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The Role of Electromagnetic Pollution in Cancer Promotion

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Abstract

Exposure to non-ionizing electromagnetic frequencies (EMF) that include extremely low frequency electric and magnetic fields, intermediate frequencies commonly referred to as dirty electricity, and both radio frequency and microwave wave radiation has been increasing. Epidemiological studies document an increased risk of cancer incidence and cancer deaths associated with cell phone use, Wi-Fi exposure, as well as living near broadcast antennas, cell phone antennas and power lines. Electromagnetic pollution at levels well below international guidelines has been shown to cause cancers (*in vivo* studies) and several plausible mechanisms (*in vitro* studies) have been identified that include, but are not limited to oxidative stress, altered calcium flux, and increased membrane permeability. Time is long overdue for the World Health Organization and governing bodies to establish guidelines that truly protect public health. Also, time it is for the medical community to incorporate strategies to deal with the harmful effects of electromagnetic pollution, as part of their medical protocol, and to teach about this concept at medical schools since our exposure is likely to continue to increase.

Introduction

Our exposure to electromagnetic pollution in the form of radio frequency (RF) and microwave (MW) radiation (MHz to GHz frequencies) has been accelerating with our growing reliance on wireless technology. Cell phones and their communication antennas; Wi-Fi routers; Wi-Fi enabled computers, tablets, and ipods; smart meters, smart appliances and smart homes; wireless computer games; wireless baby monitors; and–more recently–light bulbs that can be turned on and off with a cell phone; diapers that send out a wireless alert when they are soiled; and soothers with embeded thermometers that enable a parent to monitor their infant's temperature remotely using microwave frequencies are just some of the devices that are being developed for our convenience with no regard for health effects. Our exposure to intermediate frequencies (IF) at the lower part of the RF electromagnetic spectrum (kHz frequencies) have also been increasing with our use of electronic technology like computers, TVs, energy efficient light bulbs, solar and wind power. Add these two types of electromagnetic pollutants to extremely low frequency (ELF) electromagnetic fields (EMF) generated by electricity and electric devices and we find ourselves swimming in a sea of electromagnetic soup. Few places exist that are free of these anthropogenic electromagnetic frequencies. The International Agency for Research on Cancer (IARC), a branch of the World Health Organization (WHO), classified RF radiation and ELF EMF as "possibly carcinogenic" [1]. Since that classification additional research confirms the *possible* and, some would say, *probable* carcinogenicity of these types of exposures [2].

Non-ionizing radiation (NIR), in contrast to ionizing X-rays, does not have enough energy to break chemical bonds. It was assumed to be safe provided that it did not heat the body as microwaves are known to heat tissue, hence the use of microwave ovens to heat food. Consequently, the international guidelines for RFR recommended by International Commission on Non-Ionizing Radiation Protection [3] and accepted by the WHO and many governing bodies around the world, protect only against a heating effect. A few governments have established guidelines that are orders of magnitude lower than thermal guidelines and are based on biological malfunctions in the presence of much lower EM intensities. Thousands of peer-reviewed publications document the harmful biological effects of NIR at levels well below thermal guidelines [4]. The biological consequences of NIR exposure go well beyond cancers as they adversely affect reproduction and contribute to symptoms of electro hypersensitivity [5] @). The evidence that NIR is carcinogenic is based on a combination of epidemiological, *in vivo* and *in vitro* studies and covers the range from ELF EMF to MW radiation.

ELF EMF – Childhood Cancers & Residential Exposure

Children living near power lines and transformers have a greater risk of developing various

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cancers, the most notable of which is leukemia. This was first reported in 1979 in Denver Colorado [6]. The higher the magnetic field exposure the greater is the risk of childhood leukemia [7]. Ground currents that generate high magnetic fields around indoor water pipes, are also associated with childhood leukemia [8,9] reported a peak in childhood leukemia associated with residential electrification that emerged *de novo* in the U.K. in the 1920s and slightly later in the U.S. A 24% increase in leukemia mortality for children between the ages of 2–4 was associated with a 10% increase in homes served by electricity [9,10] documented an epigenetic component and an interaction between DNA repair genes (*XRCC1* Ex9 + 16 A allele) and low frequency magnetic field exposure in childhood acute leukemia. Authors concluded that power frequency electromagnetic fields as low as 0.18μT may inhibit certain DNA repair genes. This supports the epidemiological research that shows magnetic field values between 0.2 to 0.4μT are associated with a doubling of childhood leukemia yet guidelines in many countries allow exposures as high as 200μT for any 24-hour period.

ELF EMF – Adult Cancers & Occupational Exposure

The Bonneville Power Authority in Portland Oregon reviewed the research on the biological effects of ELF EMFs [11]. In their chapter on cancer, they found 212 studies of which 101 (48%) documented adverse biological effects associated with power frequency electromagnetic field exposure. Of the 212 studies, 170 studies dealt with occupational exposure and 78 (46%) reported an increased risk of various types of cancers while 8 studies (5%) showed a beneficial effect. The most common cancers were leukemia (41%), brain cancer (40%) and breast cancer (35%). Parental occupational exposure was also associated with cancer among offspring in 67% of the studies cited (8 out of 12 studies).

In vitro studies clearly document increased growth in estrogen receptor positive breast cancer cells exposed to 1.2μT magnetic field [2,12]. While both melatonin and tamoxifen at therapeutic levels can reduce the growth of these cells, when combined with magnetic field exposure, the beneficial effects of tamoxifen were compromised. This has direct relevance for breast cancer patients taking tamoxifen.

IF – Adult Cancers

There are relatively few studies on cancer at electromagnetic frequencies within the intermediate frequency range (kHz). This type of electromagnetic pollution involves high frequency voltage transients (HFVT) that flow along electrical wires and is commonly called *dirty electricity* [13] reported no significant increase in breast cancer (RR 1.3) but a statistically significant increased Risk Ratio (RR) for thyroid cancer (RR 13.3), malignant melanoma (RR 9.8), and cancer of the uterus (RR 9.2) among teachers in a California school who taught in classrooms where the dirty electricity exceeded 2000 GS units. Dirty electricity is becoming increasingly common. More research is needed in this area.

RFR – Epidemiological Studies

The evidence that cell phone users have a greater risk of developing gliomas, salivary gland tumors, and acoustic neuromas is considerable. Studies document statistically significant increased risk for ipsilateral tumors that become apparent after 10 years of moderate to high cell phone use [14]. For those who started using a cell phone before the age of 20, the risk increases significantly [15]. Women who keep their cell phones in their bras for 10 years or longer have a greater risk of developing multifocal breast cancer near their cell phone [16]. People who live within 500 meters of cell phone base stations [17-19] and within 3.5 km of broadcast antennas [20-23] have a greater risk of developing and dying from various types of tumors.

RFR – In vivo Studies. Two large multimillion dollar studies, conducted by the U.S. Air Force using Wi-Fi frequencies (2.45 GHz) [1] and by the U.S. National Toxicology Program using cell phone frequencies [24] documented increased cancers for mice/rats exposed to microwave radiation under carefully controlled conditions. In the Chou study [24], metastatic tumors increased 100% and primary tumors 260% within 25 months of exposure compared to controls. In the NTP study, with only partial analysis available at the writing of this communication, two types of tumors were elevated in male rats, malignant gliomas in the brain and schwannomas in the heart. These are similar to the tumors reported in human studies with cell phone use, namely malignant gliomas and vestibular schwannomas also known as acoustic neuromas.

Mechanisms

Several mechanisms have been postulated that provide insight into the effects of NIR on living organisms. We have evidence that the body is under physiological stress with the production of stress proteins [2] that calcium flux is altered leading to a cascade of biochemical reactions [25]; that membrane permeability especially of the blood brain barrier increases allowing toxins to enter tissue where they do not belong [26-28]. That levels of free-radicals increase in the body due to impaired repair mechanisms [5]; and that DNA is damaged [10,14,26]. All of these mechanisms can promote the growth of cancer.

Conclusions

When epidemiological studies that show an association between an agent and an outcome, in this case NIR and various types of cancers, are combined with *in vivo* studies that show a cause-effect relation between the same agent and cancer and with *in vitro* studies that identify the different mechanisms involved (stress protein production, increased membrane permeability, altered calcium flux, increased free radical content, impaired enzyme activity, etc.), it is naive and unscientific to repeat the outdated mantra that, *since NIR doesn't have enough energy to break chemical bonds it cannot cause cancer* [29]. This is an invalid statement based on a flawed assumption and is contrary to scientific evidence. Scientific evidence clearly supports the concept that non-ionizing radiation from extremely low frequency electromagnetic fields through intermediate frequencies (dirty electricity) to microwave radiation contributes to cancer by promoting the growth of pre-existing cancer cells and by interfering with repair mechanisms leading to an increase in free-radicals and DNA damage. This occurs at levels well below international thermal guidelines.

It is time for IARC, WHO, and governing bodies to establish guidelines that truly protect public health and it is time for the medical community to incorporate strategies to deal with the harmful effects of electromagnetic pollution as part of their medical protocol and to teach about this concept at medical schools, especially since the levels of electromagnetic pollution will continue to increase unabated until governments and health care authorities take it seriously.

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