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IN THE BEST OF ALL POSSIBLE WORLDS

A Medical Perspective on Electromagnetic Safety and Health

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Note to the Reader. The author wrote this article on a general approach to occupational health and safety assessments concerning electromagnetic radiation in 1994. The article addresses issues of general approach to electromagnetic environmental health assessment and medical moral values, and recommended changes in IEEE and other health guideline setting procedures. Since the article was outside the assigned research area of the author, and did not represent Air Force policy, the article was written using personal resources only. The article was cleared by Air Force officials for public release as a private work in 1995, and was submitted to the IEEE Technology and Society Magazine. The journal editor asked that the article be placed in the broader context of ongoing radiation research. The requested revisions were beyond the scope of the effort.

Imagine that in your living room you had one radio for every radio station in your local area. Imagine further that in that same living room you had one television set for every T.V. station in your area. Add to the regular radios a police radio and five or six receiving and broadcasting cellular phones. If you had to listen to all these transmissions for long, I suspect that you would get very tired and distracted. It strikes me as amazing to think that living cells in your body have to listen to this every day. Your cells do not literally listen, but they listen in the sense of receiving and partially absorbing the electrical and magnetic fields associated with these radio, television and phone transmissions. My research asks "how can your cells constantly receive the cacophony of electric and magnetic signals that modern society and technology propagate every minute of every day and not get tired and distracted?" Or, perhaps, the cells do "get tired" and distracted and manifest these responses as disease.

I am a medical doctor who specializes in the study of radiation effects on human beings. The radiation I am primarily concerned with is the kind of radiation emitted by radio stations, television broadcast stations, radar systems, cellular telephones and power lines.

In this article, I emphasize not the science of radiation biology, but the human values by which that science is applied in our society. I believe a scientist loses objectivity when becoming a public advocate of a particular scientific point of view. On the other hand, all scientific work and application is done in the context of values. I believe we must work hard together to be clear about these values, and, we should strive to act on the highest moral level

The opinions expressed herein are those of the author and do not reflect the policies of the United States Air Force.

possible.

My personal attitudes or values are those I associate with the old fashioned family or country doctor. People and their well-being come first. Inanimate things, including money, can not compare in value to real living people. Faced with more sick people than I can handle, I am inclined to treat the most sick ones first. If I have to choose among those equally sick, I tend to worry foremost about the children and pregnant women, because these seem to have so much more to lose compared to the others. These simple, personal values are those I bring to issues of electromagnetic exposure and human health.

There is no federal law limiting how much radiation can be put into your living room. However, the Institute for Electronics and Electrical Engineering (IEEE) has a committee called the C95 committee that has established an exposure guideline. The guideline says that at those electromagnetic wave frequencies (frequency equals wave cycles per second) that are most absorbed in the body, the electromagnetic fields surrounding a person should not exceed 1 milliwatt per square centimeter when that power is averaged over a continuous 6 minute period. Higher values are permitted at less absorbed frequencies. I am about 150 centimeters tall and 40 centimeters wide for a total of 6000 square centimeters. That means that in a 1 milliwatt per square centimeter field, my body is receiving 6 watts from the front and 6 watts from the back for a total of 12 watts. That is about the energy in a good night light: not a lot of power, but a 15 watt light bulb is hot when you hold it.

What does the body do with this received energy? Some scientists say all the absorbed energy is simply turned into heat. Spread over a large body, 12-15 watts is not much of a heat load. Other scientists hold that the electromagnetic fields interact with charged molecules in our body and cause direct effects independent of heating. I am neither a "thermalist", believing effects of electromagnetic radiation are mediated through temperature rises in the body, nor a "nonthermalist". As a person with a family doctor mentality, what I want to know most is do these absorbed fields cause disease? Does my patient who works at a T.V. broadcasting station, or my patient who uses a microwave heat sealer all day at work, or my child patient who lives near an electromagnetic power distribution station have an increased risk of lung cancer, stomach cancer, colon cancer, leukemia, lymphoma, heart disease, lupus, kidney disease, or endocrine dysfunction? And, in my mothers to be, need I be concerned with birth abnormalities in their offspring?

There is little in the medical literature that addresses the questions I pose from the point of view of a simple family doctor. There are indications of leukemia and brain cancer in certain exposed groups, but the scientists who work in this area of research provide no consensus on whether or not radiation actually produces these diseases. And, the IEEE C95 committee has promulgated its guideline of 1 milliwatt per square centimeter without directly referring to whether disease rates are increased or not by exposure to radiation.

In the context of my value system, I believe the first thing one should want to know when exposing a large number of people to a physical force or energy is whether or not that force or energy immediately injures those exposed and whether or not the force or energy influences the subsequent development of disease in those exposed. My study of the radiation literature indicates that it has been fairly well established that there is no serious immediately detectable injury from exposure to electromagnetic radiation when one is exposed within the IEEE C95 guideline. On the other hand, I am alarmed to report that little is known, and nothing agreed, about the relationship of electromagnetic energy and disease. This is a profoundly disappointing state of affairs from the point of view of my system of values.

You will frequently hear radiation experts say that there is no conclusive evidence of an association between electromagnetic radiation exposure and cancer. I tend to agree with such experts. However, their comment begs the important point. If I work in an electromagnetic field at 1 milliwatt per square centimeter 40 hours per week for 5 years, an exposure permitted by the IEEE C95 guideline, does my chance of getting leukemia go up? That is the kind of central, critical question to which I feel we should collectively know the answer. If the job pays really well and a medical doctor tells me that leukemia goes up from 1 in 1000 workers to 2 in 1000 workers in a 1 milliwatt per square centimeter field, I might consider working the job. On the other hand, if my chances are that 3 in every 100 of the radiation work force will get leukemia, I might look elsewhere for work. My concern and real worry is that such numbers on disease risk are simply not available today!

While I might not personally be too concerned about a change in my risk of leukemia from 1 in 1000 to 2 in 1000, from the national point of view that represents a large increase in leukemia cases. Roughly, it amounts to 3500 additional cases per year. I am the kind of person who would like to avoid those deaths if they are, in fact, occurring.

On what basis would the C95 committee propose a 1 milliwatt per square centimeter guideline having little or no data on disease? I am not a member of the committee but have some sense of the thinking behind the guideline through studying the scientific literature on the subject. First, there is no immediate injury from permitted exposures. Also, if exposure limits are set too low, some societal and technology efforts will have to be modified and sometimes at great cost. Some vital social services (health, defense for example) could be compromised because of cost. People could lose jobs, and business owners could lose profits. As a physician I know that job loss is associated with illness. People get sick when they are out of work. Sick from worry and, I think, sick from the emotional feeling that they are not good enough to be given something to do by our society. So I worry about job loss from the medical point of view. I imagine that the IEEE C95 committee was weighing their impressions of no immediate harm, and controversial cancer studies, with a concern with job loss and technology limitation. Nonetheless, I am medically concerned about the nonavailability of reliable disease rate data. In my opinion, the IEEE C95 committee should exhort the associated scientific community to direct its energies toward getting this disease rate data soon. We may be making a bargain with technological convenience, employment and profit that we will later regret.

An additional option available to the IEEE C95 committee is to recommend that radiation exposure be kept as low as possible within financial and employment constraints, since needed disease rate data is presently not available. This policy has been used in the ionizing radiation industry (X-rays, neutron radiation, alpha particles etc.) and can work if humanely applied. I think it should be attempted. There may be some labor-management quarrels, but that is not the worst to be feared.

Some have said that the guideline setting process in the United States suffers from conflict of interest. Dr Nicholas Steneck has written a carefully studied book on the subject called *The Microwave Debate*, and concluded that the guideline has been disproportionately influenced by those who produce radiation and radiating devices, and too little influenced by people not involved in those activities. Paul Brodeur, journalist for the New Yorker magazine, has also made this point forcefully and with great concern for the association between electromagnetism and disease. A medical scientist employee of a business or agency that produces electromagnetic energy such as power or radar systems will certainly be concerned about the health of his or her colleagues and individuals in the general population who might be exposed to emanations. However, that scientist might also receive pressures acting against safety stemming from market forces or mission deadlines and other requirements. University professors needing grant money to continue their research might be subconsciously biased toward producing research results that create a safety concern to stimulate further funding. It makes one uncomfortable to think about conflict of interest in science, and I do not know how to measure the degree to which some scientists may fail to be independent and objective in their research on sensitive issues like electromagnetic radiation. Nonetheless, I think conflict of interest in science is an issue we must think carefully about. I have come to believe that it is very important for our society to treasure and preserve the role of the curmudgeonly scientist who has sufficient tenure and other security to seek knowledge for knowledge's sake unbothered by granting agencies, and policies of institutional directors.

Hopefully in the next 10-20 years some disease rate data will become available. I advise the reader to carefully consider any disease rate data with which you are presented. One thing scientists often report is that they have found "no difference" between the group that was exposed to radiation in some special activity such as their employment, and those who only received non-occupational radiation. I am sure you have heard this claim. There is no way that scientists could have found "no difference" between their exposed and non-exposed groups if for no other reason than that the exposed and non-exposed groups were a different set of people, or the same set of people observed at different times, and thus at different ages. If there truly is "no difference" a real fraud has been perpetrated! What the scientists mean is that the difference in disease rates that they observed could be explained by chance. This relates to the fact that all 20 year smokers do not get lung cancer. Disease is a sometimes thing, . . . a probabilistic thing. What the scientist means is “no statistically significant difference.”

The issue of “statistically significant difference” is also not of much importance. What is important is people and disease rates in people. Disease rate estimation performed on 100 people is very much poorer than an estimation performed using 1000 or 10,000 people (or research animals). What the research scientist should tell you is that he or she has 99% confidence that the disease increment due to exposure is less than 1 in 1000 or some other number. This relates to the “error in measurement” you see reported for the various political polls that are provided frequently in the news today. Unfortunately, this method of reporting is rarely used in radiation studies. Were it used the public would be better informed of the very great uncertainty associated with the question of electromagnetic field exposures and human disease.

I mentioned above the difference between the “thermalists” and the “nonthermalists”. Again, the “thermalists” believe that all effects of electromagnetic radiation are mediated by temperature rises in the body. The “nonthermalists” believe that there may be direct effects of electromagnetic fields. The central point I would like to make is that it is dangerous to say a person is safe based upon some theory you have. Theory can be used to suggest the possibility of a danger, but I advise that theory never be used to suggest safety.

For example, the fluctuations in body temperature normally occurring with activity can be as much as a half a degree Fahrenheit or more. One can argue that since electromagnetic exposure does not cause such a large temperature change it must be safe. Such an argument would be to assert safety based on theory. The human body is far too complex to be reliably explained by simple theories available today particularly when it comes to human disease. When one’s temperature naturally rises or falls this is in response to physiological changes in the body. Temperature changes caused by electromagnetic energy do not correlate with physiological needs and, therefore, could have long term health consequences. The only sure proof of safety is data. Do not accept any other assurances.

Unfortunately, theory has been used to assert safety of some electromagnetic systems. The literature contains data on continuous wave systems and pulsed electromagnetic systems. Continuous wave systems are like AM (amplitude modulated) radio waves. They are always “on”. Examples of pulsed systems are radar systems used for aircraft detection and navigation. Here the radiation is intermittently “on”. Common wisdom today states that continuous wave and pulsed systems are not different when their power is the same averaged over six minute intervals.

There are radiation sources outside these two classes. One such source is the phased array radar. This is a pulsed system, but with this system the pulses are allowed to overlap (thus the term “phased”). Phased array systems have been used for several years now and I can find no animal research or human research relating to them. This is a case where scientists have used their belief (theory) that overlapping pulses (“phasing”) introduces nothing new and thus they feel they can use the usual IEEE C95 guideline that is based on common continuous wave or pulsed systems. This is an important example of using theory when data is far better.

Phased systems are different from continuous wave or pulsed systems. When your body is in a continuous wave electromagnetic field, the molecules of your body undergo a rocking or oscillatory motion something like that of a boat on a constantly rolling sea. A pulsed system will suddenly jolt molecules into motion and then cease the stimulus as if you were in a boat on a very calm lake and a single set of evenly spaced waves passes you for a while due to some distant disturbance of the surface such as a passing boat. A phased array field is like being on a lake surrounded by numerous boats. Wave systems are being created by each of the boats and you are being hit by new wave systems at the same time that you are being rocked by multiple wave systems that have already reached your boat’s hull.

Paul Brodeur has written that the community living around the phased array radar system operating on Cape Code (PAVE PAWS system) has experienced higher cancer rates than the State of Massachusetts as a whole. He reports that the state Department of Public Health was unable to tell whether the disease increment was due to radiation, or due to chemical dumping in the region. He writes that in 1985 the residents east of PAVE PAWS had an overall 17% higher rate of cancer than other residents in Massachusetts.

A 17% increase in overall cancer rates is a large increase in human terms. However, many scientists and epidemiologists do not consider this a large increase. This is because present epidemiological methods are weak instruments in the sense that they only reliably register disease increases of 100% or more. But the fact that a lesser increase is difficult to evaluate does not mean it is not important to humans. A 17% increase in overall cancer rates is a terrible burden in suffering and pain and in economic loss as well. Phased array animal experiments examining cancer development and further human studies are needed.

I believe that in the best of all worlds the general population would not be exposed to radiation whose effects on disease are unknown. With respect to electromagnetic radiation the genie is out of the bottle and what I would prefer not happen, has happened, and is happening. I would prefer a new radiation be introduced only after adequate study of disease first in animals, then in controlled, monitored human populations. It will take a science and technology historian to determine why this gradualist pattern was not followed with electromagnetism. Parenthetically, I also recommend this gradualist approach for the introduction of chemicals.

We can catch up in the matter of electromagnetic radiation if scientists begin to study disease in animals and if money is spent to study various test populations. Of great interest to me are those people who use cellular telephones. Their phones are registered and the rate of use is charged. After studying the pattern of phone sharing between individuals, a radiation exposure dose can be estimated for the owner and we can see whether the radiation has had an effect on disease by tracking hospital admissions or death certificates. This is just one example of what can be done.

With the obvious problems in our society such as AIDS and breast cancer is it worth while investing resources in something like electromagnetic radiation health research? After all, there is no apparent immediate harm and the associated industries actually contribute substantially to society. Nonetheless, a targeted prudent investment seems wise to me with an emphasis on preserving human well-being. I would not control exposures so strictly that vital social services are compromised or industries laid off employees and thus induced distress and illness. On the other hand, I would ask a good faith effort in achieving as low exposures rates as are possible within reasonable financial constraints. Also, I would fund targeted studies using animal subjects and human groups living or working in high radiation settings or heavy cellular phone users, emphasizing disease causation.

I am not arguing here that electromagnetic fields are or are not harmful. I am arguing that the manner by which we expose ourselves and our children to these fields in the absence of disease rate data reflects profoundly on how we value human life. Population exposure to a radiation or chemical in the absence of good data addressing exposure effects on disease rates, and in the absence of vigorous organized efforts to obtain such data, and further, in the absence of attempts to limit exposures as far as practicable, all point, in my mind, to a less than adequate concern for human well-being.

People and their well-being should be our focus. For this researcher with family doctor values, technology and business only exist to serve people by providing useful work, goods and services. The measure of our humanity is the degree to which we care for the weakest among us. I urge acceptance of the ideal that there should be no unmonitored occupational or environmental exposures whose associated disease rates are unknown.