HEALTH ASPECTS OF ENVIRONMENTAL ELECTROMAGNETISM

Andrew A. Marino, Ph.D., J.D.
Department of Orthopaedic Surgery
Louisiana State University Medical Center
P.O. Box 33932
Shreveport, LA 71130-3932

Consideration of the role of electrical forces in biological systems began with a move away from a purely chemical view of life, and towards one that emphasized electron dynamics and the electrical properties of biological tissue. Studies of the physiological role of the body's intrinsic electrical signals led to experiments on the therapeutic effects of artificial signals. A variety of devices are now available for treating bone nonunions, and intense efforts have begun to exploit other potential applications of electromagnetic therapy. These efforts include the areas of soft tissue growth, wound healing, infection control, and the diagnosis and treatment of cancer. Preceding this developmental period of bioelectricity, electricity itself had become firmly established in society. There was a proliferation of transmitter towers, high-voltage lines, and the innumerable devices they serve, and it resulted in environmental levels of electromagnetic energy comparable to those being studied in the laboratory and applied clinically. The actual extent of the health consequences attendant uncontrolled environmental exposure to electromagnetic energy are presently only dimly perceivable; the existence of such consequences is no longer in serious doubt.

The first transmission line was built in 1882, and five years later the first transmitter-receiver system was successfully operated. From this beginning came our modern electrical power and communications systems. Traditional engineering concepts, at least in the United States, sanctioned only two electrical bioeffects, namely heating and shock. They became the sole design criteria with regard to possible side-effects. The rule developed that electromagnetic energy could be beamed through the environment or directed along high-voltage lines at any intensity level up to that which produced heating or shock.

It is convenient to divide environmental electromagnetic energy into the power and broadcast regions. The power system operates at a single frequency of 60 hertz and includes all transmission lines and line-powered devices. The Broadcast frequencies are characterized by wireless energy transmission and include radio, TV, radar, and microwave ovens. The traditionally-recognized electrical bioeffects can occur only above 10,000 microwatts (to be read "microwatts per square centimeter") or, at the power frequency, if one touches an energized wire. Thus, in all American jurisdictions and in the military, electrical sources are considered safe with regard to side-effects if these precautions are followed.

In the USSR regulation of environmental electromagnetic energy followed a much different course. Soviet scientific literature contains many reports of biological effects below 10,000 microwatts, and, many reports of biological effects due to power-frequency electric and magnetic fields—effects associated with merely being in the *vicinity* of high-voltage lines. Based on these studies, national exposure standards were adopted; the standard at broadcast frequencies is 1 microwatt.

What are some typical levels of environmental electromagnetic energy in the United States? Mount Wilson is a high point where many commercial broadcast installations have been built to serve Los Angeles. A level of 1,000 microwatts was measured by the Environmental Protection Agency in the Mount Wilson post office. There is a similar transmitter concentration near most other U.S. urban

areas. The elevation necessary for efficient energy transmission is frequently attained by mounting transmitters on tall buildings. This can produce high levels in nearby buildings. About 2 million Americans are exposed daily to environmental electromagnetic energy above the USSR safety levels.

There have been many studies—mostly Soviet—describing non-thermal biological effects due to broadcast-frequency radiation (Figure 1). Many studies have also shown the existence of biological effects of electrical and magnetic fields such as arise from the electrical power system. Several such studies are shown in relation to the fields produced by a typical high-voltage line (Figure 2). Beischer, at the Naval Aerospace Medical Research Laboratory, found that one day's exposure to a 1-gauss magnetic field caused elevated serum triglyceride levels in humans. We found that electric fields of 3,500–15,000 volts per meter altered the growth rate and mortality of mice. Wertheimer, of the University of Colorado, found an association between child cancer and transmission lines. These studies used fields which exist within the first 100 feet of a high-voltage line. The remaining five studies used field intensities which exist at the indicated distances from a typical 765 kV line. Lott, of North Texas State University, found altered EEGs in rats after 90 minutes' exposure. Wever, of the Max Planck Institute, found that weak electric fields altered human circadian rhythms after several weeks. Noval, of Temple University, found that 30 days' exposure to an electric field equivalent to that at 2,000 feet from the line produced stunted growth in rats. There are many other similar reports of biological effects.

Electromagnetic energy does not act only on a single target organ. There is a clear pattern in the literature indicating that electromagnetic energy is a biological stressor—that it places a nonspecific physiological demand on the exposed organism. When the organism's capacity to resist has been exceeded, a clinical sign—an effect—is manifested whose nature depends in part on the predisposition of the exposed subject. It follows, therefore that the exposure of a substantial part of the population in an uncontrolled, random, and essentially involuntary manner amounts to a significant public-health (and ethical) problem.

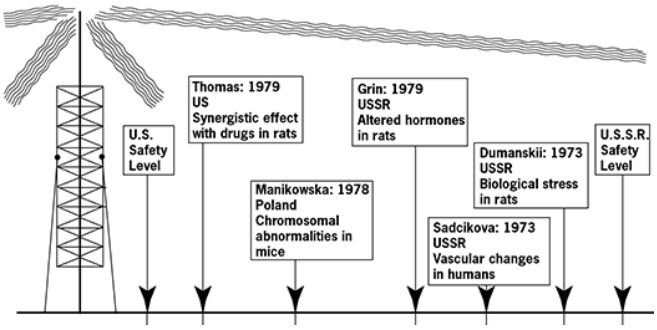

FIGURE 1: Environmental Levels of Electromagnetic Radiation in Relation to Observed Biological Effects

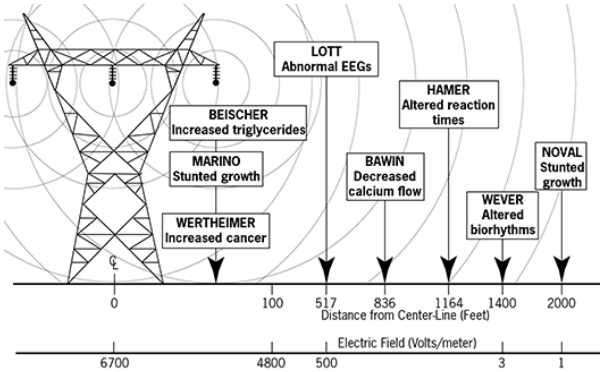

FIGURE 2: Power Frequency Fields of a 765 kV Line in Relation to Observed Biological Effects