



Effects of EM Radiation on Human Health

T.S.H.Balaji rao, M Tech (BME),

P.Raju ,M Tech (BME)

Y. Ratna Kumar, Senior Research Fellow, Centre for Bio Medical Engg

Andhra University, Vishakhapatnam.

Abstract:

The electromagnetic environment consists of natural radiation and man-made electromagnetic fields that are produced either intentionally or as by-products of the use of electrical devices and systems. The natural background is orders of magnitude below local field levels produced by man-made RF-sources considered here. Sources generating high levels of electromagnetic fields are typically found in medical applications and at certain workplaces. Medical devices used for magnetic resonance imaging, diathermy, hyperthermia, various kinds of RF ablation, surgery, and diagnoses may cause high levels of electromagnetic fields at the patients position or locally inside the patient's body. In addition, some of these medical applications may produce high fields at certain workspaces. For broadcasting high RF power is generally required to maximize the area of coverage. It is suggested that exposure systems for laboratory studies need to fulfil certain criteria in order to prevent or at least minimize any non electromagnetic fields exposure related interference of the system itself with the study subject.

Key words: Environment, hyperthermia, ablation, surgery

1. Introduction

Interaction of non-ionizing EM waves with biological bodies and

tissues results in thermal heating as well as non-thermal effects such as field-force effect, polarization and depolarization of body cell



membranes. Maximum recommended safe power limit for long-term human exposure has been specified as 10 mW.cm^{-2} [1]. Yet use of power densities up to 590 mW.cm^{-2} is common in routine diathermy treatments [1]. So it is important to understand the limits of EM power exposure that human body can sustain without any crucial biological damage.

2. An overview

In the frequency range of 1 MHz to 300 GHz, wave lengths of EM waves are in the range of 300 m to 1 mm and are larger compared to the cell size. Hence there is little scattering of EM waves by a human body in this frequency range. Normal laws of reflection and transmission of waves can be applied in this range. As EM waves propagate through a human body, propagating EM energy can get absorbed by muscles and tissues producing localized heating. Fields in the EM waves also may cause other non-thermal effects such as electromechanical field force in the cells and polarization and depolarization of cell membranes. The heating in tissues possibly

results from both ionic conduction and vibration of the dipole molecules of the water and the protein in tissue cells. Continuous temperature rise leading to severe damage of tissues can happen if the absorbed power is greater than the normal metabolic output of a human body. The normal metabolic heat production for a 70 kg man on a 2500 Calorie diet is around 4×10^{-4} calorie per gram per second [2]. Maximum power density, safe for long term exposure to the human body was decided to be 10 mW.cm^{-2} [2]. Higher values for radiation power density can be used if exposure time is brought down [2]. Based on the maximum power density, Schawn [3] estimated current density that can be induced inside a human body without causing any thermal hazard. Assuming an exposed area of 1 m^2 , total power received for a 10 mW.cm^{-2} radiation exposure is $100 \text{ W} = I^2 R = J^2 \rho A^2 . L . A^{-1}$. Here A is exposed area, I is current, J is current density, L is thickness of a human body = 10 cm and ρ is resistivity of human body. It can be seen that $J^2 \rho = 1 \text{ mW.cm}^{-3}$. For $\rho =$



100 ohm cm [3], $J \approx 3 \text{ mA.cm}^{-2}$. Apparently resistivity of the human body tissue is frequency dependent and decreases with frequency. So 3 mA.cm^{-2} limit will go up at the higher frequencies. Therefore, current density of 3 mA.cm^{-2} can be taken as a safe upper limit for induced current density to avoid damaging body heating due to long term exposure of a human body to EM radiation. It is also found that induced electric field inside a human body can depolarize the cell membranes if it is greater than a certain threshold value. It is reported that induced electric field strength greater than 500 kV.cm^{-1} can polarize or depolarize body cell membranes [3].

Heating due to EM power absorption in human body is non-uniform. Heating inside a particular tissue depends on the dielectric and conductive properties of that tissue. High water content tissues normally have high conductivity, whereas those with low water content have low conductivity. Absorption is high and depth of penetration is low in tissues of high water content.

Standing wave pattern causing severe hot spots has been reported to result in the interface of muscles and fat. The relative heating produced at and near the fat-muscle interface. Skin burns and even deep burns of the tissues under the skin have been found in test animals [4]. Heating of body tissues called diathermy by using RF power to give a therapeutic temperature rise in the range of 43°C to 45°C has been in practice. But this temperature range is very close to the temperature range where a little increase in temperature may lead to destructive damage of body tissues [2].

There are non-thermal effects of EM radiation as well. EM waves can result in alignment of cells, because of the induced dipole charges in those cells. Frequency at which this effect is important may be different for different cells. Also intense microwave field can cause polarized side chains of macromolecules to line up with the direction of the E field, leading to possible breakage of hydrogen bonds and to alterations of the hydrogen zone. Such effects can



cause denaturizing or coagulation of molecules [3]. This effect is also known as field force effect. Different muscle movements in the human or an animal body is caused by depolarization and polarization of cell membranes. Induced electric field can result in substantial potential difference to develop across cell membranes causing unwanted polarization and depolarization.

3. EM Wave Effects on Biological Tissues at the Molecular Level

EM waves cause two types of effects at the molecular level. One is the oscillation of the free charges or ions and the other is the rotation of dipole molecules at the frequency of the incident wave. First one gives rise to conduction current and the second one cause's displacement current with an associated loss due to viscosity. Conductivity and dielectric properties of a tissue decide which current would dominate in that tissue. Conductive current is higher in conductors whereas displacement current (charging and

discharging current) is higher in tissues with high relative permittivity values.

4. EFFECTS OF CELL PHONES:

The cell phones operate by emitting and receiving electromagnetic waves. Human being cannot see, touch, smell, taste or hear the electromagnetic waves. All the five senses of human beings are not useful to identify the presence of electromagnetic waves. Such waves have harmful and hazardous effects on humans. The cell phone is called electromagnetic weapon. The cell phone effects on humans are ridiculed first, secondly, they are violently opposed, thirdly, they are accepted after they became self evident. Most of the people do not know the facts about the dangers of cell phones.

The wireless network keeps emitting an ever-increasing and dangerous levels of microwave radiations. The antennas which are the sources of electromagnetic waves from cell towers are still created on the house tops, in the



vicinity of residential areas in the work places, schools, and most dangerously near the hospitals. It is evident from research and literature that there are about 80 immune system disorders.

One must understand and remember that the users of cell phones become sick gradually. The host of illnesses includes Alzheimers, allergies, heart disease, stroke, diabetes, insomnias, depression, infertility, leukemia, breast cancer, brain tumors, miscarriages, birth defects and several other illnesses

Dr. George Carlo [3] reported the dangers posed by cell phones. He uses the analogy of putting a frog in water. A frog in a boiling water jumps. But the frog in cold water lives happily. If the water is heated gradually, the frog is cooked as the frog's body adjusts to the slight changes in temperature and the frog does not notice that it is cooked.

The same thing happens to the people who do not know the dangers of cell phones, other wireless networks, high frequency

radiation coming from cell towers, microwave towers, radar antennas etc. In the early stages of exposure, the following are effects are reported.

- Decreased stamina
- Memory problem
- Fatigue
- Sleep disturbances
- Headaches
- Eye sensitivities
- Increased allergies
- Dizziness
- Irritability
- Concentration problems
- Nausea and
- Restlessness etc.

The above problems depend on frequency, duration and exposure levels.

The high exposure levels leads to Unexplained anxiety

- Insomnia
- Swollen lymph nodes
- Depression
- Loss of appetite



- Hypoxia (lack of oxygen getting to the tissues)
- Hyper activity
- Dry eyes
- Vision problems
- Weaken immune system
- Frequet urinals
- Night sweats
- Extreme thirst
- Weight gain or weight loss
- Testicular pain etc.

Microwave exposure induces oxidative damage which leads to Depletion of the body's natural production Stored number of antioxidative enzymes etc when the body becomes depleted in antioxidants, free radicals – aka reactive oxygen species will wreck havoc on the body's cellular systems.

The cellular system includes cell wall, DNA etc. The oxidative damage leads to premature aging, weakened immune system, sticky blood and other serious problem. The depressed level of antioxidants in the blood leads to the formation

of plaque on arterial wells. This also leads to more viscous blood. This in turn causes blood clots. The blood clot leads to strokes and heart attacks.

Microwave exposures depending on the frequency, are found to affect an abnormal flux of calcium into or out of cells. Microwave exposure is found to induce mitochondria dysfunctions. These mitochondria are the power of the cell. The dysfunctional mitochondrion is found to interfere with the cellular energy production and leads to fatigue and obesity.

Microwaves depolarize the body's red blood cells. This leads to diminishing flow of oxygen to brain cells and the body's other organs. This in turn causes nausea, dizziness, inability to concentrate and headaches etc. The microwaves induce protein destruction from the cellular membrane of red blood cells.

Microwave exposure is also found to induce decreased numbers of natural killer cells. The killer cell is a form of white blood cell. It is the body's first line of defense against



pathogens. This leads to the body's weakened ability to recover from viral and other types of infections.

Microwave exposure is found to induce subliminal stress causing the adrenal glands to excrete an abnormally greater amount of cortisol and adrenaline. Excretion of adrenaline can lead to irritability and a feeling of hyperactivity. The feeling of hyperactivity is very common in children with attention deficit hyperactivity disorder. Microwave exposure is found to induce decrease levels of the brain hormone.

It disturbs the sleep

It drops melatonin levels which lead to breast cancer.

It increases restlessness.

It increases allergies.

It produces more histamine – a chemical responsible for allergic reaction.

It affects the heart and heart irregularities and responsible for triggering heart attacks.

It opens the blood brain barriers (BBB). It protects brain from foreign substances like viruses, bacteria and clinical toxins in the blood which may injure brain. Thus exposure to microwave radiation leads to viral and bacterial infections of the brain.

It increases brain tumors and other cancers.

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