TOPIC #14: POLICY IMPLICATIONS

SYNOPSIS

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Purpose

The goal of the RAPID EMF Engineering Program is to provide information on the types and extent of human exposure to electric and magnetic fields, as well as guidelines and methods to measure, characterize, and manage-magnetic field exposures. This synopsis explores the implications of this research for the risk assessment that is being conducted by the National Institute of Environmental Health Sciences.

Typically, the policy implications of an exposure research and assessment program are explored after all the data have been gathered and reviewed. When performed for the purposes of risk assessment, one also expects to already have at hand the answers to two important questions: *Does the agent pose a hazard to human health?* and *What is the relationship between exposure and disease occurrence in humans?* (National Research Council, 1983). At present, these activities as initiated by the RAPID program, have not come together, and we do not have final answers to questions about hazard and about dose-response. In this situation, it would appear to be appropriate to anticipate the kinds of questions that the scientists who perform the EMF risk assessment for NIEHS will ask over the next three or four months.

What Is the Extent and Character of Exposure to Magnetic Fields in the Population?

Available research provides some information in response to this critical question. The extent of exposure in the population can be characterized by measurements that have been taken in systematic studies and surveys. However, without having identified an exposure characteristic such as TWA, time above 5 mG, etc. that predicts disease risk, one cannot be certain that the parameters chosen to characterize population exposures are at all relevant to health. With this caveat in mind, consider the data that have been summarized for this workshop.

Residential Populations

In a few areas of the country, epidemiology studies have gathered data about magnetic-, and, to a much lesser extent, electric-field exposures. The field parameters measured include spot measurements in different rooms, spatial averages, 24-hour recordings in bedrooms, and the exposure surrogate known as wire code. More useful data for estimating the exposures of residential populations are those data obtained in a nation-wide survey of randomly selected residences (Zaffanella, 1993). In each of 996 residences, the spatial distribution of magnetic fields from internal and external sources, spot measurements of fields from appliances, and the physical characteristics of sources were recorded. However, the time-location-activity data that would be required to characterize the exposures of individuals living in these residences were not collected. The same investigator has completed another survey of magnetic-field exposures of more than 1000 randomly selected persons for the EMF Rapid Engineering Project #6 (Zaffanella and Kalton, 1998a; 1998b). A third study, nearing completion, has collected magnetic-field data and wire-code classifications on more than 200 residences at periodic intervals over more than a two-year period (Rankin and Bracken, 1994). The residences were selected from a stratified random sample of utility customers. A study of personal exposures of utility employees to magnetic fields at home, as collected during up to six visits over two years, may also be helpful in estimating population exposures, even though the participants were not randomly selected (Bracken et al., 1994). See also Synopsis 12.

Occupational Populations

Epidemiology studies also provide information about electric- and magnetic-field exposures in the workplace. In the latest epidemiology studies of North American electric-utility workers, past exposures to magnetic fields have been estimated by sampling the exposures of present-day workers with PE monitors (Sahl et al., 1993; Savitz and Loomis, 1995; Thériault et al., 1994).

One study expanded number of workers studied at one utility reported on by Thériault and analyzed data collected on the personal exposures of workers to both electric and magnetic fields (Miller et al., 1996). However, the electric-field data should perhaps be interpreted only in terms of relative exposure levels, given the difficulty in interpreting field levels perturbed by the body and nearby objects. The studies above therefore provide useful information about occupational exposures within this industry. Utility workers as a whole are an industrial group with higher-than-average exposure and therefore are not representative of other occupational groups. There are no comparable data on other industries or the general working population.

Are There Highly Exposed Populations?

Exposures to electric and magnetic fields are not evenly distributed in the population. As with many other environmental and occupational exposures, average magnetic-field levels tend to be quasi-log-normally distributed (cf. Zafanella and Kalton, 1998a). Log-normal distributions are not symmetrical about the mean. Therefore, the magnetic-field levels encountered by a relatively small number of persons in the population are distributed widely across the high end of the magnetic field distribution. For example, in the survey of persons sampled in RAPID Project #6 (Zaffanella and Kalton, 1998b), it was reported that the geometric mean 24-hour magnetic-field level recorded by 853 randomly selected adults was 0.90 mG. The average field levels encountered by 90% of these persons were at or below 2.36 mG. However, the range of average field levels encountered by the remaining 10% of the sample ranged from 2.37 mG to 25.7 mG. In the context of this distribution of average magnetic-field levels, the persons in the highest 10% of the sampled population clearly have higher exposures than the remaining 90%.

The data on occupational exposures to electric and magnetic fields show positively skewed distributions. For example, in a study of workers at five U.S. utilities, the geometric mean magnetic field recorded at 10-second intervals over the workday was 2.8 mG; at the 90th percentile, it was 19.3 mG (Savitz et al., 1994). However, these exposure statistics by themselves have no verified implications for health unless the metric, 24-hour TWA can be linked by epidemiological data or whole animal studies to adverse effects.

Special Populations Disproportionally Affected by EMF Exposures

The population is heterogeneous in many characteristics that may affect responses to environmental agents. Infants and children, the elderly, and individuals with underlying diseases have been considered at increased risk from other environmental agents. Therefore, it is important to consider whether there are special populations that, by reason of age, sex, health condition, or racial/income, might be disproportionately susceptible to, or affected by, EMF exposures.

A small fraction of residential and occupational populations are characterized by high-end exposures. However, with regard to health, a scientific determination that some magnetic-field characteristic poses a hazard logically must precede the determination of impacts on populations. No such determinations have yet been made. There are also no known demographic factors that would confer a risk to populations exposed to electric and magnetic fields. The data are not available to determine whether higher magnetic-field exposures, however defined, are found more often among special subpopulations. Such concerns appear to be lower for occupational populations. In fact, with regard to health, populations of utility workers (who are among the occupational groups most highly exposed to electric and magnetic fields) are reported to have lower mortality from all causes, including cancer, e.g., Savitz and Loomis (1995).

Can Exposures and Risks of EMF be Ranked Against Those From Other Environmetal Agents?

It might be argued that even if no definitive risk can be determined, efforts to target special populations for action could be considered. However, this raises a question: is it fair to do so when these special populations might already be dealing with public health or social issues that have known impacts? Unless the risks of magnetic-field exposure were to be determined to be large and certain, then special populations might very well prefer to have the limited public health resources directed towards reducing more pressing risks of environmental exposures. This question could be examined in the overall RAPID EMF risk assessment process from the perspective of a comparison of exposures and risks.

The US Environmental Protection Agency (USEPA) and more than a dozen states have initiated risk comparison efforts to identify which environmental problems are most severe and which strategies for risk reduction will do the most good. For example, USEPA and California Environmental Protection Agency (1994) supported the California Comparative Risk Project to develop rankings of human health risk from environmental health stressors and to consider populations at potentially disproportionate risk from these stressors. It should be noted that, at the time this comprehensive assessment was completed, the project committee concluded that electromagnetic fields could not be included in the rankings of high-, medium-, or low-ranked risks because the scientific data were insufficient to reach a scientifically supportable evaluation (CEPA, 1994).

Do We Have the Methods and Technologies to Characterize Field Exposures for the Next Generation of Research Studies?

The RAPID exposure assessment projects have been very successful in summarizing the available information on instrumentation, and developing guidelines for obtaining personal measurements, surveying specific environments, and specific sources.

Instrumentation has been developed to conveniently record a variety of magnetic-field characteristics over a wide range of intensities. However, the instrumentation for measuring electric fields, while improved, is limited by the physical nature of electric fields: the presence of the human body perturbs the electric field, as do nearby conductive objects. Until new instruments and methods are developed for characterizing electric-field exposures in spite of this obstacle, considerable uncertainty will remain in quantifying such exposures.

While any investigator can purchase the most sophisticated devices to measure and record magnetic fields, relatively few have the knowledge and experience to develop protocols for using the instruments to obtain valid and reproducible measurements. This is one of the reasons that many laboratory studies and some epidemiology studies have not adequately characterized exposures. The RAPID engineering projects address these deficiencies by providing comprehensive, detailed, and tested protocols for performing measurements of magnetic fields. Funding agencies and journal editors should be be made aware of these, which could serve as models against which the methods for collecting exposure data in proposed studies are to be judged.

Even so, other conditions will need to be fulfilled before the challenge posed by Savitz and Loomis (1997) can be met: they emphasize that ". . . Future investigation of these diseases in relation to magnetic field exposure should be driven either by a unique opportunity to more accurately reconstruct historical exposure or by more specific, testable hypotheses regarding biologically relevant exposure metrics or markers of susceptibility to exposure that could test with more precision whether there is a causal link between exposure and disease." (Savitz and Loomis, 1995: 133).

If the Weight-of-the-evidence Were to Support the Conclusion That a Risk Exists, What Are the Options for Managing Field Exposures?

Deciding what field-management options to pursue depends strongly upon the data and on assumptions about the type and prevalence of health effect related to electric or magnetic fields, the relevant field parameters or dose metric, the shape of the dose response curve, and the degree of certainty about all of the above. Such decisions are likely to be made by health agencies, if necessary, in response to the risk assessment performed by scientists for the RAPID program. An independent decision analysis process is already underway, sponsored by the California Department of Health Sciences.

It may not now be meaningful to speculate about the scope and outcome of such decision analyses. Risk is a multidimensional concept. Therefore, issues concerning electric and magnetic fields may need to be addressed by social and political actions, not just by exposure reduction. However, if a risk were to be confirmed, and public health or other agencies determined that the risk was more certain than not, then data from the RAPID engineering assessment program and other sources could be used to develop field management options in two categories:

1. Source Control

   This category of options applies known technology to reduce the intensity or other relevant characteristics of a field source. In this category are technical standards or source modifications, including shielding, that might be applied to transmission and distribution lines, sources in schools, buildings, and residences. An evaluation of the relative lifecycle costs for six source types was performed in RAPID Engineering Project #8 (Johnson and Gauger, 1997).

2. Exposure Control

   This category of options reduces magnetic-field exposure by non-engineering means that restrict the time that people spend using or near sources. For powerlines, such options might include wider rights-of-ways and greater housing setbacks. Information about field levels from appliances could be used to support recommendations for reducing non-essential time spent using or near high-field appliances.

Implications for Risk Assessment

Without having identified an exposure characteristic such as TWA, time above 5 mG, etc., that predicts disease risk, one cannot be certain that the field parameters that have been chosen to characterize population exposures are at all relevant to health.

Data from a few sources are available to characterize the distribution of field intensities and some other characteristics to which people are exposed in residential environments. Unless assumptions are made about the time that people spend in various activities and locations, these field measurements cannot be used to estimate relative exposures over time. Magnetic-field characteristics of exposures of occupational populations have been sparsely sampled, except for workers in the utility industry.

Barring a new finding from the to-be-completed RAPID risk assessment, there is no health basis, or available demographic data, to consider a sensitivity to, or greater exposure to electric and magnetic fields in subpopulations.

Improvements have been made in measurement instrumentation and methods, but other considerations, including the ability to reconstruct past exposures and test biologically relevant exposure metrics, are more important for future epidemiology studies.

The contribution of engineering options to field-management objectives through controlling the fields from sources would appear to be cost-effective *only* if a likely health risk of field exposure were to be identified. Reducing exposure by restricting the time spent near sources may also be effective. Other social and political responses to risk-based health findings regarding field exposures are outside the scope of engineering options.

Remaining Questions

1. What more needs to be done? Methods? Instrumentation?
2. What is the proper exposure or dose metric?
3. What are the best data sets from which to estimate the distribution of exposures in the population?
4. Is it worthwhile to include appliances other than electrically heated beds in total exposure estimates?

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