NONIONIZING RADIATION

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4/3/2006

INTRODUCTION

Microwaves and lasers are forms of nonionizing radiation. Mobile or cellular phones which transmit and receive information in the microwave part of the electromagnetic spectrum, have become a $100 billion a year industry. About 650 million phones are expected to be sold to consumers by the year 2005, and over 1.5 billion people around the world use them. The extensive use a cellular phone for at least an hour a day leads to a risk of developing a brain tumor, such as an acoustic neuroma or a glioma, that is 240 percent higher than a person who never uses one.

The technology is relatively new and is evolving so rapidly that it is outstripping the analysis of any potential impacts on health. Some research suggests radio frequency fields could interfere with biological systems but it has not been possible to carry out human based long-term studies. Third Generation (3G) phones, which emit higher rates of radiation than earlier models are now marketed all over the world. Studies suggesting mobile phones can cause non malignant brain tumors, cognitive impairment or DNA damage in humans may be inconclusive but should not be dismissed.

BACKGROUND

Cellular phones emit electromagnetic radiation in the microwave part of the electromagnetic spectrum. The energy of a photon of electromagnetic radiation is expressed as:

$$E = h\nu \ [eV] \tag{1}$$

where h is Planck's constant [eV/sec] and ν is the frequency of the electromagnetic radiation, given by:

$$\nu = \frac{c}{\lambda}[Hz],[\sec^{-1}] \tag{2}$$

where c is the speed of light [cm/sec] and λ is the wave length [cm] of the radiation.

The energy of the photon is expressed in electron Volts [eV], which is the kinetic energy acquired by an electron upon being accelerated through a potential drop of 1 Volt.

Since microwaves have a longer wave length and consequently a lower frequency than x or gamma rays, the energy they carry is considerably less. Whereas x and gamma rays with their high energy in the range of kilo to million of electron volts (keV-MeV) can break molecular bonds and cause the creation of ions or ionization, microwaves do not carry enough energy to cause ionization.

Microwave radiation from cellular phones is classified as non ionizing radiation, so its effects are considered as less serious than ionizing radiation such as x and gamma rays, electrons, protons, alpha particles and neutrons. However, cellular phones antennas emit when in use microwaves that deposit energy in vital organs particularly the brain as well as the eyes. Radiation is emitted not just during active usage, but also during the standby mode, since a cellular phone is continuously polling for the location of the nearest cellular tower.

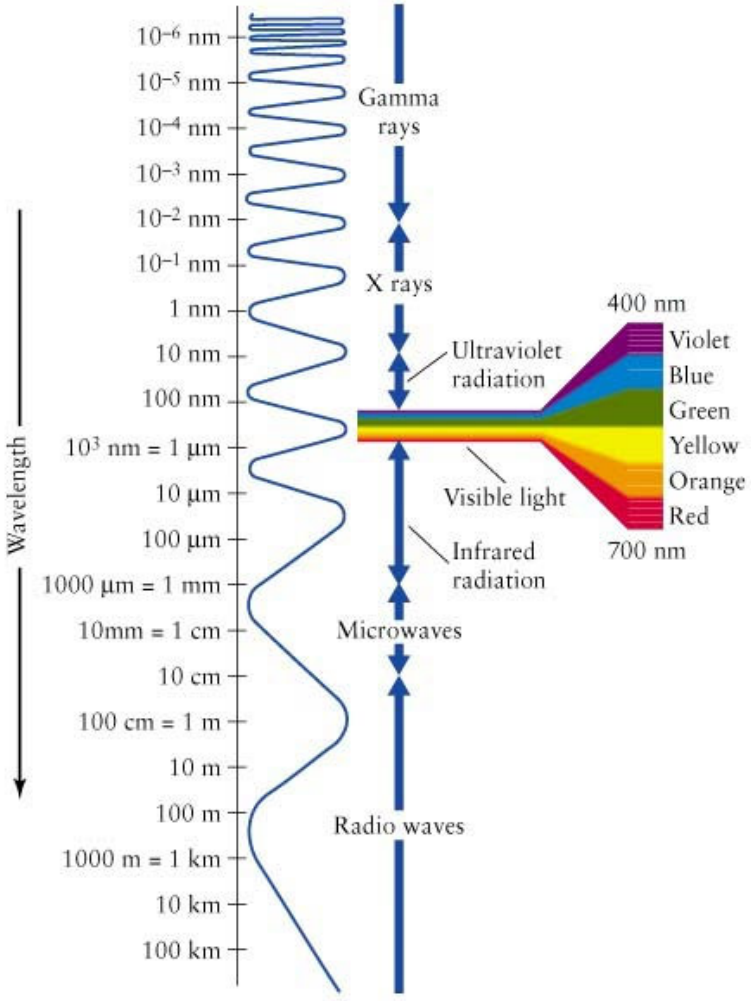

Fig. 1: Microwaves cover the wave length range from about 1 mm to 10 cm in the electromagnetic spectrum.

Microwave towers themselves, with their geographical spread subject neighboring people in stationary objects such as offices and homes and mobile objects such as cars to microwave radiation. Microwave energy absorption is measured in terms of the Specific Absorption Rate (SAR), where:

$$SAR = \frac{\text{Energy absorbed [Joules]}}{\text{Organ Mass[kgs].Irradiation time[secs]}} = \frac{\text{Power [Watts]}}{\text{Organ mass [kgs]}} \quad (3)$$

Most cellular phones emit radio signals at the level between 0.5-1.0 [Watts/kg]. SAR has a unit of specific power is a measure of the rate of radio energy absorption or power absorption per unit weight of body tissue The SAR specific radiation dose rate exposure limit recommended by the International Commission on Non-Ionizing Radiation Protection is 2 [Watts/kg].

REFLEX EUROPEAN STUDY

Radio waves from mobile phones harm body cells and damage DNA under laboratory conditions, according to a study conducted by European Union, researchers. The Reflex study, conducted by 12 research groups in seven European countries, did not prove that mobile phones are a definite risk to health but concluded that more research is needed to see if effects can also be found outside a lab.

The $100 billion a year mobile phone industry asserts that there is no conclusive evidence of harmful effects as a result of electromagnetic radiation. About 650 million mobile phones are expected to be sold to consumers per year, and over 1.5 billion people around the world use one.

The research project lasted for four years and was coordinated by the German research group Verum and headed by Franz Adlkofer. It studied the effect of radiation on human and animal cells in a laboratory setting.

After being exposed to electromagnetic fields that are typical for mobile phones, the cultured human and animal cells showed a significant increase in single and double strand DNA breaks. The damage was sometimes permanent and could not always be repaired by the cells. The concern arises from the fact that DNA carries the genetic material of an organism and its different cells.

There was remaining damage for future generation of the cultured cells. This means that the change had procreated. Mutated cells are seen as a possible cause of cancer.

The radiation used in the study ranged in levels between a Specific Absorption Rate (SAR) of between 0.3 and 2 [Watts/kg]. The study also measured other harmful effects on cells.

Because of the laboratory setup, the study did not prove any health risks on humans. However, the genotoxic and phenotypic effects would require further studies on animals and human volunteers. Further research would need five years to reach a conclusive result.

Previous independent studies into the health effects of mobile phone radiation have found it may have some effect on the human body, such as heating up body tissue and causing headaches and nausea.

BRITISH NRPB REPORT

A report issued in January 2006 by the UK's National Radiological Protection Board (NRPB), an independent advisory group, recommended a precautionary approach, because there is still no hard evidence that the health of the public in general has been adversely affected by the use of mobile phone technologies. The Mobile Operators Association in Britain, which represents operators on health and planning, supported the report. According to the NRPB, children might be more vulnerable to the effects of microwave radiation because their brain and nervous systems are still developing. They have a greater absorption of energy in the tissues of the head and they would have a longer lifetime exposure than adults.

SWEDISH STUDY

According to a Swedish study headed by Kjell Mild, published in the "International Archives of Occupational and Environmental Health" in April 2006, extensive use a cellular phone for at least an hour a day leads to a risk of developing a brain tumor that is 240 percent higher than a person who never uses one. The definition of extensive use is over 2,000 hours of cell phone use, spread over many years.

The results of the study contradicted another recent one carried out in the UK and published in January, 2006, which suggested that cell phone use is safe for humans.

The researchers found that the location of the tumor, for extensive cell phone users over many years, tends to be on the side of the head where the phone is frequently used. They examined cell phone use among 905 people who had a malignant brain tumor and compared them to a control group of 905 healthy people. All the volunteers were aged 20-80 years. Of the 905 people, 85 who had a malignant tumor were high users of cell or mobile phones: they started using mobile phones a long time ago, and have used extensively, on average for about an hour a day.

ACOUSTIC NEUROMAS

Acoustic neuromas are slow-growing cancers that only affect the function of the ear and can lead to loss of hearing and balance. They do not metastasize to other parts of the body.

There is public concern that use of mobile phones could increase the risk of brain tumors. If such an effect exists, acoustic neuroma would be of particular concern because of the proximity of the acoustic nerve to the handset."

Scientists at the Institute of Cancer Research in London have found that cellular phones do not increase the risk of cancer of the nerve that links the ear to the brain, during the first decade of cell phone use.

Data from 678 people with the benign tumor: acoustic neuroma of the nerve that connects the ear to the brain, and 3,553 people without it, were examined. The data came from people living in four Nordic countries and the UK, in which cell phones were introduced particularly early

No correlation was found between the number of calls, the duration of calls, or someone's lifetime cumulative hours of cell phone use and the risk of developing such a tumor.

There is a higher risk of developing a tumor on the same side of the head that people use their cell phones, after at least 10 years of use. However, the researchers conceded that there is little information on which long term effects can be judged.

Whether there are longer term risks remains unknown, reflecting the fact that this is a relatively recent technology.

GLIOMAS INCIDENCE

Gliomas are the most common type of brain tumors. A Swedish study suggested that there was an increased risk of contracting brain cancer among rural cell phone users. It also found increased incidence of brain tumors on the side of the head where people reported using their mobile phones. Early mobile phones tended to use stronger analog signals than more recent ones.

Researchers from the Universities of Leeds, Nottingham, and Manchester, and the Institute of Cancer Research in London, conducted a four year study between December 1, 2000, and February 29, 2004, on 966 adults diagnosed with glioma. A group of 1,716 healthy volunteers was used as a control group.

They found there was no correlation between the risk of glioma and the time since the adults' first use of a cell phone, the number of years they had been using a cell phone, the number of calls they made, and the hours of mobile phone usage.

However, the researchers did find a significantly increased risk for tumors that developed on the same side of the head as where the adults said they held their cell phones and a paradoxical decreased risk of tumors on the other side of the head.

A possible explanation is that people with glioma brain tumors might be over reporting their use of the phone on the same side as where the tumor developed, and under reporting their usage on the other side of their heads.

The researchers acknowledged their own study was limited in predicting the long term effects of cell phone use since mobile phones have only been popular in the UK since the late 1990s, although they have been available in the UK since 1985.

Cell phone makers have been making efforts in recent years to reduce the amount of radiation emitted from phones and listing the amount of radiation they can measure in their Specific Absorption Rate (SAR) ratings.

The study received criticism from advocacy groups such as Powerwatch, a British group that is examining the links between electromagnetic fields and health risks. It pointed out that 49 percent of the 966 brain tumor patients in the study were not interviewed by the researchers.

The University of Leeds, which helped carry out the study, received funding from various British mobile phone carriers, such as O2, Orange, T-Mobile, Vodafone, and 3, to support the research. However, they signed contractual agreements to ensure the independence of the scientific investigators.

Various mobile phone industry groups, such as the GSM Association and the Mobile Manufacturer Forum, provided funds for a larger 13 country Interphone study, of which the British study is one part.

RECOMMENDATIONS

In Hong Kong, where consumers tend to spend more time talking on a mobile phone than in Europe, a German company, G-Hanz has been marketing a new type of mobile phone which it claims had no harmful radiation. It uses military radar technology which emits shorts burst of radiation at different frequencies to avoid detection and subsequent targeting. Using short pulses instead of continuous operation is suggested as minimizing, but could not exclude the radiation exposure.

There is a need for the monitoring of base station towers, including new Third Generation 3G stations and Terrestrial Trunked Radio (TETRA), used by police and taxicab companies.

These towers are in such high demand in European cities, that churches rent their steeples to be used as radio towers as an extra source of income. The use of a mobile phone when an alternative fixed line phone is available using the low frequency 60 Hz of ordinary electric current, and the use of a headset connected to a cellular phone whenever possible; are two recommended measures.

Young adults are advised to use mobiles phones for as short a time as possible, since their brain and eyes tissues are still in a formative stage and are consequently more vulnerable to the effects of radiation. Using text messaging and a phone with a low SAR value are also recommended. Turning off the phone when not in use, is also a recommended measure. To reduce the risk, the use of hands free cellular phones is recommended.