CANCER FACTS

National Cancer Institute • National Institutes of Health
Department of Health and Human Services

Magnetic Field Exposure and Cancer Studies at the NCI

Electric and magnetic fields (EMF) arise from the motion of electric charges. They are characterized as nonionizing radiation when they lack sufficient energy to remove electrons from atoms. In contrast, the energy in ionizing radiation, such as x-rays and gamma rays, can break atomic bonds and cause chromosomal changes. EMFs are emitted from devices that produce, transmit, or use electric power. These include power lines; transmitters; and common household items, such as electric clocks, shavers, computers, televisions, electric blankets, heated waterbeds, and microwave ovens. The intensity of the field drops off as distance from the source increases.

For the past few years, public concern has been growing over the possible health effects of EMFs produced by power transmission and distribution lines located near residential areas, as well as from electrical devices used in the home. Over the past 15 years, there have been numerous studies of children and adults evaluating residential exposures to electric and magnetic fields in relation to the risk of cancer. Recently, research has focused on magnetic fields. The findings have been inconsistent.

To evaluate the possible effects of magnetic fields on human health, scientists rely on epidemiological studies. However, these studies are often difficult to conduct due to the need to enroll a large number of subjects to detect potential small increases in risk; the difficulty in estimating exposure after it has occurred; the necessity for minimizing selection bias; the need to

obtain high participation rates; the effort to minimize the number of surrogate, or next-of-kin respondents; and the necessity for considering potential confounding variables.

The following summarizes research being conducted or supported by NCI.

Studies of Magnetic Field Exposure and Childhood Acute Lymphoblastic Leukemia

NCI and the Children's Cancer Group (CCG) collaborated on a large-scale investigation to determine whether exposures to magnetic fields contribute to the development of acute lymphoblastic leukemia (ALL) in children under age 15. ALL comprises 70 to 80 percent of all childhood leukemias in the United States. The results of the residential measurement component of this study were published in *The New England Journal of Medicine*, July 3, 1997, while the results of the interview component evaluating exposure of the child's mother during pregnancy and the child's exposure after birth to electrical appliances were published in the May 1998 issue of *Epidemiology*.

The CCG is an NCI-supported, multicenter network of pediatric oncologists, epidemiologists, and other cancer researchers from 38 institutions and affiliated hospitals throughout the United States. The operations center of the CCG is headquartered at the University of Southern California (USC) in Pasadena.

The study of residential magnetic field exposures and childhood ALL, directed by NCI scientist Dr. Martha Linet, was initiated in September 1989 because of public concern and a need for more precise epidemiologic data. It is part of a larger CCG investigation evaluating the risk of ALL associated with a wide range of factors, such as prenatal X-rays, childhood and maternal diseases, maternal drug use, maternal smoking, parental occupations, household chemical exposures, and familial cancer and related disorders.

For the magnetic field evaluation, 638 children with ALL and 620 matched controls were selected from more than 1,900 cases and 1,900 controls (the latter identified by random-digit telephone dialing) who participated in the comprehensive CCG study. The subjects in the residential magnetic field exposure assessment component, all under age 15, included residents

of nine states: Illinois, Indiana, Iowa, Michigan, Minnesota, New Jersey, Ohio, Pennsylvania, and Wisconsin.

Magnetic field exposure (from both household sources and electric power lines) and its relationship to childhood ALL was examined by data collectors who were unaware of the health status of the children. They measured magnetic field levels in four rooms within current and former homes of children with leukemia and matched controls (including where the mother slept during her pregnancy). They also diagramed the location, type, and size of external power lines outside the residences (wire coding).

There was little evidence of a relationship discovered between risk for ALL in children and exposure to magnetic fields. This study provides one of the largest comprehensive measures of magnetic field exposure in children's residencies.

In a detailed evaluation of the use of electrical appliances and childhood ALL, investigators from NCI and CCG examined whether the use of household electrical appliances by the mother during pregnancy and by the child might be associated with an increased risk of childhood ALL. Compared with EMF exposure from power lines, the contribution of appliances to a person's total exposure to EMF is thought to be small. Most appliances are used for short periods of time and EMF exposures are elevated only when close to the appliance.

The researchers compared the reported use of household electrical appliances of 640 children under age 15 who were diagnosed with ALL between l989 and l993 with the appliance use of 640 matched controls. Over half of the cases (59.4 percent) were less than 5 years old when they were diagnosed with ALL. The study participants lived in Illinois, Indiana, Iowa, Michigan, Minnesota, New Jersey, Ohio, Pennsylvania, and Wisconsin. The data are based on the mothers' responses to a detailed questionnaire administered in their homes. No measurements were taken of magnetic fields associated with the actual appliances used.

The mothers were asked to describe how often during their pregnancy and in which trimester specific appliances were used. The interview also included questions about the child's use of the appliances before the diagnosis of ALL. The controls were also asked about the use of

the appliances during a comparable frame of time. Electric appliances included in the study were electric blankets, mattress pads, heating pads, water beds, stereo or other sound systems, television and video games connected to a television, video machines located in arcades, computers, microwave ovens, sewing machines, hair dryers, curling irons, ceiling fans, humidifiers, night lights, and electric clocks.

There was no clear conclusion drawn from the data. Although the data showed some association between appliance use and leukemia, there was no consistent pattern of increasing risk with increasing exposures. The scientists speculate that the magnetic fields from electrical appliances are unlikely to increase the risk of childhood ALL.

Brain Cancer Studies

The causes of tumors of the brain and nervous system are largely unknown, but genetic factors and a variety of environmental exposures have been implicated to varying degrees, said Peter Inskip, Sc.D., of NCI's Division of Cancer Etiology. Certain inherited syndromes, such as neurofibromatosis, predispose persons to developing tumors of the nervous system; however, such syndromes are rare. Parents and siblings of children with brain cancer appear to have a slightly increased risk of developing brain tumors.

Epidemiological studies have linked central nervous system cancers with a variety of environmental exposures (including physical, chemical, and biological agents), according to Dr. Inskip. Public concern recently surfaced over the possibility that hand-held cellular telephones, as well as other sources of magnetic fields, may cause brain cancer.

While there is strong evidence that high doses of ionizing radiation, such as that received from radiotherapy, can increase the risk of tumors of the central nervous system, the picture is less clear concerning possible risks posed by low doses of ionizing radiation or magnetic fields. Most studies of groups occupationally exposed to low doses of ionizing radiation have not found an increased risk of brain cancer.

The few studies of magnetic fields and cancer of the nervous system have focused on low-frequency (50–60 Hz) fields, such as those associated with electric power lines and household appliances. There is very little information available concerning possible risks associated with microwave frequencies, such as those emitted from hand-held cellular telephones (800–900 MHz). While the possible health hazards of magnetic field exposure remain an active area of research, expert panels that have reviewed the existing evidence have judged that available data are insufficient to support the conclusion that magnetic fields cause cancer.

To address this problem, Dr. Inskip is heading a comprehensive study of malignant and benign adult brain tumors to identify environmental and genetic causes for these serious but poorly understood diseases. NCI and extramural researchers will examine numerous factors that may affect brain cancer incidence, including cellular telephone use, occupational exposures, residential appliances, diet, vitamin supplements, reproductive and medical history, inherited susceptibility, and other factors. This NCI case-control study is being conducted at hospitals in Phoenix, Pittsburgh, and Boston, and will include 700 newly diagnosed brain tumor cases and an equal number of matched controls. The controls will be patients admitted to the same hospitals with any of a variety of non-cancerous diseases or conditions.

Researchers are gathering information about possible risk factors through personal interviews, self-administered questionnaires, and biochemical and molecular genetic analyses of blood samples. The occupational component of the study will improve on previous efforts to evaluate occupational risk factors for brain cancer by asking job-specific questions about tasks performed, specific chemicals and equipment used, and whether or not protective gear was worn. The early identification of brain tumor cases will provide the opportunity to interview brain cancer patients directly, rather than having to depend on a family member for the needed information.

A distinction will be made between cordless phones, which are commonly used in homes, and cellular phones, which operate at a higher frequency and power. Information to be obtained

about use of cellular telephones will include the types of phones used (hand-held, car, transportable cellular phones, or cordless phones), duration of use, and frequency of use.

Researchers will also look at family histories of brain tumors and other cancers; consumption of vitamins, fruits, and vegetables; consumption of foods and beverages containing N-nitroso compounds or their precursors; medical and dental exposures to ionizing radiation; reproductive histories; exposure to viruses; and pre-existing medical conditions. Data collection, which began in June 1994, will finish at the end of 1998. Separate analyses will be conducted for the different types of brain tumors.

Radar Exposure and Cancer

In 1980, the National Academy of Sciences conducted a 20-year followup study of 20,000 U.S. Navy personnel to determine whether sailors exposed to high intensity microwave radiation (radar) were more likely to get cancer than 20,000 sailors with no or minimal radar exposure. The study, which was published in the July 1980 issue of the *American Journal of Epidemiology*, found no association between radar exposure and cancer. Currently, NCI and the National Academy of Sciences are conducting a 40-year followup study on the 20,000 U.S. Naval personnel exposed to magnetic fields from radar equipment used during the Korean War versus the 20,000 sailors receiving no or minimal radar exposure. The results of this study will be available in 1999.

NCI Grants

In addition, the NCI supports a number of grants to determine whether magnetic fields are associated with cancer risk. Listed below are descriptions of a few NCI-funded studies investigating the relationship, if any, of exposure to magnetic fields and specific types of cancer. These projects will be funded for 4 more years.

Brain Cancer

The University of California, San Francisco, will enroll approximately 15 percent of the projected 450 newly diagnosed cases of brain cancer patients and 450 controls needed for a large-scale study of brain cancer. Patients from the San Francisco area will participate in this study, which is jointly funded by NCI and the National Institute of Environmental Health Sciences (NIEHS), the Nation's principal agency for environmental health research and information.

In addition, NCI is also supporting several studies by the American Health Foundation in New York. A case-control study of brain cancer is identifying over 150 cases and controls in five collaborating hospitals in New York, Rhode Island, and Ohio. Information on magnetic field exposures, cellular telephone use, and other potential risk factors will be examined.

The American Health Foundation is also conducting a study to see how many New York State cellular phone subscribers were diagnosed with cancer from 1990 through 1993, as recorded by the New York State Cancer Registry.

NCI is funding two epidemiologic case-control studies: one at USC that includes 500 children with brain tumors, and one that includes 300 children in Israel with brain tumors. These studies assess whether exposure to magnetic fields or radio frequency radiation, among other possible risk factors, is associated with an increased risk of brain tumors.

Leukemias and Lymphomas

Exposure to magnetic fields has been suggested as risk factors for leukemia. An NCI grant to the University of Torino, Italy, is supporting a case-control study of 3,400 Italians with leukemia or lymphoma to assess magnetic field exposures, as well as exposure to solvents and pesticides.

Breast Cancer

Several studies are investigating the association between magnetic field exposure and breast cancer. An NCI-supported case-control study of breast cancer (800 cases) is in progress at

the Fred Hutchinson Cancer Research Center in Seattle, and another case-control study of breast cancer, supported by NCI and NIEHS, is being conducted by the University Medical Center at Stony Brook, New York. This study is part of NCI's Long Island Cancer Study, which is investigating environmental factors and breast cancer. Both studies will measure in-home magnetic field exposures and proximity to power lines as possible risk factors.

Through a grant to the University of North Carolina at Chapel Hill, NCI will support the development of a new program of research on the environment and breast cancer, including a national conference on magnetic fields and breast cancer. (Magnetic field exposure may lower melatonin, a hormone found in the pineal gland. Melatonin may be protective against breast cancer.)

A project at Brigham and Women's Hospital, Boston, is evaluating whether electric blankets are associated with breast cancer in a group of 121,700 nurses studied since 1976. These projects, together with research being conducted by intramural researchers at NCI, and grants supported by NIEHS should provide a comprehensive evaluation of cancer risks from magnetic field exposures.

The NIEHS recommends that anyone concerned about the possible health effects of magnetic fields may do the following to reduce exposure:

- Increase the space between a person and devices that may emit magnetic fields.
- Avoid standing too close to computers, microwave ovens, or televisions.
- Reduce the time of exposure to possible magnetic fields by turning off devices such as electric blankets when not in use.
- Avoid keeping such devices as electric alarm clocks too close to the bed.
- Discourage children from playing near high power lines or transformers.
- Avoid activities near magnetic field sources.

For more information on this subject, please refer to the National Institute of Environmental Health Sciences' Web site at http://www.niehs.nih.gov/emfrapid/home.htm on the Internet.

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Sources of National Cancer Institute Information

Cancer Information Service

Toll-free: 1–800–4–CANCER (1–800–422–6237)
TTY (for deaf and hard of hearing callers): 1–800–332–8615

NCI Online

Internet

Use http://cancer.gov to reach the NCI's Web site.

LiveHelp

Cancer Information Specialists offer online assistance through the *LiveHelp* link on the NCI's Web site.

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