PRESENTATION

Dana Loomis
University of North Carolina
Chapel Hill, NC

Dr. Loomis provided an epidemiologist's view of the characterization of EMF personal exposure. He focused on the question of variability in magnetic fields and its importance for characterizing PE. The following summary was prepared from the symposium transcript. This material was reviewed by the presenter for accuracy.

Variability is important both in considering measurements of exposure and in using those measurements in epidemiological studies. In examining the history of EMF exposure assessment in epidemiology, it is important to note that measurements have been directed in different ways for occupational and residential studies. In occupational studies, measurements are aggregated and used to assign exposures to groups, while in residential studies the measurement and exposure data have been directed towards individuals. Whereas occupational studies have relied on PE measurements, residential epidemiological studies up to now have relied on wire-code classification schemes, spot measurements, 24-hour measurements, and some historical reconstruction of field levels.

Magnetic-field exposures are variable: they depend on the place, the person, and the time of the exposure. Quantifying the sources of variability improves our understanding of the power of an epidemiological study to detect a risk if it happens to be there. One approach is to partition the variability into various components. This can be done by applying a simple analysis of variance model to exposure data to determine the relative contributions to the total variance of between- and within-person variance components. These two components of variance are important: the larger the within-person variance relative to the between-person variance, the weaker the study's ability to detect a risk if it is there.

Variation in exposures over time periods of seconds and hours can be captured very well by modern instruments. Unfortunately, for epidemiologic studies of cancer, the time periods of interest are much longer and the time scale over which the disease occurs is much longer than the time scale of measurements. In the context of cancer studies, such as those conducted in the workplace and on residential magnetic field exposures, the TWA magnetic flux density is a good indicator of exposure for epidemiological studies; for practical purposes, within-day variability of exposure is not of interest.

The concept of variance components was applied to the exposure data from the occupational study of utility workers in five U.S. utilities to assess and select methods of grouping job category/company for the purpose of assigning exposures. The best way to assign exposure to the workers in the cohort was to maximize the separation between exposure groups and minimize the variability within exposure groups. The optimum combination for doing this was an ad-hoc grouping based on measured exposures: five groups were formed from the four quartiles of the exposure measurement distribution, with the upper quartile divided in two.

Relative risks were analyzed using the different methods of assigning exposures. The optimum exposure grouping produced the strongest relative risk, as expected. Each of the alternatives produced a somewhat attenuated relative risk.

This example demonstrates the grouping of categories to optimize the within-person/ between-person variance balance and thereby improve exposure estimates. It also demonstrates that risk analysis is sensitive to the grouping method that is selected, and that exposure assessment methods can have significant impact.

For residential exposure, variability enters into considerations of the stability of various exposure indicators. Some have argued that wire-code category may be a more stable indicator of exposures than contemporary spot measurements; hence, studies see positive correlations of risk with wire-code category, but weaker or no association with measurements. If this is in fact true, improvements in the ability to gauge long-term exposures ought to strengthen the exposure-disease association in those studies using the improved methods relative to older studies that used wire-code categories.

In a meta-analysis of studies for childhood leukemia, Loomis and colleagues have augmented previous work done by the National Academy of Science with studies completed in 1996-1997. These new studies included improved methods for assessing historical exposures such as contemporaneous 24-h measurements and historical reconstruction of field levels. The results of this new meta-analysis are shown in Table 8-1, which was included in Loomis' presentation. It appears to show that there is an increased association of disease with exposure as exposure assessment methods have strengthened from wire codes and spot measurements, to 24-h measurements, to calculated historical fields.

Table 8-1: The wire code paradox — or is it?

	Meta-Analysis: Odds Ratios (ORs) for childhood leukemia	
Exposure Index	**NAS 1979-93 Studies**	**+ 1996-97 Studies***
Code ≥ LCC	1.5 (1.0-1.9)	1.4 (1.0-1.9)
Distance > 50 m	1.4 (1.1-1.8)	1.3 (0.8-2.2)
Spot > 0.2	0.9 (0.6-1.5)	1.0 (0.6-1.7)
24 h > 0.2	-	1.7 (1.1-2.5)
Calculated	-	1.6 (0.9-2.8)
Calculated or measured	-	1.6 (1.2-2.3)

* Meta-Analysis from Loomis et al., 1998

Loomis concluded that the short-term stability of residential fields can be captured by measurements, but that long-term stability is not as strong. However, improved exposure assessment methods for long-term fields, such as 24-h measurements and historical field calculations, appear to strengthen epidemiological results.

References

Kromhout,H; Loomis,DP; Mihlan,GJ; Peipins,LA; Kleckner,RC; Iriye,R; Savitz,DA (1995): Assessment and grouping of occupational magnetic field exposure in five electric utility companies. Scand. J. Work Environ. Health 21(1, January), 43-50.

Loomis,D, Lagorio,S, Salvan,A, Comba,P (1998): Update of evidence on the association of childhood leukemia and 50/60 Hz magnetic field exposure. (Manuscript submitted to Journal of Exposure Analysis and Environment Epidemiology.)

SUMMARY OF DISCUSSION

Several issues came under discussion following the presentation on personal exposure characteristics by Dr. Dana Loomis. The summary below was prepared from the symposium transcript.

The presenter, Dr. Dana Loomis, an epidemiologist, offered a different perspective on the problem of PE characterization, including the opinion that most EMF epidemiological exposure assessment was less than adequate.

The use of residential wire codes as a surrogate for magnetic-field exposure was discussed in the context of TWA exposure. Some felt that wire-coding appears to be less effective because it does not minimize the overlapping of categories vis-a-vis TWA magnetic-field exposures (noted earlier). Others felt that wire-code category was useful as a risk factor indicator, but not necessarily for magnetic fields.

Commenters noted that PE characterization in both occupational and residential environments requires documenting the surroundings and collecting time/location data, not just measuring magnetic-field PE data. One discussant noted the importance of work environment and task in describing occupational exposures. Loomis noted that magnetic fields are not unique in that respect: the same problems arise for any attempt to measure environmental or occupational exposures. He also advocated PE measurements as the preferred method for exposure assessment.

One commenter suggested that we may be dealing with non-linear processes in terms of dose/response, in which case reliance on TWA as an exposure metric and certain other traditional assumptions may not be appropriate. Following up on this point, some wondered whether epidemiological studies could provide a means to test exposure metrics. Dr. Loomis thought that this was unlikely. Another discussant noted that this approach would be difficult for retrospective studies, but for prospective studies, epidemiology might be able to provide useful information.

In seeking guidance on study design and evaluation, Dr. Chris Portier of NIEHS asked what exposure metric is best to use for retrospective studies (a case-control study one year after diagnosis): historical reconstruction of the fields, contemporary spot measurements, contemporary 24-hour measurements, or wire-code category?

Dr. Olsen preferred historical reconstruction, but recognized the difficulty of acquiring adequate data for real-world cases.

Loomis responded that, limited to those choices, and without a definition of the research question, he would choose field reconstruction. However, if it were permissible in this scenario to do a second 24-hour measurement in the house, then he would select that option. He would not use wire-code category.

One commenter cautioned against focusing exclusively on studies that show effects. For example, two studies did find a disease risk associated with reconstructed historical field exposures to transmission lines, but three other studies using reconstruction have not.

In response to a question about the importance of 24-h variability, Loomis responded that he could not think of any other human carcinogens for which this would be important; he therefore assumed that daily variability was not a factor compared to long-term exposure level.

In a discussion of the possibility that TWA was not the appropriate measure of exposure, Loomis responded that TWA ought to be a good exposure metric for most disease processes that involve linear kinetics and for things that respond to long-term exposures rather than to isolated peaks. TWA may not do a very good job of capturing peak exposures.

He continued, to note that it could be that magnetic fields involve not only linear kinetics, or it could be that the instantaneous peak exposures are important. So if either of those things is true, then the TWA might not be such a good exposure measure after all. On the other hand, we do not have any evidence to lead us to think that that is the case.

In response to comments about public exposure to high fields from Japanese transmission lines, Dr. Isaka, the session chair, stated that an epidemiological study was underway, but the data had not yet been made public.

Submitted written comments on this topic are found in Appendix C.