during pregnancy or before conception; and parental, fetal, or childhood exposures to environmental toxins such as pesticides.

A study by E. George Knox, Ph.D., a retired professor at the University of Birmingham, England, received wide attention when it was published in the April 1997 *Journal of Epidemiology and Community Health*. Knox examined proximity of childhood cancer deaths to dozens of potential hazards including factories, power stations, railroads, and motorways. He found higher-than-expected numbers of cancer deaths among children living near sources of petroleum product emissions and kiln and furnace smoke and gases.

Knox's study has been widely criticized on methodological grounds, including its reliance on postal codes rather than exact addresses. But some scientists say Knox may nevertheless be

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**EMF Findings Called Reassuring, but Controversy Persists**

Knowing the difficulties in making an accurate assessment of such a controversial topic as magnetic fields or EMFs, the U.S. National Cancer Institute and the Children's Cancer Group launched one of the most thorough studies of its possible effects on cancer risk in 1993.

In the July 3, 1997, *New England Journal of Medicine*, NCI's Martha Linet, M.D., and colleagues concluded that the study's "results provide little evidence that living in homes characterized by high measured time-weighted average magnetic-field levels or by the highest wire-code category increases the risk of acute lymphocytic leukemia in children." Wire coding, a proxy measure of in-home magnetic fields, showed associations with childhood leukemia in earlier U.S. studies.

Many scientists, starting with NEJM deputy editor Edward Campion, M.D., hailed the finding as finally putting to rest a hypothesis that was scientifically tenuous and largely based on public hysteria. "The 18 years of research [on power lines and cancer] have produced considerable paranoia, but little insight and no prevention," Campion wrote in an editorial. "It is time to stop wasting our research resources."

Not everyone agreed. Though most praised the study's painstaking approach, many experts have taken issue with the authors' interpretation of their results and with Campion's dismissal of EMF research. Letters published in the Nov. 13 NEJM pointed to the significantly elevated risk seen in the small group of children exposed to average EMF levels of 0.3 microtesla or greater.

"Abandoning research on exposure to magnetic fields on the basis of this study is premature," wrote Daniel Wartenberg, Ph.D., of the Environmental and Occupational Health Sciences Institute, Piscataway, N.J. "Given that ALL is the most common childhood cancer and that we have little insight into its causes, it is imperative from a public health standpoint that we aggressively seek explanations."

Sir Richard Doll, M.D., of the University of Oxford, who chairs the management committee of the U.K. Childhood Cancer Study, said in an interview that "the reaction in the U.K. has not been quite the same as in the U.S.—certainly very different from the reaction in the [Campion] editorial. I think this is because we’ve put much more emphasis on the Scandinavian studies than [scientists] have in the states, and we’ve put less emphasis on wire configuration. . . ."

Among the four Scandinavian cancer/EMF studies, three showed little evidence of a relationship between estimated residential power line magnetic field levels and rise of childhood leukemia, whereas a 1992 study in Sweden found that children living in homes with magnetic field levels at the time of diagnosis retrospectively estimated at 0.1 to 0.29 microtesla had a leukemia risk 1.5 times higher than those in homes with lower levels; above 0.3 microtesla the risk was 3.8 times higher. But these risk estimates were based on just four and seven cases, and no cancer association was found with in-home magnetic field measurements generally made years after diagnosis.

Results from the EMF component of Doll’s U.K. study—including more than 1,000 children with ALL, 3,000 with other cancers, and 8,000 controls—are expected later this year along with those from a similar Canadian study. A group of top international experts met Jan. 12-14 in San Antonio to review all epidemiologic evidence to date on health effects of EMF as part of the National Institute of Environmental Health Sciences’ and the Department of Energy’s "EMF-RAPID" program. The results of that symposium will be used to prepare a report to the U.S. Congress in 1998.

— Tom Reynolds
onto something, particularly in light of his earlier research showing spatial clustering of cancer cases suggesting focal environmental hazards.

Both the CCG study and the U.K. Childhood Cancer Study, headed by Sir Richard Doll, M.D., of the University of Oxford — the largest childhood leukemia studies in their respective countries — are casting wide nets that the researchers hope will snare some environmental culprits. And in doing so, they hope also to identify subgroups of leukemia that might have different genetic and immunologic characteristics as well as different etiologic mechanisms.

**Confining Risk Factors**

“One of the overriding things our study was designed to determine is whether risk factors are confined to biologically defined subgroups,” said Leslie L. Robison, Ph.D., of the Department of Pediatrics at the University of Minnesota, Minneapolis, and principal investigator of the CCG study, which includes more than 1,900 children with ALL. Subgroups may be defined by cell type (B versus T cells), by the presence of specific cell surface markers (or immune phenotypes), or by cytogenetic characteristics.

Subsets of the subjects in the CCG study have been used to examine in greater depth questions of particular interest. Besides the EMF study, these include an investigation of indoor residential radon radiation risks for ALL led by Jay Lubin, Ph.D., of NCI, and an analysis of pesticides, polyaromatic hydrocarbons, and heavy metals, led by Jonathan D. Buckley, M.D., Ph.D., at the University of Southern California, Los Angeles.

In Buckley’s study, household dust samples were collected with special high-powered vacuum cleaners to be analyzed for dozens of commonly used pesticides and other known or suspected carcinogenic compounds. Studies by EPA have shown that pesticide levels indoors on carpets — where young children crawl and play — are higher than those typically found on the lawns and gardens where the chemicals were applied. The study will also estimate automobile traffic density in the children’s neighborhoods.

Other components of the CCG study expected to see publication soon, Robison said, are investigations of prenatal diagnostic x-rays (one of the few risk factors considered already established), parental smoking (see News, March 5, 1997), breast feeding, and military service.

The U.K. investigators have collected information on all children diagnosed with cancer in England and Wales since 1992. They will test five hypotheses: that childhood cancer may be caused by radiation exposures in utero or after birth, by in utero or postnatal chemical exposures, by occupational chemical or radiation exposures to fathers’ sperm, by postnatal EMF exposures, and as a rare abnormal response to infection.

Blood samples have been taken from all children and their families for determination of genetic and immunologic characteristics. Doll said data collection from parents was completed in late 1997; medical record data are still under way, and preliminary results should be available by the end of 1998.

At the University of California, Berkeley, Patricia A. Buffler, Ph.D., dean of the School of Public Health, and Martyn T. Smith, Ph.D., professor of toxicology and director of the Superfund Research Center there, are collecting information on all cases of childhood leukemia diagnosed in Northern and Central California, including bone marrow, blood, and cheek swab samples (for genetic tests).

The study’s primary aim is to assess chemical exposures of the child and the parents to pesticides and other chemicals, dietary exposures, and genetics, and like their U.K. and CCG counterparts, the Berkeley researchers are interested in identifying subtypes of leukemia that may help elucidate causes.

“We are characterizing the cases on a molecular and cytogenetic basis: Do they contain things like a mutation in the ras gene, or translocations . . . or changes in chromosome number?” Smith explained. “And independently of leukemia type on a pathological basis, can we subgroup these cases by asking, are there similar things about those that have a loss of a particular chromosome, for example, and is there a common exposure or a common genetics associated with that? Because we think we’re dealing with a group of diseases that might look similar clinically, but are actually quite different in their etiology. And we’re trying to understand if the genetic changes occurred before birth, trying to find the window when exposure would have been critical.”

The study is funded by the federal Superfund program although it does not focus on Superfund sites. Smith said studies focused on suspected cancer clusters near such sites have not been productive, and useful answers are more likely to emerge from large and broad-based studies such as the one Buffler and he are doing.

— Tom Reynolds