

DOES ELECTRICITY¹ CAUSE CANCER?

**Advice by the CEO of the Australian Radiation Protection and Nuclear Safety Agency –
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1. Introduction

The Advisory Group on Non-Ionising Radiation (AGNIR) to the UK National Radiological Protection Board has published a report on power frequency electromagnetic fields and the risk of cancer (1).

Prior to the publication of this report, there was substantial media interest in Australia as to what had been suggested (misleadingly) to be its conclusions: that there was a link between high voltage power lines and cancer, especially childhood leukaemia. I undertook to provide early advice on the report as soon as it was released.

2. What Does the AGNIR Report Actually Say?

The report reviews scientific research published since an earlier review by AGNIR of this topic in 1992-1994. It contains detailed reviews of:

- sources and measurements of electromagnetic fields
- biological studies on cells relevant to cancer induction
- animal and volunteer studies relevant to cancer induction
- epidemiological studies on domestic exposure to electromagnetic fields; and
- occupational exposures.

The overall main conclusion of the report deserves to be quoted in full:

“Laboratory experiments have provided no good evidence that extremely low frequency electromagnetic fields are capable of producing cancer, nor do human epidemiological studies suggest that they cause cancer in general. There is, however, some epidemiological evidence that prolonged exposure to higher levels of power frequency magnetic fields is associated with a small risk of leukaemia in children. In practice, such levels of exposure are seldom encountered by the general public in the UK. In the absence of clear evidence of a carcinogenic effect in adults, or of a plausible explanation from experiments on animals or isolated cells, the epidemiological evidence is currently not strong enough to justify a firm conclusion that such fields cause leukaemia in children. Unless, however, further research indicates that the finding

¹ ‘Electricity’ in this context means the varying electric and magnetic fields arising from the supply and use of electric power in homes and workplaces. The frequency of the fields is 50/60 Hz and they are called ELF (Extremely Low Frequency) EM (Electromagnetic) fields.

is due to chance or some currently unrecognised artefact, the possibility remains that intense and prolonged exposure to magnetic fields can increase the risk of leukaemia in children.”

The elements that make up this complex conclusion are worth drawing out:

- laboratory experiments have provided no good evidence that ELF EM fields are capable of producing cancer;
- human epidemiological studies do not suggest that such fields cause cancer in general;
- there is, however, some epidemiological evidence that prolonged exposure to higher levels of ELF magnetic fields is associated with a small risk of leukaemia in children;
- the evidence is not strong enough to justify a firm conclusion that such fields cause leukaemia in children;
- but that possibility remains.

Importantly, the report indicates that, in adults who are occupationally exposed, a causal relationship between EM field exposure and tumour incidence at any site is not established.

The Advisory Group notes that considerable advances have been made in methods for assessing exposure to electromagnetic fields, both in the case of experimental studies and in epidemiological investigations. It notes that this has provided a substantially improved basis for many of the epidemiological studies reviewed by the Group.

With respect to studies at the cellular level, the report states that there is no clear evidence that such exposure, at levels that are likely to be encountered, can affect biological processes. There is no convincing evidence that exposure to these fields is directly genotoxic or can bring about the transformation of cells in culture and thus the fields are unlikely to initiate carcinogenesis. Many of the effects reported occurred with exposure to fields at high levels that are unlikely to be sustained in a residential situation.

Turning to animal and volunteer studies, the report concludes again that there is no convincing evidence from its review of a large number of animal studies to support the hypothesis that exposure to ELF EM fields increases the risk of cancer. Volunteer studies have focused on impacts on the hormone melatonin and its role as a possible natural tumour suppressor and on any possible inhibitory effect of power frequency magnetic field exposure on those aspects of immune system function relevant to tumour suppression.

The report then turns to evaluation of epidemiological studies² of residential exposure to ELF magnetic fields. The suggestion that there may be a link between exposure to such magnetic field and childhood cancer has been made for over 20 years and the subject has been extensively studied. The most recent evidence on which the AGNIR relies to a substantial extent for its conclusions is a pooled analysis of nine studies in a number of countries (2). Taken together, they suggest that prolonged exposure above 0.4 microtesla³ is associated with a doubling of the risk

² Epidemiology is the study of the possible causes of disease through the comparison of selected population groups.

³ A microtesla is a unit of measurement of magnetic field. By comparison, the earth's (static) magnetic field has a strength of around 50 microtesla.

of leukemia in children under 15 years of age.

The nine studies that were pooled included 3247 children with leukaemia and 10,400 control children. The positive result of a relative risk of two, with a confidence interval from 1.27 to 3.13, occurred in the group with exposure level above 0.4 microtesla. This group included just 44 children with leukaemia and 62 controls. The study adjusted for a number of potential confounding variables: socio-economic class, urbanization, type of dwelling, mobility, and level of traffic exhaust. These adjustments did not appreciably change the results.

It is illustrative of the complexity of the field to note that the single largest study included in the pooled analysis was the UK Childhood Cancer Study – at the time of its publication it was stated that it found no link between overhead power cables and childhood cancer.

The AGNIR report points out the limitations of the pooled analysis that make the evidence not conclusive. In the majority of the projects grouped together in the analysis, direct measurements were made of the magnetic field exposures but there is some doubt about whether the control groups in these studies were representative of children from low socio-economic backgrounds. A number of projects were carried out in the Nordic countries using population registers that avoided this issue of representativeness, but in these cases the fields were estimated, rather than measured.

3. What Do Other Authorities Say?

In May 1999, the Director of the US *National Institute of Environmental Health Sciences* (NIEHS) brought forward a report on “Health Effects from Exposure to Power-line Frequency Electric and Magnetic Fields” (3). The preparation of this report had been required by an Act passed by the US Congress in 1992 and it drew upon a research and evaluation program (EMFRAPID) conducted by NIEHS with the support of other US agencies.

A conclusion of the NIEHS report was:

“that ELF-EMF exposure cannot be recognised at this time as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In my opinion, the conclusion of this report is insufficient to warrant aggressive regulatory concerns. However, because everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted, such as a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposure.”

As did AGNIR, the NIEHS reached this conclusion on the basis of epidemiological studies:

“While the support from individual studies is weak, the epidemiological studies demonstrate, for some methods of measuring exposure, a fairly consistent pattern of a small, increased risk with increasing exposure that is somewhat weaker for chronic lymphocytic leukemia than for childhood leukemia”.

“mechanistic studies and the animal toxicology literature, failed to demonstrate any consistent pattern across studies although sporadic findings of biological effects have been recorded. No indication of increased leukemias in experimental animals has been observed.”

During the work of the NIEHS on the EMFRAPID program there was a working group formed to evaluate the evidence in relation to the carcinogenic effect of EMF fields using the criteria laid down by the International Agency for Research on Cancer (IARC). The majority of the working group concluded that ELF-EMF would be classified as “a possible human carcinogen”.

In 2000, the *Health Council of the Netherlands* issued a report prepared by a committee of the council on the issue (4). The committee also reported that:

“some epidemiological data points to a reasonably consistent association, that is, a statistically significant relation, between residence in the vicinity of power lines and an, otherwise slight, increase in the incidence of childhood leukaemia.”

The committee took the view that, in the light of the weakness of the association and the lack of evidence from experimental research, it has not been demonstrated that exposure to ELF EM fields at permitted levels “induces any kind of disease or abnormality”.

4. Relevant Circumstances in Australia

The evidence principally relied upon in the AGNIR report comes from advanced countries – Canada, Denmark, Finland, Germany, New Zealand, Norway, Sweden, USA and the UK. There is no reason to expect that Australian exposures to ELF EM fields will be significantly greater than exposures in those countries.

There have not been any large-scale epidemiological studies carried out in Australia on any link between ELF EM fields and cancer. As a consequence, there have been few systematic and recent studies of magnetic field exposures in Australian homes.

There are no Australian exposure standards applying to the general public or workers. The National Health and Medical Research Council published ‘*Interim guidelines on limits of exposure to 50/60Hz electric and magnetic fields*’ in 1989. These interim guidelines were those proposed under the auspices of the body that has now become the International Commission on Non Ionizing Radiation Protection (ICNIRP). The exposure levels permitted by these guidelines were set on the basis of preventing harmful levels of induced current in the tissues of the central nervous system. The magnetic field exposure at 50 Hz permitted by these guidelines on this basis is 100 microtesla.

5. Position of the CEO of ARPANSA

It is first worth noting what AGNIR, NIEHS and the Health Council of the Netherlands say in common – that there is no evidence, either laboratory or epidemiological, that fields generally cause cancer. That is it does not appear that ELF magnetic fields are a broad carcinogen.

There is, however, epidemiological evidence that there may be a link between ELF magnetic fields and childhood leukaemia. The evidence is that if this effect is real, it occurs at relatively high long-term residential exposure levels. It appears to involve a doubling of the risk at these higher exposure levels, noting that childhood leukaemia is, fortunately, a fairly rare disease.

There can always be discussion about the interpretation of epidemiological studies of weak

effects. There are nearly always confounding factors – that is other factors which affect the incidence of the disease under study and are also correlated with the exposure under study- and these may be difficult to allow for properly in the analysis of the data. Studies of EM fields are also bedevilled by the difficulty of actually measuring exposures over a long period of time in domestic circumstances.

Nonetheless, as both the AGNIR report and the NIEHS report state, the epidemiological studies stand and have not been shown to be invalid or an alternative explanation established.

In thinking about how to deal with this issue, it is important to emphasise that, if the effect is real, it does seem only to occur at average levels of exposure at the high end of what is normally encountered on average in a residence. The level of 0.4 microtesla and above that provides a positive association in the pooled analysis applied to no more than 0.8% of the total population sampled in these studies. There is no reason to believe that Australia would have a vastly different proportion of people in this higher residential exposure range. There are some 175 cases of leukaemia diagnosed in Australia each year in children under 15. If no more than 1% of children are exposed above 0.4 microtesla and the risk factor were doubled for these children, this would result in 2 cases in Australia each year.

It is also important not to fixate on the location of external power lines, including high voltage transmission lines, as the prime cause of exposure. Exposure to ELF magnetic fields can arise from ground currents, internal household wiring and the use of electrical appliances as much as from exposure to the external power lines.

In my view, while noting all the qualifications on the AGNIR and NIEHS findings, it does behove public health authorities to consider what action should be taken now, in case the link with childhood leukaemia is real. In the final section of this report I have set out some actions that I believe should be considered and undertaken in this context. The actions that I have proposed are of an informative and precautionary nature. The weakness of the scientific evidence and the size of effect that is pointed to by the epidemiological studies do not in any way warrant a complete overturning of our approach to the use of electricity in industrialised countries. Furthermore, in terms of regulation, we have no certain basis on which to change our regulatory approach, because we do not know the mechanism that may be at work.

6. What Should Happen in Australia

It is important that the public are informed of the findings in a factual and direct way that enables people to make their own decisions about whether they need to limit exposures and how they might go about that should it be their wish. ARPANSA will prepare a new fact sheet as a matter of urgency in consultation with the Radiation Health Committee⁴ and make it widely available through the Internet and through other outlets. Additional support for widespread distribution of this fact sheet could be sought from the electricity supply industry.

People will seek information about their personal exposures and that of their children. I believe that, as a matter of some urgency, a protocol should be drawn up to ensure that such measurements are done on a reliable and consistent basis, employing a methodology suitable for

⁴ The Radiation Health Committee is established by the ARPANS Act 1998 and includes State/Territory regulators of radiation and independent members.

household measurement at modest cost. I propose that ARPANSA lead this work in consultation with other relevant bodies. The protocol should address what sensible advice can be given to people in residences with higher levels of fields present.

As noted above, there is a range of reasons why exposures may be at a certain level in a household or residential situation. The UK authorities have described the relatively small number of people likely to be exposed above 0.4 microtesla and such information that we have indicates that that would be similar around Australia. There may be value in a wider survey of exposures in Australian homes, using the techniques that would allow clear measurement of the average exposure levels. A significant survey would be expensive and preliminary estimates are that it could be in the order of \$500,000. Whether this is of value to recommend to the Government is a matter I intend to put to the Radiation Health Committee in the first instance for a report to the Radiation Health and Safety Advisory Council⁵.

I would not see any value in an Australian epidemiological study as it is unlikely that there would be sufficient numbers to add to the current results. Researchers who formulate hypothesis-driven proposals to examine biological effects or to undertake animal experiments should be considered under the usual NHMRC and other funding arrangements.

As noted above, there is no formal exposure standard and the current health guidelines for exposure to ELF fields were released in 1989. At the relevant frequencies, the permitted exposure levels are the same as current ICNIRP guidelines, though the rationale for the exposure levels is dated. I will ask the RHC to place review of the interim guidelines and the need for an exposure standard on its agenda for early action. The issue of how such a standard might deal with precautionary approaches to limiting exposures of children clearly will be important.

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CEO of ARPANSA
15 March 2001

References

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- (3) Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields. A report prepared in response to the 1992 Energy Policy Act. NIH Publication No. 99-4493 (1999).
- (4) Health Council of the Netherlands : ELF Electromagnetic Fields Committee. Exposure to electromagnetic fields (0 Hz – 10 MHz). Publication No. 2000/06E. (2000).

⁵ The Radiation Health and Safety Advisory Council is established by the ARPANS Act 1998. It has a high level advisory role in issues of radiation protection and nuclear safety.