



Protecting, maintaining and improving the health of all Minnesotans

October 18, 2000

Frank Tiffany
Mayor of Sunfish Lake
369 Salem Church Road
Sunfish Lake, Minnesota 55118

Dear Mr. Tiffany:

Thank you for your concern regarding the potential health risks from exposures to electric and magnetic fields (EMF).

In January 2000 the Minnesota Department of Health (MDH) completed an assessment of EMF health effects research (attached). The MDH conducted this assessment because of public concerns regarding the potential for EMF to cause cancer and other adverse health effects. This assessment included a review of the peer-reviewed literature and the conclusions of scientific committees convened by federal agencies and the US Congress.

The MDH provided this assessment to an interagency EMF workgroup which is evaluating current state policy on EMF and power line infrastructure in Minnesota. The workgroup consists of representatives from the Department of Commerce, Public Utilities Commission, Environmental Quality Board, Minnesota Pollution Control Agency, and the MDH. The MDH assessment is part of a larger report which is being developed by the workgroup.

If you have any questions regarding IEMF or the assessment, please contact a member of my staff, Chuck Stroebel, at 651-215-0919.

Sincerely,

Agnis Leitheisan, Assistant Commissioner

For Jan Malcolm Commissioner

Enclosure

An Assessment of Health Effects Research on Electric and Magnetic Fields

Minnesota Department of Health

January 2000

INTRODUCTION

Public concern about the potential health risks from exposure to electric and magnetic fields (EMF) has generated questions and concerns among state agencies regarding EMF research and public health policy. As a result, the Minnesota Department of Health (MDH) prepared this summary of technical information on EMF health effects research. This information is based on an assessment of the peer-reviewed literature and the conclusions of scientific committees convened by federal agencies and the US Congress. It is beyond the scope of this assessment to conduct a historical review of all EMF research; however, this summary does include the conclusions of extensive literature reviews conducted by scientific committees, and an evaluation of recently published EMF studies.

BACKGROUND

The relationship between childhood leukemia and residential exposures to magnetic fields from power lines has been extensively researched. Epidemiological studies have reported an association between surrogate indicators of residential magnetic field exposure (e.g., wire coding) and two to threefold excesses of leukemia among US children (Wertheimer et al, 1979; Savitz et al, 1988). Other studies, which have used direct measurements of magnetic fields to estimate exposures, have found no relationship between the measurements and childhood leukemia (Linnet et al., 1997; Day et al., 1999).

The limitations of EMF epidemiologic studies have been extensively reviewed (NRC, 1996). Inconsistent findings; discrepancies between results based on proxy estimates and those based on direct magnetic-field measurements, and the absence of supportive laboratory evidence or a plausible biologic mechanism of disease causation have resulted in uncertainties about the relation, if any, between, childhood leukemia and exposure to magnetic fields.

Public concern about the potential health risks from exposure to electric and magnetic fields (EMF) has generated questions and concerns among state agencies regarding EMF research and public health policy. The MDH conducted this assessment of EMF research to summarize technical information for state agencies.

NATIONAL SCIENTIFIC REVIEWS

National Research Council

In 1991 the National Research Council convened a committee of experts with experience in a variety of disciplines. The committee reviewed and evaluated the existing scientific information on the possible effects of exposure to electric and magnetic fields on the incidence of cancer, on reproduction and developmental abnormalities, and on neurobiologic response. The committee focused on residential EMF exposures, and summarized their findings in the 1996 report,

“Possible Health Effects of Exposure to Residential Electric and Magnetic Fields~” The following was their conclusion:

Based on a comprehensive evaluation of published studies relating to the effects of power frequency electric and magnetic fields on cells, tissues, and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human-health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioral effects, or reproductive developmental effects

The committee reviewed residential exposure levels to electric and magnetic fields, evaluated the available epidemiologic studies, and examined laboratory investigations that used cells, isolated tissues, and animals. At exposure levels well above those normally encountered in residences, electric and magnetic fields can produce biologic effects (promotion of bone healing is an example), but these effects do not provide a consistent picture of a relationship between the biological effects of these fields and health hazards. An association between residential wiring configurations (called wire codes) and childhood leukemia persists in multiple studies, although the causative factor responsible for that statistical association has not been identified. No evidence links contemporary measurements of magnetic-field levels to childhood leukemia.

National Environmental Health Sciences

In 1992 the US Congress instructed the National Institute of Environmental Health Sciences (NIEUS) to direct a program of research and analysis to evaluate the potential for health risks from EMF exposure. In 1999 the NIEHS released their report, Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields.” The report states:

The scientific evidence suggesting that ELF-EMF exposures pose any *health risk is weak*. The strongest evidence for health effects comes from associations observed in human populations with two forms of cancer: childhood leukemia and chronic lymphocytic leukemia in occupationally exposed adults. While the support from individual studies is weak, the epidemiological studies demonstrate, for some methods of measuring exposure, a fairly consistent pattern of small increased risk with increasing exposure that is somewhat weaker for chronic lymphocytic leukemia than for childhood leukemia. In contrast, the mechanistic studies and the animal toxicology literature fail to demonstrate any consistent pattern across studies although sporadic findings of biological effects (including increased cancers in animals) have been reported. No indication of increased leukemias in experimental animals has been observed.

The lack of connection between the human data and the experimental data (animal and mechanistic) severely complicates the interpretation of these results. The human data are in the “right” species, are tied to “real life” exposures and show some consistency that is difficult to ignore. This assessment is tempered by the observation that given the weak magnitude of these increased risks, some other factor or common source of error could explain these findings. However, no consistent explanation other than exposure to ELE-EME has been identified.

Epidemiological studies have serious limitation in their ability to demonstrate a cause and

effect relationship whereas laboratory studies, by design, can clearly show that cause and effect are possible. Virtually all of the laboratory evidence in animals and humans and most of the mechanistic work done *in vitro* fail to support a *causal* relationship between exposure to ELF-EMF at environmental levels and changes in biological function or disease status. The lack of consistent, positive findings in animal or mechanistic studies weakens the belief that this association is actually due to ELF-EMF, but cannot completely discount the epidemiological findings.

The NIEHS concludes that ELF-EMF exposure cannot be recognized at this time as entirely safe because of weak scientific evidence that exposure may pose a leukemia hazard. In our opinion, this finding is insufficient to warrant aggressive regulatory concern. However, because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF, passive regulatory action is warranted such as continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. The NIEHS does not believe that other cancers or non-cancer health outcomes provide sufficient evidence of risk to currently warrant concern.

American Physical Society

In 1995 the American Physical Society (APS), which is a national professional organization of US physical scientists, concluded the following:

Physicists are frequently asked to comment on the potential dangers of cancer from electromagnetic fields that emanate from common power lines and electrical appliances. While recognizing that the connection between power line fields and cancer is an area of continuing study by research workers in many disciplines in the United States and abroad, we believe that it is possible to make several observations based on the scientific evidence at this time. We also believe that, in the interest of making the best use of the finite resources available for environmental research and mitigation, it is important for professional organizations to comment on this issue

The scientific literature and the reports of reviews by other panels show no consistent, significant link between cancer and power line fields. This literature includes epidemiological studies, research on biological systems, and analyses of theoretical interaction mechanisms. No plausible biophysical mechanisms for the systematic initiation or promotion of cancer by these power line fields have been identified. Furthermore, the preponderance of the epidemiological and biophysical/biological research findings have failed to substantiate those studies which have reported specific adverse health effects from exposure to such fields. While it is impossible to prove that no deleterious health effects occur from exposure to any environmental factor, it is necessary to demonstrate a consistent, significant, and causal relationship before one can conclude that such effects do occur. From this standpoint, the conjectures relating cancer to power line fields have not been scientifically substantiated.

These unsubstantiated claims, however, have generated fears of power lines in some communities, leading to expensive mitigation efforts and, in some cases, to lengthy and divisive court proceedings. The costs of mitigation and litigation relating to the power line/cancer connection have risen into the billions of dollars and threaten to go much higher. The diversion of these resources to eliminate a threat which has no persuasive

scientific basis is disturbing to us. More serious environmental problems are neglected for lack of funding and public attention, and the burden of cost placed on the American public is incommensurate with risk, if any.

MDH Comments

The NRC, NIEHS, and APS have similar conclusions regarding the inconsistencies and limitations of epidemiological studies; the lack of supporting laboratory data regarding cause and effect; and the lack of a plausible biological mechanism. However, the NIEHS report is more ambiguous, suggesting that the available evidence warrants taking passive regulatory action. Limited information is provided in the report regarding what passive actions are appropriate.

The NIEHS report included both public and scientific input in its review. The report states, "In the preparation of the NIEHS report....meetings were aimed at including a broad spectrum of the research community and the public in the evaluation of EMF health hazards," In contrast, the NRC report was based on the evaluation of a committee of experts in a variety of scientific areas. The MDH considers the NRC evaluation and report to be more scientifically rigorous than the NIEHS evaluation.

LITERATURE REVIEW

The MDH conducted a literature review to evaluate recently conducted EWF studies (see Appendix). This review was limited to research published since the publication of the NIEHS report (May 1999).

The results of epidemiological studies of childhood leukemia were inconsistent. One case-control study reported an association between personal exposure measurements and leukemia (Green et al., 1999a). This study included a small number of cases (88). Another study with over 3000 cases reported no relationship between leukemia and residential measurements (Day et al., 1999). A third study reported a weak non-statistically significant association, with no evidence of a dose-response relationship (Green et al., 1999b). A fourth study evaluated the hypothesis that power lines increase the deposition of pollutant aerosols formed from charged ions in the air (Pews et al., 1999). This study introduces an interesting hypothesis, but provides little support that there is any relationship between increased deposition of pollutant aerosols and leukemia.

In summary, the findings of these studies are inconsistent. Results from the largest study (3000 cases in UK), which included direct measurements and detailed information about exposure assessment methods, found no evidence that magnetic fields are a health risk. This finding is consistent with the results of the largest US study of 600 cases from 9 states, including Minnesota (Linet et al., 1997).

CONCLUSIONS

The MDH concludes that the current body of evidence does not show that exposure to these fields is a health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer or any other adverse human health effect.

The current body of research lacks fundamental evidence to support a cause and effect

relationship between magnetic fields and childhood leukemia. This conclusion is based on laboratory studies which have failed to demonstrate adverse health effects or a plausible biological mechanism of causation (*in vivo* and *in vitro*).

As with many other environmental health issues, the possibility of a health risk from EMF cannot be entirely dismissed. The MDH considers it prudent public health policy to continue to monitor the EMF research and to support prudent avoidance measures, such as providing information to the public regarding EMF sources and exposure.

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APPENDIX

The MDH conducted a literature review to evaluate recently conducted EMF studies. This review was limited to research published since the release of the NTEHS report (May 1999). The following are the citations and summaries of some of the studies, which have been cited by concerned citizens and agencies (alphabetical order by author):

Exposure to Power-Frequency Magnetic Fields and the Risk of Childhood Cancer (Day et al, 1999)

This study evaluated the relationship between all childhood cancer and exposure to power-frequency magnetic fields. This case-control study included 3838 documented childhood cancer cases in England, Wales, and Scotland. The authors concluded, “this study provides no evidence that exposure to magnetic fields associated with the electricity supply in the 13K increases risks for childhood leukemia, cancers of the central nervous system, or any other childhood cancer.”

MDH Evaluation: This was a large well-conducted population based study. The authors collected detailed personal histories and exposure assessment information. The measurements for this study were residence and school based, rather than based on personal monitoring. However, the authors report good overall correlation between study measurements and mean annual personal exposure measurements. A limitation of any retrospective study of this kind is that measurements were collected after the time of diagnosis, and therefore, they may not represent exposures during the time period of interest.

Increased Exposure to Pollutant Aerosols Under High Voltage Power Lines (Fews et al, 1999)

This study evaluated the deposition of airborne pollutants near power lines. The authors hypothesize that power lines increase the deposition of pollutant aerosols formed from charged ions in the air. The study reports that two to three-fold increases in deposition of radon decay aerosols (214Po, 218Po) on spherical surfaces mimicking the human head under power lines. The study suggests that the observed increases may be linked with increases in leukemia reported in other studies.

MDH Evaluation: This study introduces an interesting hypothesis, but provides little support that there is any relationship between increased deposition of pollutant aerosols and leukemia. The authors present these findings as a possible mechanism for further study. Inadequate information is provided by the authors to determine if there is any relationship between power line induced exposure to pollutant aerosols and leukemia.

Childhood Leukemia and Personal Monitoring of Residential Exposures to Electric and Magnetic Fields in Ontario, Canada (Green et al., 1999a)

This study evaluated the relationship between childhood leukemia and personal exposure magnetic field measurements. The study included 88 cases and 133 controls. The authors

reported an association between the personal measurements and increased risk of leukemia (odds ratios of 1- 4.5). Residential proximity to power lines having a high current configuration, which has been used to estimate exposure in other EMF studies, was not associated with increased risks of leukemia. Exposures to electric fields as measured by personal monitoring were associated with a decreased leukemia risk.

MDH Evaluation: The authors in this study used personal exposure measurements, which is a significant improvement over many other EMF epidemiologic studies that have used exposure surrogates (e.g., wire coding). This study has a very small sample size with 88 childhood cancer cases total. Limited information is provided regarding participation rates, exposure assessment methods, and whether interviewers were blinded to case status. As noted above, a limitation of any retrospective study of this kind is that measurements were collected after the time of diagnosis, and therefore, they may not represent exposures during the time period of interest.

A Case-Control Study of Childhood Leukemia in Southern Ontario, Canada, and Exposure to Magnetic Fields in Residences (Green et al., 1999b)

This case-control study evaluated the relationship between childhood leukemia and residential magnetic field measurements (indoors and outdoors). The authors reported that the magnetic field exposures measured both inside and outside the residence showed weak, non-significant, positive associations with childhood leukemia. They add that there was no evidence of a uniform increase in risk with increasing exposures. The authors state that exposures measured outside the perimeter of the residence (>0.15 uT) for children younger than 6 years at diagnosis, were associated with increased leukemia risk (OR = 3.45).

MDH Evaluation: Limited conclusions can be made from this study because of the small sample size used for the analysis. For example, the increased leukemia risk for children younger than 6 years at diagnosis was based on 35 cases. Overall, the results of this study are weak, and provide no consistent evidence of a dose-response relationship.