case).

In our study we also found two other exposures significantly linked with acute leukaemia: high and medium exposure to benzene (OR = 2.77, 1.34–5.70) and high and medium exposure to weed-killers (OR = 3.17, 1.08–9.34). On the contrary, there was no significant increase of risk associated with professional exposure to X-rays: OR = 1.39 (0.12–15.4). To take into account possible confounding, ORs adjusted for other EMF for exposures to benzene or weed-killers were calculated. The adjusted OR for benzene decreased but remained significant: OR_{MH} 3.63, (1.04–10.87, $P = 0.035$), and similarly the adjusted OR_{MH} for weed-killers was 3.59 (1.12–11.50, $P = 0.018$). In a logistic regression analysing simultaneously these three exposures and taking into account the matching variables and a history of radiotherapy or chemotherapy, the OR for other EMF exposures was still significant: OR = 3.2 (1.2–5.3, $P = 0.02$).

The attributable risk for EMF exposures (apart from arc welding) was in the range of 2% to 3% depending on whether one considers adjusted or non-adjusted ORs.

DISCUSSION

This study, in contrast to most of the previous studies, was designed to assess lifetime work exposure and to control for other types of work exposure with a complete work history questionnaire. Nevertheless, a questionnaire only provides a surrogate measure of exposure with possible misclassifications. It is difficult to assess exposure to EMF accurately [8]. We did not take into account domestic or environmental exposure to EMF. For industrial exposure, the industrial hygienist relied on a detailed job description which decreases the probability of misclassification, but not on direct dosimetry. However, the use of blind coding of each individual work history avoided any bias due to preferential classification of cases as having been exposed to EMF.

With the range of occupations exposed to EMF that we found in our study, the frequency and characteristics of the EMF exposure will undoubtedly vary considerably, and in such a retrospective study it is not possible to differentiate between electric and magnetic fields. It is worth noting nevertheless that in the occupations listed, a magnetic field was most likely present because of the flowing of an electric current. As previously reported [9] arc welders do not have an increased risk of acute leukaemia, which is puzzling in view of their known exposure to some EMF. Job titles of the cases (metal workers or electronic engineers) are consistent with other studies [2]. A further validation of the study is provided by the finding of the well-known association with benzene. Finally, as reported in previous studies except two [1, 5], the excess was confined to AML.

Our study supports the hypothesis that workers exposed to some EMF have an increased risk of leukaemia. The estimated attributable risk of 2% to 3% is notable but this value should be treated prudently since it is based on a small number of exposed patients.

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