PRESENTATION

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*The presenter for this topic (**Field Parameters**) was also the synopsis preparer. The presentation closely followed the synopsis material.*

SUMMARY OF DISCUSSION

Several issues came under discussion following the presentation on instrumentation by Dr. Gary Johnson. The summary below was prepared from the symposium transcript.

The presenter, Dr. Gary Johnson, indicated that engineering has developed increasingly sophisticated instrumentation to measure a wide variety of parameters. Key improvements identified by Johnson are frequency response and increased data-collection capability. However, engineering continues to need guidance from biology on what specific parameter(s) (other than TWA) to measure that are relevant to biological or health-related effects. There was no suggestion by the discussants that any important field parameter had been missed in selecting what to measure or not to measure in previous studies.

One focus of discussion compared earlier instruments and measurement techniques (e.g., portable meters used in the initial Denver studies) with later ones. Some surprise was expressed that the early study in Denver, using fairly uncertain and less precise measurements, yielded the same results (risk ratios) as later studies with more precise field instruments and measurement protocols. The table below of estimated uncertainties in these early measurements was generated by Luciano Zaffanella to explain this apparent ambiguity. The table suggests that the uncertainties in early measurements with less sophisticated instruments were still less than or comparable to uncertainties in actual exposures as determined from the 1000-person Study (RAPID Project #6). Thus, even early imprecise measurements of magnetic field were still sufficient to characterize highly variable exposures. Consequently, it was noted that, although meters are improved, variability in exposures and uncertainty in measurements make it difficult to establish a link between exposure and health outcome in epidemiologic studies.

Table 3-1: Estimated sources of uncertainties in magnetic-field assessment (example: Denver Savitz epidemiological study)

Source of Uncertainty	Standard Error (per unit)	Variance
Instrument accuracy	0.05	0.0025
Instrument property	0.05	0.0025
Where to measure	0.40	0.16
Variability within one day	0.20	0.04
Variability day-to-day	0.10	0.01
Historical extrapolation	0.30	0.09
Other	0.20	0.04
Total	0.55	0.35
Variability of exposure data in subject population	1.2	1.44

Source: Luciano Zaffanella, 1998

Discussants emphasized the need to ensure that EMF meters do not experience interference from fields other than the one being measured. Johnson indicated that the coils in magnetic-field meters are now electrostatically shielded to prevent interference from strong electric fields. However, interference can still be of concern. One PE meter that recorded the percent-of-time high-frequency transients present was found to respond to handheld communication transmitters, thus complicating the interpretation of measurements with the unit.

Waveform-capture instrumentation (the most recent development) allows for a range of parameters to be measured, but is larger in size and more costly than simple field meters that display and/or record the magnetic-field magnitude. A consensus seemed to be that waveform capture is the instrument of choice to characterize fields fully in an area where the parameters of interest are not yet determined. However, where cost and size are considerations, such as in monitoring PE for a large group, simple rms-resultant field meters are sufficient. Johnson pointed out that a flat-response meter characterizes the field, but that, if induced current is the parameter of interest, a meter with a linear frequency response might be more appropriate.

Some consideration was given to the problem of variability in exposure according to areas of the body. For instance, it was pointed out that there is an order of magnitude difference between retina and skin exposure for a subject lying under an operating electric blanket; a PE meter worn at the waist will not necessarily pick up fields from appliances with localized fields. Johnson indicated that if the need to differentiate exposures at different locations is identified, the technology exists to equip human subjects with appropriate meters.

Discussion also touched on possible needs for modified or new instrumentation. Discussants asked whether we are missing measurements in the time periods associated with biological response times and processes. In particular, it may be of interest to look at field variability in the 60-Hz field over periods of a few cycles up to 0.5 seconds. A sampling rate of 0.5 seconds was used for the PE meter in the 1000-Person study (RAPID Project #6). Waveform-capture systems could be used to look at the field variability over periods of time from a few tenths of a second down to a few cycles.

Some noted that it may be desirable to characterize fields with frequencies lower than 40 Hz, and thus below the range of some of the instruments. Depending on the sampling frequency, waveform-capture instruments can characterize fields down to very low frequencies. However, in using simpler meters with low frequency response, care must be taken to avoid artifacts from motion of the sensor in the static field of the earth due to a shaky hand, vibration, or motion relative to the earth. Johnson concluded that, as with other instrumentation needs, there are no engineering limits imposed on measuring EMF fields in the frequency range of interest, but that the whole measurement process must be addressed in establishing a protocol for a particular study.

The difficulties of performing PE measurements of electric field were discussed briefly, with the caveat that absolute measurements linked to the unperturbed electric field were not possible, but that some confidence could be placed in comparing exposures on a relative basis.

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