Cellphones, Radars, and Health

Exposure standards for electromagnetic radiation do not adequately address current realities

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Ten years ago, the only source of electromagnetic waves most of us encountered with any regularity was the microwave oven. Today, we hold cellphones against our heads, walk past cellphone base stations in cities, cradle wireless personal digital assistants in our hands, and clip text-messaging devices and pagers to our belts. We are even starting to connect our computers, cellphones, and peripherals with various wireless schemes.

Yet amid this increasingly dense "electro-smog," we are still using the same outdated and inadequate standards to calculate our exposure to radio and microwaves.

These standards are based on conclusions drawn from many experiments in the decades after World War II. Few of those studies, however, were designed to study low-level, localized biological effects not linked to heat. But electromagnetic theory and decades of experiments clearly indicate that the electromagnetic fields of radio and microwaves can also affect cells mechanically, without producing significant amounts of heat.

These standards, formulated in the late 1980s by the American National Standards Institute, the IEEE, and others, are based on the assumption that if nonionizing radiation affects living cells and tissue, it must do so by heating the tissue. The standards, known as IEEE/ANSI C95.1-1991, also calculate exposure over a person's entire body, rather than specific organs or the head and cheek (in the case of, say, exposure to a cellphone). These heat-based, whole-body standards are used to calculate maximum exposures permissible for people who work around radiation, such as soldiers or sailors who work around radars, or technicians who work on cellphone base stations. The standards are also used in the design of antenna towers, to limit what passers-by are exposed to.

The possible link between radio and microwaves, which are forms of nonionizing radiation, and human health remains one of the most complex and controversial subjects in all of biophysics. I couldn't possibly review the vast literature on this topic in a short magazine article. Nevertheless, there is growing scientific evidence that prolonged exposure to some kinds of radio waves does cause at least low-level changes in the movements, workings, and possibly structure of molecules and cells in living tissue. This evidence raises the possibility of health effects- ones against which our current exposure standards are not adequately protecting us.

The relevant physics starts with the fact that all living things absorb and scatter electromagnetic waves. As they do so, they convert, on a molecular level, the electromagnetic fields of the waves into mechanical forces. Our bodies are full of ions- in nerve endings, in cell nuclei, in muscles. In addition, the body's most common molecules, including water, have an irregular distribution of charge, so that they are influenced by an electric field (or a magnetic field if the ions or molecules are moving).

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Thus electromagnetic fields can physically move, reorient, or even alter molecules or ions- or their distributions- in the body. They can affect the rate of chemical reactions and the ability of molecules to pass through a membrane. In addition, if charge acceleration occurs, perhaps as a result of radar pulses with extremely fast rise times, the tissue itself may reradiate or scatter this energy inside the human body, complicating and intensifying the radiation's effects.

Possible links between molecular or cellular effects and human health are controversial, but a number of experts are focusing their attention on the blood-brain barrier. This physiological complex, which includes as its primary line of defense the cellular lining of capillaries in the brain, shields the brain and central nervous system from foreign and harmful substances. The barrier also seems to control the concentrations of ions in cerebral tissue.

Radiation-caused movements or alterations of ions and molecules can be particularly vigorous when they are caused by electromagnetic pulses that are sharp and intense. A case in point is the Air Force's early-warning radar, the Pave Paws system in Falmouth, Mass. In a 1994 paper, Richard Albanese, a researcher at Brooks Air Force Base (San Antonio, Texas), reported that ultrashort electromagnetic pulses, of the sort emitted by Pave Paws and similar phased-array radars, may cause mechanical damage to tissue through what is called precursor radiation. The term describes the secondary bursts of radiation that occur inside living tissue when the tissue is hit by the radar pulses. This precursor radiation is a potential secondary source of tissue damage- and it is ignored in current exposure standards.

"Until the issue of tissue damage mechanisms associated [with] pulses that cause precursors is fully studied," Albanese wrote in his 1994 publication, "the author recommends zero human exposure to such unique precursor and gendering pulses."

Another study made worldwide headlines little over a month ago, on 20 June. A team at Finland's Radiation and Nuclear Safety Authority reported its discovery that mobile-phone- type radiation has an effect on hundreds of proteins found in lab-grown cells taken from human blood vessels. The leader of the study, Dariusz Leszczynski, refused to cite the results as proof of a connection to human health. But he did hypothesize that one of the molecules affected, the so-called stress protein, hsp27, might be the key that opened gaps in the blood-brain barrier, letting harmful or at least foreign entities into the brain.

More supporting results come from Henry Lai, in the department of bioengineering at the University of Washington in Seattle. Lai has documented biological effects caused by rates of radiation absorption at levels down to 0.001 W/kg of irradiated tissue and at power densities in the microwatt-per-centimeter range. These levels are significantly smaller than those permitted under current standards. The effects include damage to DNA in cells, increases in calcium efflux in cells, and decreases in cell division after exposure.

We have more than enough solid experimental evidence to question the validity of formulating standards that take only thermal effects into account. It would be irresponsible to continue using standards based on average, whole-body radiation exposures to laboratory animals, more especially because a great deal of tissue damage has been done long before a laboratory animal shows behavior changes or dies from thermal effects.

What next? We must revise our safety standards and set conservative new ones using all of the available results and information- not just the data that fits previously held assumptions. The telecommunications industry, which is in deep denial, needs to face reality. Professional groups, such as the IEEE's Standards Association, must work with the U.S. government and international agencies to ensure that studies of long-term, low-level, nonthermal bioeffects are put in place. The U.S. Congress needs to recognize the urgency of these studies and not just defer to the telecommunications industry when creating or modifying legislation.

For many of us, cell telephones are an indispensable part of our lives and lifestyles. Cellphone towers now line our highways and dot our communities. There is no turning back now. But we have a right to expect standards that will truly protect our health and well-being. ●