

WIRELESS RADIATION: A THREAT TO HUMAN HEALTH

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Abstract-Worldwide revelation to the promising wireless technologies emits harmful radiations which may possess severe damage to human health. Communication devices like mobile phones, WI-FI, Bluetooth, WLAN, laptops, headphones, and cellular phones all use wireless technologies. Wireless networks emit radiation in the microwave frequency range. These radiations are invisible, elusive, and they enter and leave human body without their knowledge making it more threatening. The radiations whose wavelength are shorter than human cells enters the cell structure causing disruption to cells and therefore leading to many health hazards. This paper characterizes that radiations which are emitted from various wireless devices can be tremendously injurious, causing genetic damage, anxiety, suffocation, sleep disturbance, heart palpitation, migraine, tumour, memory loss, increase in blood pressure and waning of the immune system. The detrimental effect of the radiations can fabricate a broad range of physical symptoms. Some symptoms are seen within a short interval of time while others take several years to be shown. Long term exposure to radiation may also cause cancer. In this paper in addition to the adverse effects of the wireless radiations we are also providing the mitigation measures.

Keywords: wireless, radiations, threat, health, hazards.

I. INTRODUCTION

Now a day's most of the communications are done wirelessly. Wireless technology in several forms is an area of electronics which is being developed and has grown very fast. Wireless technology had made its way into homes and public spaces in the form of Wi-Fi, Bluetooth, Wimax, Zigbee and more and more people are exposed to electromagnetic signals which pose significant danger to human health. Electromagnetic waves are defined as a form of energy that consist of vibrating electric and magnetic fields. Electric fields are produced by the forces of electric

charges and when electric charges are in motion then magnetic fields are produced. Charged particles emit and absorb a form of energy i.e. electromagnetic radiations which exhibit wave like behavior as it travels through space. In vacuum, electromagnetic radiations propagates at the speed of light. Electromagnetic radiation is divided into two broad categories:-

- 1) Ionizing Radiation
- 2) Non-Ionizing Radiation

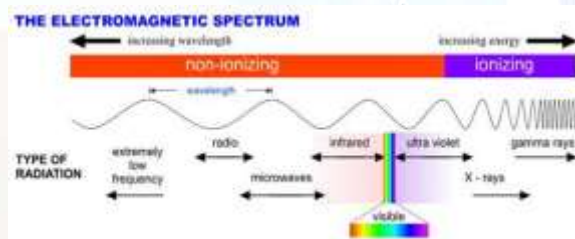


Fig1. Electromagnetic Spectrum

i. Ionizing Radiation

Ionizing radiation is defined as radiation with sufficient energy so that when it interacts with an atom, it has tendency of removing tightly bound electrons from the orbit of an atom which causes the atom to become charged or ionized. It has more energy than non ionizing radiation which is adequate to cause chemical change by breaking the chemical bond. This effect is hazardous and may damage living tissue. Ultraviolet has shorter wavelength and have adequate energy to break chemical bonds. X-ray and gamma ray radiation have very short wavelengths and very high frequencies. The process in which an electron is given enough energy to break away from an atom is called ionization. As a result two charged particles or ions are formed i.e. the molecule with net positive charge, and the free electron with negative charge. Each ionization releases

energy that is absorbed by material which surrounds the ionized atom. The energy from one ionization has tendency to disrupt the chemical bond between two carbon atoms. Either directly or indirectly all ionizing radiations are capable of removing electrons from molecules. Three main types of ionizing radiations are as follows:-

- Alpha particles :- It includes two protons and two neutrons
- Beta particles:- They are essentially electrons
- Gamma rays and Xrays: - They are photons.

Sources of ionizing radiation:

- 1) **Natural sources:** - It includes solar radiation, cosmic rays and radiation on earth.
- 2) **Medical sources:** These radiations are generated by imaging tests Radiation therapy X-ray tubes.

ii. Non Ionizing Radiation

Non-ionizing radiation is defined as any type of electromagnetic radiation where there is inadequate energy to cause ionization. It lies at the long wavelength end of the electromagnetic spectrum. When it passes through the matter, it provides sufficient energy only for excitation i.e. the electron moves to a higher energy state for e.g. in a microwave oven radiation causes water molecules to vibrate faster which creates heat. It includes electric and magnetic fields, radio waves, microwaves, infrared, ultraviolet, and visible radiation. Extremely low frequency radiations consists of very long wavelengths and frequencies in the range of 100 hertz or less. Radiofrequencies have wavelengths in between 1 and 100 meter and frequencies in the range of 1 million to 100 million hertz. Microwaves have wavelengths that are about 1 hundredth of a meter long and have frequencies of about 10 billion hertz.

Sources of Non Ionizing Radiation

Non-Ionizing radiations are originated from different sources:

- Natural origin for e.g. sunlight or lightning discharges etc.
- Man made for e.g. in wireless communications, industrial, scientific and medical applications.

NIR is divided into two main parts:

Optical radiations:-These are located around visible light. Those radiations which have high energies are termed as UV radiation and those which have lower energies are called as IR radiation.

Electromagnetic Fields: - Microwave radiations are used in telecommunications, radar/satellite links, cell phones, microwave Ovens and TV transmitters. Radio Frequencies are used in radio communications, television sets etc. Extremely low-frequency (ELF) electric and magnetic fields (EMFs) are used in electrical machinery, home appliances, electric wiring, transformers etc.

II. ADVERSE EFFECTS OF DIFFERENT WIRELESS RADIATIONS ON HUMAN HEALTH ARE EXPLAINED BELOW:

Exposure to the electromagnetic radiations both ionizing and non ionizing discussed above poses substantial danger to human health.

a) Biological effects caused due to ionizing radiations are as follows:-

The biological effects due to ionizing radiations are divided into two parts:"Deterministic effects" and "Stochastic effects".

i. Deterministic Effects

As a result of several experiments it was revealed that severity of some effects on human beings will increase with increasing doses. There exists a level called as threshold. Below the threshold level these effects will be absent. Such kinds of effects are called as deterministic effects.

Features of deterministic effects:

- Damage depends on absorbed dose
- Threshold exists

Examples of deterministic effects

Skin Effects: - It incorporates sunburn, tanning, burning of skin and skin cancer. Erythema occurs 1 to 24 hours after 2 Sv have been received. Breakdown of the skin surface occurs approximately four weeks after 15 Sv have been received.

Cataracts: - Cataracts induced by ionizing radiation (e.g., X-rays and gamma rays) usually are observed in the posterior region of the lens, often in the form of a posterior

sub capsular cataract. Increasing the dose of ionizing radiation causes increasing opacification of the lens, which appears after a decreasing latency period [1].

Radiation sickness: - Radiation sickness (acute radiation syndrome) includes nausea, vomiting, and diarrhea. All these fatalities can develop within hours or minutes of a radiation exposure.

Infertility: - Exposure to large doses of ionizing radiation can affect the forming reproductive tracts of male and female embryos. Sterility occurs after 2.5 to 3.5 Gy have been received by the gonads.

Loss of hair: - Due to excessive exposure of ionizing radiations hair loses rapidly.

Fetal Effects: - Fetal death mostly occurs within first 2 weeks after conception. It involves cataracts, malformations, and mental and growth retardation.

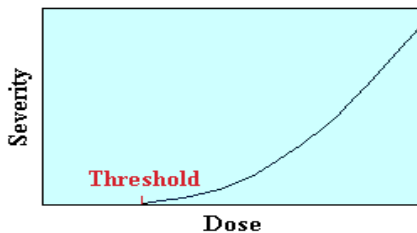


Fig2. Deterministic dose relationship
Deterministic effects and dose relationship

Severity of deterministic effects depends on dose. Above the threshold level effects will occur. The International Commission on Radiological Protection (ICRP) reveals that if the annual radiation doses to the lens of the eyes of radiation workers are restricted to 150 mSv then cataract may occur during his/her life assuming a working period of 50 years. For other major organs, the annual dose limits for preventing deterministic effects are as follows.

Table1. Deterministic Effects

Threshold for deterministic effects (Sv)			
	Effects	One single absorption (Sv)	Prolong absorption (Sv-year)
Testis	Permanent infertility	3.5 - 6.0	2

Ovary	permanent infertility	2.5 - 6.0	> 0.2
Lens of eyes	milky of lens cataract	0.5 - 5.0	>0.1 > 0.15
Bone marrow	Blood forming deficiency	0.5	> 0.4

(Source: 1990 Recommendations of the International Commission on Radiological Protection (ICRP Publication No. 60))

ii. Stochastic effects

Severity of stochastic effects does not depend on the absorbed dose. In some exposure conditions these effects may or may not occur. In these effects no threshold exists and the probability of having the effects is proportional to the dose absorbed.

Features of stochastic effects:

- Severity is independent of absorbed dose.
- Threshold does not exist.
- Probability of occurrence depends on absorbed dose.

Example: radiation induced cancer, genetic effect. Stochastic effect of radiations does not have any thresholds and cancers or genetic modifications are caused due to these radiations which are not cured easily thus these effects have become a major subject of research in radiation protection.

Cancer: - Cancer caused due to ionizing radiations are Lung cancer, Skin cancer, Thyroid cancer, Multiple myeloma, Breast cancer and Stomach cancer.

Genetic effects:-These effects come into existence everlasting change either in a gene or in a chromosome carried by a germ cell in the reproductive organ of the body. Thus prolonged exposure to ionizing radiations may result in gene mutation that causes birth defects which they inherit from forebears. Other effects include disabilities and illnesses including such types of neurologic degeneration.

b) Biological effects caused due to non ionizing radiations are as follows:-

Biological effects occur after a modification is measured in biological system subsequent to the overtone of certain kind of stimuli. A biological effect only becomes a safety hazard

when it “causes detectable impairment of the health of the individual or of his or her offspring” [2]. Biological changes that can occur in an organism can be physiological, or behavioral. The interaction of NIR with tissues occurs through the production of heat. The vulnerability depends on the capability to infiltrate into human body and the absorbing features of various tissues. Several suspicions exists regarding the consequence of both acute and chronic exposure to several types of non ionizing radiations. Usually general public is anxious about the risk associated with Extremely Low Frequency, Radiofrequency and Microwave. Although the maximum risk to humans possibly occur from natural Ultraviolet radiation.

Hazards due to optical radiation are mainly restricted to eye and skin. Risks due to optical radiations are divided into two groups:-

- Thermal damage
- Photochemical damage.

Even though an ultraviolet radiation does not have sufficient energy to ionize atom, its single photon can rupture tissue by disrupting the bond inside DNA molecule and gives a everlasting risk of cancer. Visible light and infrared radiations pose threat only when multiple photons with high-intensity interact with each other. Biological effects that induces into human body is similar for both, however coherent

light i.e. lasers are proficient and can produce higher irradiance which can heat tissues to temperature which produces hasty physical change.

Table2.Non ionizing radiations

	Frequency	Biological Effects
UV	750–950 THz	Eye–photochemical cataract; Skin-erythema,inc.pigmentation
Visible light	385–750 THz	Skin photoaging;eye photochemical & thermal retinal injury
IR-A	215–385 THz	Eye – thermal retinal injury, thermal cataract; skin burn
IR-B	100–215 THz	Eye – corneal burn, cataract; skin burn
IR-C	300 GHz–100 THz	Eye – corneal burn, cataract; heating of body surface
Microwave	1–300 GHz	Heating of body tissue

Radio-frequency radiation	100 kHz-1 GHz	Heating of body tissue, raised body temperature
Low-frequency RF	<100 kHz	Cumulation of charge on body surface; disturbance of nerve & muscle responses
Static field	0Hz (technically static fields are not "radiation")	Magnetic – vertigo/nausea; electric – charge on body surface

Nature and extent of damages due to non ionizing radiation rely on various factors:

- Energy of incident radiations.
- Power density of the beam.
- Source emission characteristic.
- Length of exposure.
- Environmental conditions.
- The spatial orientation.
- Biological characteristic of irradiated tissues.

Lower frequency range: Its frequency lies between 300 Hz to 1 MHz .In this range induction current may damage the performance of central nervous system.

Intermediate frequency range: Its frequency lies between 100 kHz to10 GHz. In this range when EMF is absorbed heat is generated.

Upper frequency range: Its frequency lies between 10 GHz to 300 GHz. In this range superficial tissues may get heated up.

Biological effects that occur when tissues are heated up due to Radiofrequency radiations are called as *thermal effects*. Human body has efficient ways to adjust its temperature, however if exposure is extreme then body may be harmed. Various experiments have concluded that there might be biological effects at non-thermal exposure levels, but the substantiation for production of health hazards is incongruous and not proven [3-7] .The scientific community and international bodies suggested that more research is to be done for improving our knowledge in various areas. In the intervening time the consensus is that no reliable and compelling scientific evidence exists for proving the harmful health effects caused by RF radiations [3-7].

Emissions and Exposure:

Optical radiations

If humans are being exposed to solar UV radiation for longer time then it results in acute and chronic health

effects on the skin, eye and immune system. Acute effect includes

- Sunburn
- Tanning
- Degenerative changes in cells, fibrous tissue and blood vessels causes premature skin ageing
- Inflammatory reaction of the eye, for eg photokeratitis.

Chronic effects include two major public health problems: skin cancers and cataract [8, 9].

III. CASE STUDIES

Brain tumors

Gliomas are most common type of brain tumors. Evidences exists for cancer which results from radiofrequency exposure that large number of people who used mobile phones regularly for ten or more years are at higher risk of having malignant glioma. [11,12,13,14,15,16].Hardell et al. [16] reported higher odds ratios in the 20–29-year-old group than other age ranges after more than 5 years of use of either analog or cordless phones.

DNA damage

Radio waves from mobile phones harm body cells and damage DNA under laboratory conditions, according to a study conducted by European Union Researchers. Both single and double stranded DNA damages have been stated by several researches conducted in different laboratories. These damages can cause mutations which can be inherited, or which can cause cancer, or both. Damage to DNA from RF mobile phone frequency at very low intensity has been established in many studies [10, 17–22].

Stress proteins

Prolonged exposures to low intensities ELF and RF is that stress proteins (heat shock proteins) are created that signal a cell is being placed under physiological stress .

Sleeping disorders and Cognitive impairment

People who are chronically exposed to low-level wireless antenna emissions report symptoms such as problems in sleeping (insomnia), as well as other symptoms that include fatigue, headache, dizziness, grogginess, lack of concentration, memory problems, ringing in the ears (tinnitus), problems with balance and orientation, and difficulty in multi-tasking [23-25]. In children, exposures to cell phone radiation have resulted in changes in brain oscillatory activity during some memory tasks [26,27]. Cognitive impairment, loss of mental concentration, distraction, speeded mental function but lowered accuracy, impaired judgment, delayed reaction time, spatial disorientation, dizziness, fatigue, headache, slower motor

skills and reduced learning ability in children and adults have all been reported [28–32]. These symptoms are more common among “electro sensitive” individuals, although electro sensitivity has not been documented in double-blind tests of individual identifying themselves as being electro sensitive as compared to controls [33,34].

IV. MITIGATION MEASURES

Radiation protection can be defined as the protection of people and the environment from the harmful effects of radiations, which includes both ionizing radiation and non ionizing radiation. We can adopt following measures to protect ourselves from wireless radiation:-

i. Make your immune system stronger:

We can strengthen our immune system by eating healthy, exercising, and taking extra supplements. This will minimize the damaging effects of EMR (electromagnetic radiation) and cell phone radiation exposure. Healthy eating and drinking lots of water will also allow for quicker repair of damage already done.

ii. Shorten the time of exposure:

If people are exposed to radiation source for short interval of time then less will be the absorbed dose.

iii. Increase distance from radiation source:

If people are at large distance from radiation source then less will be the absorbed dose.

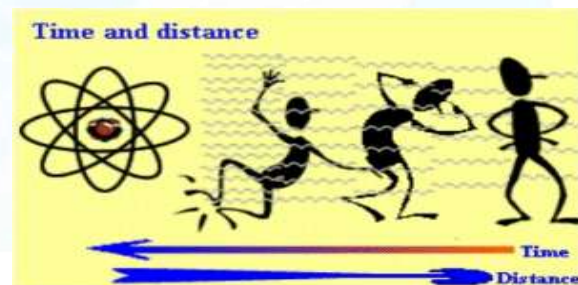


Fig3. Effect of radiation with respect to distance

iv. Radiation shielding devices

Shielding a radiation source can effectively reduce radiation exposure rate. Barriers of lead, concrete or water can stop radiation or reduce radiation intensity. Windows can be screened with one or different type of material which can reduce the incoming radiation by 98%. Walls and ceilings can be carefully painted with special carbon paint. One coat

stops over 98% of the incoming microwave radiation. Personal protection - head nets can give you personal protection from pulsed microwaves in the home, garden, and out and about in your neighborhood.

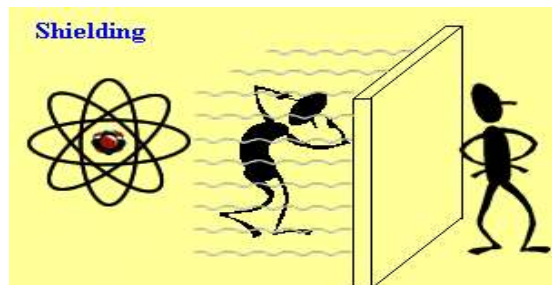


Fig4.Radiation Shielding devices

V. CONCLUSION

Wireless technologies have greater impact on our lives. They have made their way in schools, public places etc. Thus they help us effectively to communicate and collaborate .Despite of these advantages we should be aware of the possible risks. Radiation from the wireless technologies causes several short term and long term effects .Thus we should use it efficiently by adopting protective measures and using the wireless devices only when needed .Hence various steps should be adopted by the existing systems to particularly in places where children spend time for example schools ,gardens etc.

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