Health Hazards of Mobile Phones: An Indian Perspective

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Abstract
The mobile phone industry has been one of the fastest growing industries in modern history. Today, India has 287 million mobile phone users, and mobile phones account for 88% of all telecommunication users. The rural sector accounts for more than 25% of all wireless phone users and this proportion is bound to grow as the access and affordability of mobile phones continues to increase. In the years ahead, an ever-increasing number of people will be exposed for long periods of time to radiation from mobile phones.

In 2008, the Telecom Commission (the policy-making body of the Department of Telecommunications, Government of India) adopted the emission guidelines prescribed by the International Commission on Non-Ionising Radiation Protection (ICNIRP). Studies have demonstrated that usage behaviours, such as duration of usage and predominant one-sided use of mobile phones are some of the chief risks that increase likelihood of hazards resulting from mobile phone use.

This article attempts to present the basic biophysics of these devices and explain the health hazards of electromagnetic radiation exposure in terms of thermal and non-thermal effects. We also present some preventive measures that can reduce the risk of these hazards. ©

INTRODUCTION
The mobile phone industry has been one of the fastest growing industries of recent times. At present, India has 287 million mobile phone users and nearly 1,15,000 towers which emit electromagnetic radiations. By the end of 2010, the number of mobile phone users is estimated to rise to 500 million.1,2 Mobile phones account for 88% of all telecommunication users and the rural sector accounts for more than 25% of all wireless phone users1 and this proportion is bound to grow as the access and affordability of mobile phones continues to increase. In the years ahead, an ever-increasing number of people will be exposed for long periods of time to radiation from mobile phones.

Mobile phones, by various biophysical mechanisms, may be responsible for a wide variety of health hazards. This article attempts to present the basic biophysics of these devices and explain the health hazards of electromagnetic radiation exposure in terms of thermal and non-thermal effects. We also present some preventive measures that can reduce the risk of these hazards.

BIOPHYSICAL CHARACTERISTICS OF MOBILE PHONE TECHNOLOGY
Wireless telephones are two-way radio transmitters.

When a call is made, voice (sound energy) is converted to radiofrequency (RF) waves (electromagnetic energy). Radio waves travel through the atmosphere to the nearest base station and, at the call receiver’s end, waves travel from the base station to the receiver’s wireless phone (Fig. 1). The receiving instrument re-converts radiofrequency waves to sound energy and the receiver hears this as voice in the ear piece.

In mobile phone technology, there are two main transmission protocols. The Global System for Mobile Communication (GSM, originally from Groupe Spécial Mobile) was established in 1987 and is the dominant protocol used in India and most European countries. Another protocol, founded by Qualcomm (a USA-based mobile service provider), is the Code Division Multiple Access (CDMA) standard. It is the major protocol used

Fig. 1 : Two-way radiofrequency transmission by a mobile phone.
machines, to name a few. (especially plasma screens), refrigerators and washing radars, industrial heaters, cardiac pacemakers, televisions encountered by people. These include microwave ovens, absorption rate (SAR) and is expressed in watts per kilogram (W/kg) or milliwatts per gram (mW/g). The electromagnetic energy absorbed by a unit mass of tissue is known as the specific absorption rate (SAR), i.e. cycles per second. The electromagnetic energy formed per second. Wavelengths are measured in metres (or fractions of metres), while frequency is measured as Hertz (Hz), i.e. cycles per second. The electromagnetic energy absorbed by a unit mass of tissue is known as the specific absorption rate (SAR) and is expressed in watts per kilogram (W/kg) or milliwatts per gram (mW/g).

In addition to mobile phones, electromagnetic radiation emission occurs from numerous devices that are frequently encountered by people. These include microwave ovens, radars, industrial heaters, cardiac pacemakers, televisions (especially plasma screens), refrigerators and washing machines, to name a few.

**Radiation Safety Standards**

The identified whole-body threshold level of exposure in terms of Specific Absorption Rate (SAR) is 4 watts per kilogram (4 W/kg). Safety standards are derived from the recommendations of two expert organizations, the United States Federal Communications Commission (US FCC) and the International Commission on Non-Ionising Radiation Protection (ICNIRP). The ICNIRP is a constituent of the World Health Organisation (WHO), which sets international standards for regulation of exposure to EMF. It gives advice on health hazards of exposure to non-ionizing radiation to everyone with an interest in the subject. ICNIRP's information and advice covers all of the non-ionizing radiations including, the optical radiations (ultraviolet, visible light, infrared and lasers), static and time-varying electric and magnetic fields and radiofrequency (including microwave) radiation, and ultrasound. It works in concert with the WHO, the International Radiation Protection Association (IRPA, the professional representative body for radiation protection professionals worldwide), the US National Council for Radiation Protection and Measurements (NCRP), the US FCC, the Institute of Electrical and Electronic Engineers (IEEE), the International Commission on Illumination (CIE), the International Electrotechnical Commission (IEC) and others.

The whole-body human absorption of RF energy varies with the frequency of the RF signal. The most restrictive limits on whole-body exposure are in the frequency range of 30-300 MHz where the human body absorbs RF energy most efficiently. For exposure of the general public to mobile phone radiation, the US FCC limits RF absorption (in terms of SAR) to 1.6 W/kg, averaged over one gram of tissue. The maximum limit prescribed by the ICNIRP is slightly higher, at 2 W/kg averaged over ten grams of tissue. ICNIRP guidelines (Table 1), which provide the benchmark for maximum permissible emission are being followed in Spain, Germany, Australia, France and Japan.

The Government of India Department of Telecommunications (DoT) adopted the guidelines set by the International Commission on Non-Ionising Radiation Protection (ICNIRP) and released a set of draft guidelines. The salient points from these guidelines are:

- It will now be mandatory for handset manufacturers to display the radiation levels on mobile phones through the menu options, making it easier for consumers to know the exact levels for each mobile device before purchase. These proposals are being framed by the Telecom Engineering Centre (TEC), which is the technical arm of the DoT.
- The draft guidelines also propose that children under 16 years of age be discouraged from using mobile phones, while adding that setting up telecom base stations within the premises of schools and hospitals may be avoided because children and patients are more susceptible to electromagnetic fields.
- Thus, all wireless phones sold in India will have to follow safety guidelines. Each agency has the authority to take action if a wireless phone produces hazardous levels of RF energy. This implies that Base Station operators will have to conduct an audit and provide certification that they are meeting the prescribed standards.
- At a later stage TEC may also set up a conformity
assessment body (CAB) to measure radiations and provide certifications.

Unfortunately, the Cellular Operators Association of India (COAI) has opposed the regulation demanding display of SAR values emitted by the handset. COAI also opposed a move from DoT to set up a CAB, which will measure radiation from mobile base stations and provide certifications to the operators. There are over 100,000 mobile towers in the country, which are known to emit electromagnetic radiation. Cellular operators maintain that the level of radiation at any tower is under permissible levels and the assessment body will only result in delays and will also add significantly to the costs of the operators, neither of which are desirable in an environment where aggressive rollout and growth of service at the most affordable tariffs is the need of the hour.

**Hazardous Effects of Mobile Phone Radiation**

Tiny electrical currents exist in the human body due to the chemical reactions that occur as part of the normal bodily functions, even in the absence of external electric fields. For example, nerves relay signals by transmitting electric impulses. Most biochemical reactions from digestion to brain activities go along with the rearrangement of charged particles. The heart is also highly dependent on orderly flow of electric current to ensure proper functioning.

Low-frequency electric fields influence the human body just as they influence any other material made up of charged particles. When electric fields act on conductive materials, they influence the distribution of electric charges at their surface. They cause current to flow through the body to the ground. Low-frequency magnetic fields induce circulating currents within the human body. The strength of these currents depends on the intensity of the outside magnetic field. If sufficiently large, these currents could cause stimulation of nerves and muscles or affect other biological processes.

Heating is the main biological effect of the electromagnetic fields of radiofrequency fields. In microwave ovens, the same property is employed to cause heating. The heating effect of radiowaves forms the underlying basis for the current safety guidelines. Biological effects that result from heating of tissue by RF energy are often classified as thermal and non-thermal.

Thermal effects: Exposure to very high RF power densities, to the order of 100 mW/cm² or more, can result in heating of biological tissue and an increase in body temperature. Tissue damage in humans could occur during exposure to high RF levels because of the body’s inability to cope with or dissipate the excessive heat that is generated. The extent of this heating depends on several factors including radiation frequency, size, shape, and orientation of the exposed part, duration of exposure, environmental conditions and efficiency of heat dissipation. Additional factors include the angle at which the phone is held and also the model of the cellphone. The testes and the eyes have been found to be especially vulnerable. Changes in sperm counts and altered sperm mobility could occur after exposure to very high temperatures. Exposure to EMF may also alter DNA, which would make it possible for transmission of genetic diseases to the offspring.

General eye irritation and cataracts have sometimes been reported in workers exposed to high levels of radiofrequency and microwave radiation, but animal studies do not support the idea that such forms of eye damage can be produced at levels that are not thermally hazardous. There is no evidence that these effects occur at levels experienced by the general public.

Non-Thermal effects: Various non-thermal effects have been briefly summarized under appropriate headings below.

Neurological: Since the head region is the most affected by mobile phone radiation, research on neurological diseases has been the most intense. Specifically, brain tumors have been intensively studied in case-control studies, prevalence studies and in vitro analyses. Risk factors such as predominant one-sided usage, high daily usage and exposure for a large duration of time (usually >10 years) have been found in some studies to raise the risk of brain tumors. Various tumors studied include gliomas, acoustic neuromas, meningiomas and neurocytomas.

Non-specific symptoms: Some individuals report “hypersensitivity” to electric or magnetic fields which is characterized by a variety of non-specific symptoms, which afflicted individuals attribute to exposure to EMF. The symptoms most commonly experienced include dermatological symptoms (redness, tingling, and burning sensations) as well as neuroasthenic and vegetative symptoms (fatigue, tiredness, concentration difficulties, dizziness, nausea, heart palpitation, and digestive disturbances). The collection of symptoms is not part of any recognized syndrome. There is little scientific evidence.
to support the idea of electromagnetic hypersensitivity. A recent systematic review found no consistent reactions under properly controlled conditions of electromagnetic field exposure. Research on this subject is difficult because many other subjective responses may be involved, apart from direct effects of fields themselves.

Psychiatric Problems: Recently, a phenomenon called as ringtone anxiety (better known as the neologism, ‘ringxiety’) was described by psychiatrists in which users imagine their phone to be ringing or feel it vibrating when it actually is not. Trials are underway to examine effects of mobile phones on sleep disorders, memory impairment and other psychiatric conditions.

Cardiovascular: It has been shown that mobile phones can cause electromagnetic interference in the functioning of implanted pacemakers. The pacemaker can be affected either by impedance to delivery of the stimulated pulses that regulate the heart’s rhythm or by causing the device to deliver irregular pulses and leading to arrhythmias or by causing it to ignore the heart’s rhythm and deliver pulses at a fixed rate. As the prevalence of heart disease requiring pacemakers increases, we can expect a larger number of people to be living with these devices. Thus, a greater population subgroup would be exposed to the interference of mobile communicating devices.

Endocrine: Influence of electromagnetic fields emitted by GSM-900 cellular telephones on the circadian patterns of gonadal, adrenal and pituitary hormones in men was studied by a French group. The study investigated the effect on steroid (cortisol and testosterone) and pituitary (thyroid-stimulating hormone, growth hormone, prolactin and adrenocorticotropin) hormone levels in healthy male volunteers. Each individual’s pre-exposure hormone concentration was used as his control. The circadian profiles of prolactin, thyroid-stimulating hormone, adrenocorticotropin and testosterone were not disrupted by RF EMFs emitted by mobile phones. For growth hormone and cortisol, there were significant decreases of about 28% and 12%, respectively, but none of these remained so in the post-exposure period or reverted back to normal.

Reproductive: Rats subjected to radiation from mobile phones were found to have damaged DNA and low sperm count, leading to infertility and reduction in testis size. A similar finding was made by a pilot study conducted at the Jawaharlal Nehru University, New Delhi. The forthcoming large-scale study planned by the Indian Ministry of Health also aims to address this issue in human beings.

Health effects in subjects living near mobile phone base stations: A study from Austria observed that the erection of mobile telephone base stations in inhabited areas can have possible health effects caused by emitted microwaves. Several cognitive tests were performed, and wellbeing and sleep quality were assessed. Average power density was slightly higher in the rural area (0.05 mW/m²) than in the urban area (0.02 mW/m²). There was a significant relation of some symptoms to measured power density; this was the highest for headaches. They concluded that effects on wellbeing and performance could not be ruled out.

Physical inactivity: A Finnish study concluded that the time spent using a mobile phone lead to inactivity and was associated with an increased risk of overweight. Increasing use of information and communication technology may be related to the obesity epidemic among adolescents.

Mobile phone use and unsafe driving: A survey of motorists found that using mobile phones while driving engage in many behaviours that place them at risk for a traffic crash, independent of the specific driving impairments that mobile phone usage may produce. The seriousness of this issue is at par with drunken driving, considering that both hamper cognitive skills considerably.

Miscellaneous hazards: Mobile phones can act like fomites and spread infections especially in hospitals. It is not safe to carry cellular phones to sterile environments like the operation theatres. It has been suggested that they may cause interference with medical equipment, especially in critical care units, though data are not entirely conclusive for all mobile frequencies.

Precautions To Minimize Hazards From Mobile Phone Radiation

As cellular telephones are a relatively new technology, we do not yet have long-term follow-up data on their causative role in various biological effects. It is impossible to prove that any product or exposure is absolutely safe, especially in the absence of such data. To avoid potential risks, simple steps can be employed to minimize exposure and effects of RF radiation. Since time is a key factor in how much exposure a person receives, reducing the amount of time spent using a wireless phone will reduce RF exposure.

- If extended conversations by wireless phone must be conducted on day to day basis then placing more distance between the body and the source of the RF could help, since the exposure level drops off dramatically with distance. For example, you could use a headset and carry the wireless phone away from your body or use a wireless phone connected to a remote antenna located outside the vehicle, a hand-held phone with a built-in antenna connected to a different antenna mounted on the outside of the car or built into a separate package, or a headset with a remote antenna to a mobile phone carried at the waist.

- Devices marketed under Cell/Wave Guard™ were found to reduce a significant amount of radio frequency emissions could be used to prevent these emissions from entering the body. While this represents a significant reduction it is not known if it is enough to guard against all potential effects. However, it is the best technology easily available today.

- Digital mobile phones emit lower RF radiation compared to analog telephones, thus lowering potential adverse effects.
Most mobile phone providers give information about the SAR values on the batteries of these phones. Further information can be obtained from their websites, which mention SAR values according to the mobile phone models.

People with pacemakers should take some simple precautions to be sure that their cellular phones do not cause a problem. For example, holding the phone to the ear opposite the side of the body where the pacemaker is implanted will add some extra distance between the pacemaker and the phone. And since cellular phones transmit electromagnetic energy whenever they are “on” (even when they are not being used), pacemaker wearers should avoid placing a switched-on phone in close proximity to the pacemaker (i.e. in a shirt pocket).

The Indian Government’s Ministry of Health has proposed India’s first large-scale, multi-centric study involving 40,000 participants, over 5 years to assess the health hazards of RF radiation. The study will be carried out jointly by Jawaharlal Nehru University (JNU) School of Environmental Sciences and the All India Institute of Medical Sciences (AIIMS). It is hoped that these data will help in the understanding of the effects of mobile phones on human physiology. Practising safe mobile phone usage habits and avoiding excessive use will go a long way in minimizing biological hazards from these devices.

REFERENCES


