Journal of Bioelectricity

ISSN: 0730-823X (Print) (Online) Journal homepage: informahealthcare.com/journals/iebm18

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To cite this article: W. C. Parkinson (1985) Letter: Comments on Variables in Research Involving Electromagnetic Bioeffects, Journal of Bioelectricity, 4:2, 585-587, DOI: 10.3109/15368378509033273

To link to this article: https://doi.org/10.3109/15368378509033273

Published online: 07 Jul 2009.

JOURNAL OF BIOELECTRICITY, 4(2), 585-587 (1985)

LETTER

COMMENTS ON VARIABLES IN RESEARCH INVOLVING ELECTROMAGNETIC BIOEFFECTS

Rather belatedly the letter to the editor by Robert O. Becker has come to my attention (1). In it he invites further discussion of the concepts that he enunciates, and this letter is in response to that invitation.

Having only recently turned my attention to problems in biophysics after having spent many years in nuclear physics research, I have been frequently surprised by the lack of precise specifications of experimental arrangements in biomedical research. It is generally not possible for someone in another laboratory to duplicate the conditions of an experiment. This is unfortunate for it is such duplication that provides the basis for progress; in the physical sciences, for example, it has prevented the propagation of hoaxes.

Becker suggests that two things are required for optimum advancement of research in the area of biological effects of nonionizing electromagnetic fields: a logical construct to explain the effects, and a recognition of the large number of variables inherent in such research. As to the first, I suggest that such a construct can come only from carefully controlled well-defined experiments each of which is designed to test a hypothesis. The physical sciences have been built on an orderly succession of such experiments. This leads in a natural way to his second point. True, there are a large number of variables, and they must be controlled. But equally important the nature of the measurement must be understood. An example will illustrate my point. Of the many published papers describing experiments using DC, AC and pulsed electric and magnetic fields it is clear that very few

 0730-823X/85/0402-0585$3.50/0

of the authors understand the physics associated with the electric and magnetic field configurations commonly used. The problem has been addressed in a recent paper (2) where it is pointed out that magnetic fields per se are usually of little importance at normal biological temperatures. Further, a changing magnetic field is of interest only in that it induces an electric field, and the electric field does not necessarily bear a simple relation to the changing magnetic field.

Becker himself has given us a good example of the kind of misinformation that traps non-physical scientists. Magnetic fields are produced by electric currents. It has been known for well over 50 years that the magnetic field of a permanent magnet is produced by the electric currents associated with the motion of electrons in atoms. Further, there is no induced electric field associated with a steady or DC current, only with a changing current.

It is the nature of research in the physical sciences to challenge the accuracy of published results which go against well-defined physical principles. The challenge involves independently repeating the experiment and searching for reasons based on accepted scientific principles as to whether the published results make sense. As a physicist it is precisely this lack of challenge in the biomedical literature that causes me concern for the validity of generally accepted results.

There is of course a difference between an epidemiological study and research that leads to understanding why the effect occurs. A case in point is the paper by Wertheimer and Leeper (3). While their results were confirmed (4), the authors pointed out that the epidemiological method used does not permit the conclusion that there is a causality between the high tension wires and the appearance of tumors in children. It does suggest, however, the need for further research on the interaction between 60 Hz fields and mammalian systems. An excellent review on this subject is that of Bridges and Preache (5) in which they suggest that, if I may paraphrase their concluding observations, in many experiments there is a misunderstanding of how

electromagnetic fields interact with biological systems and further there is often a lack of appreciation of ways to conduct a definitive experiment.

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