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Research Paper

Non Ionizing Radiation and Specific Absorption Rate (SAR)

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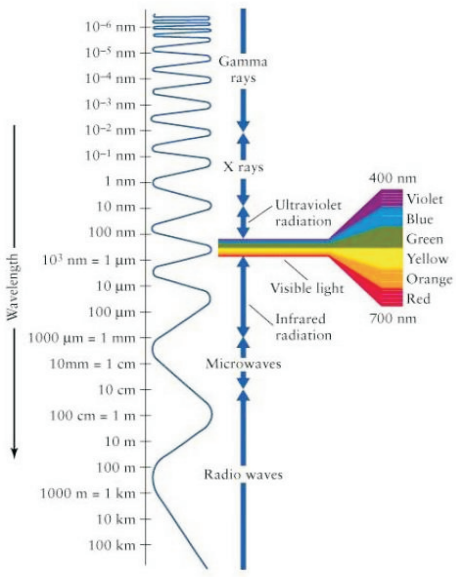
Introduction

Mobile or cellular phones transmit and receive signals using microwaves .For the past 15 years mobile industry grown and is now over $100 billion industry .India is the second largest consumer of mobile phone in the world after China . In chorus with the expanding usage, a question has been raised repeatedly as to whether frequent usage of such a device which radiates electromagnetic field onto the human head is unsafe as the deposition of excess energy can lead to rise in temperature around head. A logical concern is whether the deposited energy could locally effect the nervous system ,brain activity and the effect of rise in temperature of tissue around head . A transient change in blood-brain-barrier permeability could have important health consequences. In addition, possible morphological, metabolic, physiological, and genetic changes in neural tissues should also be considered. These effects could lead to temporary or permanent functional changes in the nervous system [4, 5].

NIR Issue

Radiations are broadly classified as ionizing and non – ionizing radiations. Ionizing radiation consists of particles or electromagnetic waves that are energetic enough to detach electrons from atoms or molecules, therefore ionizing them. Any living tissue in the human body can be damaged by ionizing radiation in a unique manner. The body attempts to repair the damage, but sometimes the damage is of a nature that cannot be repaired or it is too severe or widespread to be repaired [1]. Also mistakes made in the natural repair process can lead to cancerous cells. The most common forms of ionizing radiation are alpha , beta or gamma and X-rays. Non-Ionizing radiation (NIR) refers to radiative energy that do not have energy enough to cause above phenomena but instead of producing charged ions when passing through matter, has sufficient energy only for excitation. More over our cells use electrical energy for vital body functions so the interference of NIR can cause biological effects [1,2]. The NIR spectrum is divided into two main regions, optical radiations and electromagnetic fields. The optical can be further sub-divided into ultraviolet, visible, and infra-red. The electromagnetic fields are further divided into radiofrequency (microwave, very high frequency and low frequency radio wave). Non-Ionizing radiation originates from various sources: Natural origin (such as sunlight or lightning discharges etc.) and man-made (seen in wireless communications, industrial, scientific and medical applications).

The NIR part of the electromagnetic spectrum is divided into four approximate regions 1.Static electric and magnetic fields, 0 Hz
2.Extremely low frequency (ELF) fields, >0 Hz to 300 Hz3. Radiofrequency (RF) and microwave (MW) radiation,300 Hz to 300 GHz
4. Optical radiations: infrared (IR) 760 - 106 nm visible 400 - 760 nm ultraviolet (UV) 100 - 400 nm
On the other hand, ionizing radiations, with wavelengths less than 100 nm, constitute the
high photon energy portion of the electromagnetic spectrum shown in fig 1.1



Application of Microwaves

Microwaves are used in telecommunications, radar/satellite links, mobile phones, microwave ovens, TV transmitters. RF is used in radio communications, visual display units, television sets. Extremely low-frequency (ELF) electric and magnetic fields (EMFs) surround electrical machinery, home appliances, electric wiring, and high-voltage electrical transmission lines and transformers. Medical applications include: microwave hyperthermia, therapeutic and surgical diathermy, and magnetic resonance imaging (MRI).Biological effects could be physiological, biochemical or behavioural changes induced in an organism, tissue or cell. NIRs usually interact with tissue through the generation of heat . The hazards depend on the ability to penetrate the human body and the absorption characteristics of different tissues[3]. NIR exposures will depend on many factors such as the energy of the incident radiation (determines the penetration depth), the power density of the field or beam, source emission characteristics, duration of exposure, environmental conditions, and the spatial orientation and biological characteristics of the irradiated

tissues (molecular composition, blood flow, pigmentation, functional importance, etc.). Microwaves used in communication use different technology Popular of them are CDMA(Code Division Multiple Access),TDMA (Time Division Multiple Access),GSM (Global System of mobile communication) and the frequency use is 900 and 1800 MHz. Carrier waves are used and demodulation is done when signal is received in cellular phone .These signals are transmitted through mobile mast raised all around us now a days .

Metabolic Association of EMR exposure :

It has been suggested that exposure to weak electromagnetic fields (EMFs) can disturb the production of the hormone melatonin[4,5,6] (secreted by pineal gland sensitive to light associated with sleep)by the pineal gland in the brain, this results in sleeplessness eventually leading to an increase in the risk of degenerative diseases such as coronary artery disease, Parkinson's and Alzheimer's[6,8]. Likewise, epidemiological and laboratory reports suggest that children exposed to EMFs from power lines are at greater risk of developing leukemia, [7,9,10]and that adults exposed to EMFs at work run a higher risk of leukemia and brain cancer . Epidemiologists point to the dozens of studies that have found anywhere from a twofold to a tenfold increase in the risk of cancer [7] among people routinely exposed to EMFs .

Logical Concern

As already mentioned above mobile phone telephony involves series of technology for smooth communication .When ever we use mobile phone the signal is in the form of pulses the aggression of these pulses is too vigorous for still developing brains of young children .Since modulation of carrier waves is done to transmit signal and demodulation is done for clear voice the excess energy is dissipated and deposited on skin to measure that we use term SAR. SAR is the acronym for Specific Absorption Rate, and is a measure of the power per unit mass absorbed by a conducting body when exposed to an electromagnetic field, especially in the radiofrequency (RF) range. High SAR levels may be harmful for the human body because an excessive temperature increase is produced. The variable used to express absorbed energy per unit time is the specific absorption rate (SAR) expressed in watts per kg. In all guidelines it is assumed if the average SAR does not exceed 4W/kg body temperature does not rise by more than 1 C,but this data may not be true for younger or sub population i.e. very old sick and very young people .Atoms molecules and ions in tissue may follow the variation in time of an external electric field for example owing to he presence of internal electric dipoles .If this happens some of the energy of electromagnetic field is converted into heat the extent to which such conversion takes place is dependent on an electromagnetic property of tissue namely its

$$\text{SAR} = \frac{d}{dt}\frac{dW}{dM} \quad \frac{d}{dt}\left(\frac{dW}{dV}\right)\left(\frac{W}{kg}\right)$$

To study the exposure we have to calculate power density which can de calculated as below

$$S \quad \frac{10^{\frac{P\ G}{10}}}{1000} * \frac{4*}{2}$$

The above formula is effective only if we know the transmission frequency you can calculate power density [W/m²] from power [dBm]. You also need the antenna gain of the used antenna. S represents the power density [W/m²], p is the measured power [dBm], is the wavelength of the transmitter frequency [m] and G the antenna gain [dBi] .

The towers radiate 24 hours and it is not only the user of mobile phone who is exposed but also person who lives around the tower we can call it as passive exposure .In India the density of population is very high especially in the cities like Kanpur where the power density exceeds the international exposure limits [11]this results in more users .The mobile phone operators raise towers every where to meet the requirement of the users .The result of additive behavior of power has to be studied .Higher power density will lead to higher exposure .It is very important that some standard guidelines of radiation exposure have to followed ,one of such is ICNIRP. Most of the countries the world strictly follow the guidelines of ICNIRP .

Preventive Steps and Result :

Research is still on ,may be we may happily land in a negative note of report but its still a question mark .We can definitely do certain preventions which we feel are harmless and can be followed by both ,authorities and people.

1. Reducing use is universally regarded as the best step. Use by children should be eliminated. Indoor use increases exposure significantly because the signal strength require to create a connection from inside a car or building is much greater. Home portable phones can be replaced with wired phones and cell phone use significantly reduced.
2. If still using a cell phone or portable home phone keep the phone away from the body when in standby mode. When in use hold the phone as far away from the head as possible. Even three or four inches can significantly reduce the exposure because the energy density drops very rapidly with distance from the body. Keep the antenna away from the head and pointing away from the body. [10] “Radiation from all sources obeys the inverse square law. That is, the further you are from the source the less intense your exposure to the radiation.
3. Certain guarding devices are available in the market which can reduce the radiation level .I would like to mention the selection of model on the basis of radiation level rather than looks is important . , one can potentially reduce radiation exposure by over 80% simply by choosing the correct cellular phone As per FCC certification maximum SAR must be less than1.6W/Kg [11]

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