

Long Term Exposure of Mobile Phone Radiation and Human Health

Nigus Maregu

Wolaita Sodo University College of natural and computational science department of physics, Wolaita Sodo
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Abstract

Mobile or cellular phones are now an integral part of modern telecommunications. It has become a vital element for every person but now a day it has also become an addiction to the young generation. Different scientists study the adverse effects of mobile phone radiation. The increasing use of mobile phone in our environment is one of the reasons why many scientists believe some disease rates are on the rise. Most of them including world health organization (WHO) argued that mobile phone radiation is bad for human health and some of them are not. It is scientifically proved that the radiations produced by the mobile phones can cause different disease; especially the brain of human being and it will give them the difficulty to cope up with their systematized daily course of action and soon cause health injury. In this paper, it has been shown that there lies a tangible congruence of the result of analysis based on an extensive review on different published research's, on effects of mobile phone radiation towards long term users. We conclude that; long term use of mobile phone will cause different disease, such as Alzheimer, migraine, infertility, cancer, eye defect, electromagnetic hypersensitivity and interface etc and also it can affect psychology anxiety, insomnia, depression etc. So customers should be prudent regarding on the use of mobile phone. Consumer policy has become more cautious and governmental security and regulatory institutions function on behalf of citizens.

Keywords: Mobile phone, radio frequency, cancer risk, precautionary measure

1. Introduction

The telecommunication industry is experiencing a robust growth on a global scale and the cell phones are becoming an essential tool in the global modern society. As they allow people to maintain constant and continuous communication without hampering their freedom of movement. Since the introduction of cell phones in the mid - 1980's, there has been significant increase in the number of cell phone users and installations of base stations.

Safety is a legitimate concern of the users of wireless equipment, particularly, in regard to possible hazards caused by electromagnetic (EM) fields. There has been growing concern about the possible adverse health effects resulting from exposure to radiofrequency radiations (RFR), such as those from mobile communication devices. Mobile communication is where signal is transferred via electromagnetic wave through radio frequency and microwave signals. This signal produces electromagnetic radiation in the form of thermal radiation that consists of harmful ionizing radiation and harmless non-ionizing radiation [1, 2].

The most important and common part of technology in our life is mobile phone technology. We bring mobile phone with us in every where that we go and use it on a daily basis. It is being the part of our daily life. A mobile phone started out as a simple device that had only numbers, and most people used them for emergencies only. Now a day's cell phones have many futures such as phone calls, text messaging taking pictures accessing the web, using calculator etc as many accessories. People become addicted in cell phone because they are getting many facilities by using it. Mobile phones have many advantages but there have some disadvantages too. It has become a vital element for every person but now a day it has also becoming an addiction to the young generation [3].

Different scientists argued that the mobile phone radiation is too bad for human health [4]. The possible health hazard of cell phone can be classified in to two: these are thermal effect and non thermal effect. The main concern of non ionizing radiation is the thermal (heating or "cooking") effect. In cause of person using a cell phone most the heating effect will occur at the surface of the head, causing its temperature to increase by a fraction of degree [6]. Non thermal effects are reduce to the wave forms (causing mechanical vibration) that are determined by the frequency of carrier waves and then modulation that is way to put the information travels on the carrier wave. Certain wave forms can be used to restore of health some mental illnesses such as depression, sleepless, etc. This shows that the nerve system of people could be affected by the wave forms [7].

Though phone manufacturers, regulatory agencies and service providers assure that cell phones are safe, the global debates and controversy over the health effects of these products continue. Several studies on health effects present irrefutable evidence confirming that increased occurrences of some symptoms and diseases are directly related to the exposure of cell phone operating frequencies and output power levels. It is therefore a great demand for studying in the laboratory about biological effects that can lead to health impairment. The renewal knowledge can be used as a foundation for new exposure limits that take into account of thermal and non-thermal biological effects of microwave radiations from cellular phones and base stations.

Motivated by the activities of cell phone concerning with human body we will try to pick up our best assumptions by study different articles and finally suggest some suggestions [1].

2. Methods of the research

This research aspires the relation between mobile phone radiation and human health by collecting different published research journals. There are hundreds of research journals are available on the internet that studies the relation between mobile phone radiation and its effect on human health, from these we have been selected about fifty one journals based on their quality.

2.1. Radio frequency radiation of cell phone

The Global System for Mobile Communication (GSM) and Code Division Multiple Access (CDMA) systems are digital mobile phone services consisting of base station antennas which communicate with the mobile phone via radio frequency (RF) transmission and also microwave among base stations communication. There are two sources of radio frequency exposure from the mobile phone system, base station antennas and the mobile phone or handset. Exposure from the antennas is continuous but very low, irradiates the whole body and exposes an entire community. A mobile phone network operates with two communicating elements the hand set and the base station.

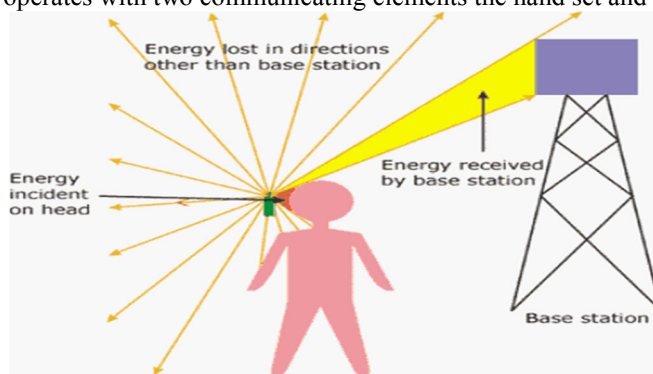


Figure:-1 Mobile phone, users and base station.

The mobile phone hand set transmits radio waves to the base station, and these carry the voice of the phone user. Similarly, the base station transmits radio waves to the mobile phone and these carry the voice of the person the phone user is listening too. The base station passes the signals to and from the phone network. Mobile phones communicate by transmitting radio waves through a network of fixed antennas called base stations.

Mobile or cellular phones are now an integral part of modern telecommunications. In many countries, over half the population use mobile phones and the market is growing rapidly. In some parts of the world, mobile phones are the most reliable or the only phones available.

Radiofrequency waves are electromagnetic fields, and unlike ionizing radiation such as X-rays or gamma rays, can neither break chemical bonds nor cause ionization in the human body [1].

2.2. Radiation absorption form mobile phones

Part of the radio waves emitted by a mobile telephone handset is absorbed by the human head. The radio waves emitted by a GSM handset can have a peak power of 2 watts, and a US analogue phone had a maximum transmit power of 3.6 watts. Other digital mobile technologies, such as CDMA2000 and D-AMPS, use lower output power, typically below 1 watt.

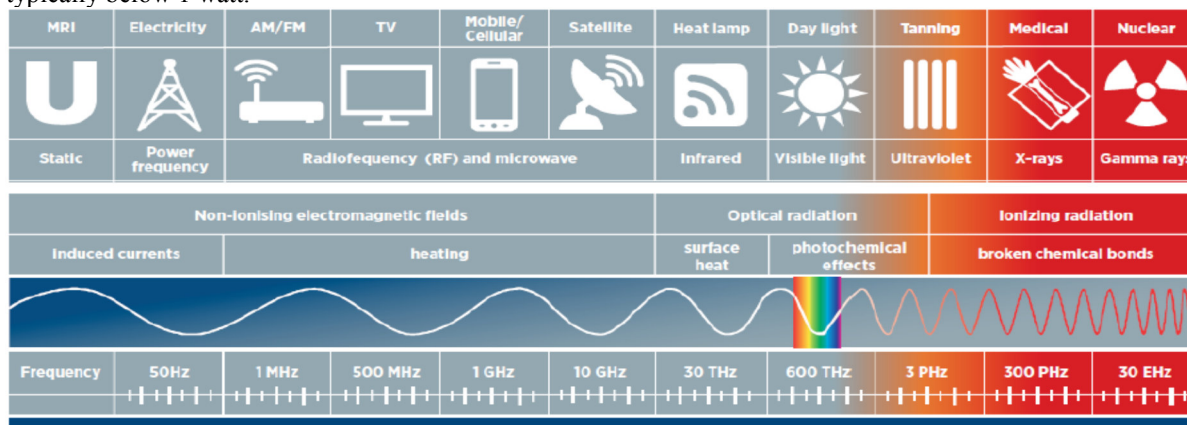


Figure 2: Electromagnetic spectrum.

Radiofrequency energy is a form of electromagnetic radiation. Electromagnetic radiation can be categorized into two types: ionizing (e.g., x-rays, gamma rays, radon, cosmic rays etc.) and non-ionizing (e.g., radiofrequency and extremely low frequency or low power frequency [2]. Exposure to ionizing radiation, such as from radiation therapy, is known to increase the risk of cancer. However, although many studies have examined the potential health effects of non ionizing radiation from radar, microwave ovens, and other sources, there is currently no consistent evidence that non-ionizing radiation increases cancer risk [2]. The only known biological effect of radiofrequency energy is heating. The ability of microwave ovens to heat food is one example of this effect of radiofrequency energy. Radiofrequency exposure from cell phone use does cause heating; however, it is not sufficient to measurably increase body temperature [6].

2.3. Health effects of radio frequency radiation

Thermal effects: One well-understood effect of microwave radiation is dielectric heating, in which any dielectric material is heated by rotations of polar molecules induced by the electromagnetic field. In the case of a person using a cell phone, most of the heating effect will occur at the surface of the head, causing its temperature to increase by a fraction of a degree. In this case, the level of temperature increase is an order of magnitude less than that obtained during the exposure of the head to direct sunlight. The brain's blood circulation is capable of disposing of excess heat by increasing local blood flow. However, the cornea of the eye does not have this temperature regulation mechanism and exposure of 2–3 hours duration has been reported to produce cataracts in rabbits' eyes at SAR values from 100-140W/kg, which produced lenticular temperatures of 41°C. There were no cataracts detected in the eyes of monkeys exposed under similar conditions [3, 1]. Premature cataracts have not been linked with cell phone use, possibly because of the lower power output of mobile phones.

Non-thermal effects: The communications protocols used by mobile phones often result in low- frequency pulsing of the carrier signal. Whether these modulations have biological significance has been subject to debate. Some researchers have argued that so-called "non-thermal effects" could be reinterpreted as a normal cellular response to an increase in temperature. The German biophysicist Roland Glaser, for example, has argued that there are several thermo receptor molecules in cells, and that they activate a cascade of second and third messenger systems, gene expression mechanisms and production of heat shock proteins in order to defend the cell against metabolic cell stress caused by heat. The increases in temperature that cause these changes are too small to be detected by studies such as reflex, which base their whole argument on the apparent stability of thermal equilibrium in their cell cultures. Other researchers believe the stress proteins are unrelated to thermal effects, since they occur for both extremely low frequencies (ELF) and radio frequencies (RF), which have very different energy levels [4]. Another preliminary study published in 2011 by The Journal of the American Medical Association conducted using fluorodeoxyglucose injections and positron emission tomography concluded that exposure to radiofrequency signal waves within parts of the brain closest to the cell phone antenna resulted in increased levels of glucose metabolism, but the clinical significance of this finding is unknown [1, 5].

2.4. Possible health effects of mobile phone radiation

Bhargavi K, KE Balachandrudu, Nageswar P Studies the connection between mobile phone radiations with health by using electroencephalogram machine. Analyses shows that mobile radiations effect human brain and GSM operated mobile phones has the higher effect on brain activity as compared to CDMA operated mobile phones [6]. The possible risks by radio frequency electromagnetic field exposure of the human body are a major concern for the society. If exposure is sufficiently intense, it can cause biological effects. The increasing use of mobile phone in our environment is one of the reasons why many scientists believe some disease rates are on the rise. It is scientifically proved that the radiations produced by the mobile phones affect especially the brain of human being and it will give them the difficulty to cope up with their systematized daily course of action and soon cause health injury.

Mobile users are affected by mobile radiation and they suffer from various diseases. It has been proved that SAR value of a particular mobile phone may cause damage to human health to some extent. But it is not the only reason that is responsible for hazards. There might be variety of reasons. It has been observed that a mobile having a low SAR value may cause more damage than a mobile having that of higher value. So the rate of hazards of human health due to use of mobile phone might not thus be estimated only on SAR value; rather many other factors such as long term use, large amount of duration are accrued in this regard.

The use of cell phone is increasing tremendously day by day but most of the people have no knowledge how the cell phones impact on human health. It is almost clear from the research that the radiation from cell phone is responsible for many diseases like brain tumor, headaches, short-term memory loss, different types of heart diseases etc. In the presence of various RF sources, including cell phone handsets and broadcast antennas which contribute the overall environmental exposure has become a great concern about safety of this new technology and as well as human health [7]. However we should contribute more efforts to transform mobile radio communication to an efficient, secure and convenient system useful for the welfare and positive advancement to the global society

[7].

Several studies among sizeable populations have found a doubling of the risk of some brain tumors after 10 or more years' mobile phone use for about half an hour a day. Studies indicate a possible link between mobile phone use and tumors of the parotid gland (a salivary gland in the region normally highly exposed to radiation during phone use) [3, 4, 7, 8].

The health effects of long term use of mobile phone will be causes different disease, these are listed below.

A. Blood-brain barrier effects

Swedish researchers from Lund University (Salford, Brun, Persson, Eberhardt, and Malmgren) have studied the effects of microwave radiation on the rat brain. They found a leakage of albumin into the brain via a permeated blood-brain barrier [8, 9, 10 and 11]. This confirms earlier work on the blood-brain barrier by Allan Frey, Oscar and Hawkins, and Albert and Kerns [11].

B. Cancer

In 2006 a large Danish study about the connection between mobile phone use and cancer incidence was published. It followed over 420,000 Danish citizens for 20 years and showed no increased risk of cancer [12]. The German Federal Office for Radiation Protection (Bundesamt für Strahlenschutz) considers this report inconclusive [13]. The 13 nation interphone project the largest study of its kind ever undertaken has now been published and did not find a solid link between mobile phones and brain tumours [14]. But the World Health Organization's International Agency for Research on Cancer (IARC) has classified the radiation emitted by mobile phones as "possibly carcinogenic to humans" (Class 2B) [15].

C. Nervous System and Cognitive effects

The effects of exposure to RF-EMFs from cell phones on the human nervous system and brain activity have been the subject of a large number of studies in recent years. The effects of exposure to RF-EMFs from cell phones on the human nervous system have been the subject of a large number of studies in recent years. Minor effects on brain activity have been found. But have not been related to adverse health effects. No consistent significant effects on cognitive performance and memory have been observed [16, 17, 18, and 19].

Experiments by Narayanan et al. found that memory retention and retrieval were significantly affected in mobile phone RF-EMR exposed rats. Several other studies have also measured cognitive effects in animals [16, 17, 18, and 19].

Examples of effects in humans include impaired cognitive performance after exposure to a pulsed electromagnetic field and slower response times to spatial working memory tasks when exposed to RF from a standard GSM cellular phone placed next to the head of male subjects [22, 23]. Most studies have focused on changes in cognitive performance after short-term RF-EMF exposure, and most have involved young and middle-aged male and female subjects. Since children represent a sensitive subgroup, as their brains are not yet completely mature, they may react differently to RF-EMF exposure [24].

A 2011 review of the literature on the effects of RF-EMF exposure on cognitive performance measured in humans found inconsistent study results due to differences in methodology, sample size, composition of study groups, experimental design and exposure setup, as well as the exposure conditions. The authors note, "The lack of a validated tool, which reliably assesses changes in cognitive performance caused by RF-EMF exposure, may contribute to the current inconsistencies in outcomes" [19].

The effects of RF-EMF exposure from cell phones on central nervous system (CNS) disorders, such as Alzheimer's disease, migraine, or vertigo, has been the focus of recent epidemiological research and the study recommended more research in this area, along with RF exposure reducing measures, until more data have been obtained [20, 21, 22, 25].

D. Reproductive Effect

Several research studies have examined the effects of RF-EMF on the male reproductive system. The focus of research has included effects on semen quality and potential changes associated with RF-EMF exposures and electromagnetic radiation. The potential effects of RF-EMF from cell phones on fertility were investigated in a 2005 epidemiological study, which found correlations between cell phone use and changes in semen quality [26]. An experimental study that same year involving exposure of male mice to RF-EMR noted a significant genotoxic effect on epididymal sperm. Other studies have correlated the duration of exposure to cell phones with defects in sperm count, motility, viability, and normal morphology, but most of the studies have been small and the evidence remains equivocal [27, 28, 29].

Agarwal et al. found out that cell phone use decreased semen quality in 361 men by reducing sperm count, motility, viability, and normal morphology, and that the decrease in sperm parameters was dependent on the duration of daily exposure to cell phones and independent of the initial semen quality. The same research group placed men's semen samples 2.5 centimeters away from a cell phone, in talk mode, for one hour. This is an average distance between the testes and the pants' pocket. Semen exposed to RF electromagnetic waves emitted from cell phones had higher levels of damaging free radicals, lower sperm motility (the ability of sperm to move and swim), lower sperm viability (the percentage of live sperm), and possibly greater oxidative stress [30].

E. DNA Damage

Researchers have studied the potential of RF-EMFs to cause changes in a cell's genetic material (DNA) and/or to damage the genome. "Genotoxic" substances can potentially cause genetic mutations or cellular damage that can contribute to the development of cancerous tumors. The European Union's in vitro reflex study of human cells exposed to cell phone microwave radiation (2000 to 2004) showed that radiation from cell phones has the potential to damage the genome of isolated human cells [31].

The lead author of the study argues that there is enough evidence that RF radiation can alter the genetic material of exposed cells [31]. Other scientists agree: A recent review papers on the genotoxic effects of RF-EMF found that reported a genotoxic effect. Numerous studies in laboratory animals have demonstrated that mobile phones or simulated RF radiation exposures can damage cells. While some authors have suggested that this could lead to neurological damage, other authors have not [32, 33, 34, and 35]. There is no standard testing methodology for the evaluation of possible genotoxic effects of EMFs, which may in part explain why the findings are inconsistent [36].

DNA studies have particular importance with respect to children. Researchers who placed a mobile phone at a one-meter (about a yard) distance from human cells found a reduction in DNA repair in cells with double-strand DNA damage. The strongest effects were observed in stem cells. Since stem cells are more active in children, researchers argue that children may be at an increased risk of cancer from cell phone exposures [37].

F. Ocular Effects

Thermal effects from microwave radiation have been reported to cause cataracts and effects on the retina, cornea and other ocular systems, but non-thermal effects are less well understood [38, 39].

Studies of non-thermal effects of RF-EMFs from mobile phones are relatively recent. Researchers have recommended further study of effects on the eye lens and lens epithelial cells [40, 41]. Electromagnetic fields from microwave radiation have been shown to have a negative impact on the eye lens. One study warns, "High frequency microwave electromagnetic radiation from mobile phones and other modern devices has the potential to damage eye tissues, but its effect on the lens epithelium is unknown at present" [42].

G. Psychological Effect

The addictive nature of cell phones has concerned psychologists for years. Recently, psychologists have warned that smart phone users are especially at risk for becoming addicted to their devices. In a recent study, subjects checked their phones many times a day. People may check their phones out of habit or compulsion, but habitually checking can be a way to avoid interacting with people. Some people can experience withdrawal symptoms typically associated with substance abuse, such as anxiety, insomnia, and depression, when they are without their smart phones. Most of the studies conducted on the potential psychological effects of cell phones have focused on young adults and adolescents [43].

According to a recent Columbia University study, "communication, responsibility, and relationships all seem to be negatively influenced by the use of text messaging" in both early and late adolescent groups. Frequent mobile phone use has been associated with stress, sleep disturbances, and symptoms of depression among young adult men and women. Yen et al. Cite "withdrawal symptoms without cellular phone use" as a common psychological reaction in adolescents to the removal of cell phone access [44].

H. Electromagnetic Hypersensitivity interference

Some individuals experience adverse medical symptoms from exposure to electromagnetic fields. People with electromagnetic hypersensitivity (EHS) report symptoms from even low levels of exposure to non-ionizing electromagnetic radiation. Concerns that cell phones may be associated with EHS are largely a result of complaints from cell phone users about headaches, nausea, dizziness, blurred vision, and other symptoms. Few studies have been conducted on electromagnetic hypersensitivity from exposure to mobile phones [45].

When mobile phones are used close to some medical devices (including pacemakers, implantable defibrillators, and certain hearing aids) there is the possibility of causing interference. There is also the potential of interference between mobile phones and aircraft electronics.

I. Children's Damage

Children may be potentially susceptible to RF effects because of their developing nervous systems, increased levels of cell division, undeveloped immune systems, thinner skulls, and more conductive brain tissue. Children experience greater RF penetration relative to head size, and longer lifetime exposure in comparison with adults [46].

Epidemiological studies demonstrating health effects of RF radiation from cell phones on children are extremely limited. The few studies that have specifically focused on cell phones and children have focused on cancer, behavior, and neonatal heart rate.

At the first international conference on mobile phones and health in 2008, Lennart Hardell, M.D., Ph.D., reported that people who started mobile phone use before the age of 20 had a more than fivefold increase in glioma. Those who started using mobile phones when they were young were also five times more likely to develop acoustic neuroma [47].

Heart Rate Pregnant women exposed to EMF emitted by mobile phones on telephone-dialing mode for 10 minutes a day during pregnancy and after birth had babies with statistically significant increases in fetal and neonatal heart rate. The study involved 90 women with uncomplicated pregnancies. The authors suggest that this may result from a physiological response to the pulsed magnetic fields, and recommend avoidance of cellular phone use during early weeks of gestation, and also recommend further studies [48].

J. Cause as Car Accident

Research has clearly shown an increased risk of traffic accidents when mobile phones (either handheld or with a "hands-free" kit) are used while driving and walking.

Exposure limit Guidelines

Radiofrequency exposure limits for mobile phone users are given in terms of Specific Absorption Rate (SAR) – the rate of radiofrequency energy absorption per unit mass of the body. Currently, two international bodies^{1,2} have developed exposure guidelines for workers and for the general public, except patients undergoing medical diagnosis or treatment. These guidelines are based on a detailed assessment of the available scientific evidence [49, 50]. International guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) are based on a careful analysis of all scientific literature (both thermal and non-thermal effects) and offer protection against all identified hazards of RF energy with large safety margins. Both measurements and calculations show that RF signal levels in areas of public access from base stations are far below international guidelines, typically by a factor of 100 or more. RF exposure levels to a user from mobile handsets are considerably larger but below international guidelines. Likewise, classifications of laser applications and requirements of safety are provided in many references. But we are not seen an international bodies that develop guidelines about long term exposure of mobile phone radiation.

3. Summary

Several studies argued that:

- Studies among sizeable populations have found a doubling of the risk of some brain tumors after 10 or more years' mobile phone use for about half an hour a day.
- A possible link between mobile phone use and tumors of the parotid gland (a salivary gland in the region normally highly exposed to radiation during phone use).
- Laboratory and observational studies have found damage to sperm, impaired female fertility and damage to the unborn fetus from exposure to mobile phone radiation.
- Even after short periods of exposure to phone radiation, DNA strands can be broken and there are effects on gene expression. Phone radiation is capable of disturbing the DNA repair mechanism, and this can continue for several hours after the phone use.
- Phone radiation can damage the blood-brain barrier, causing a leakage of albumin into the brain.
- Significantly reduced levels of melatonin in humans after about half an hour's mobile phone use per day.
- Effects on heat shock proteins (similar to a stress response), oxidative stress, apoptosis (cell death) and damage to cell membranes have been identified in research. These are thought to have a role in cancer development.
- Children's brain tissue is more conductive, radiation penetration is greater relative to head size, and children will have a longer lifetime of exposure than adults: all increase their risk of harm.
- They absorb up to double the energy that a large adult does when making a mobile phone call and that the energy can be concentrated in certain areas of the child's brain, resulting in up to 3 times the absorption in these areas.
- One study has found that the risk of brain cancer after prolonged mobile phone use is significantly greater in younger users than in adults.
- The electromagnetic fields produced by mobile phones are classified by the International Agency for Research on Cancer as possibly carcinogenic to humans.

4. General Precautionary measures to use mobile phone

The high-frequency electromagnetic fields which are produced when using mobile phones are often much stronger than the fields people are exposed to from mobile phone base stations in their vicinity. The following recommendations may be helpful:

1. Use a fixed network telephone if you have the choice between using a mobile phone and a fixed network phone. Always make the fixed telephone your first choice.
2. Keep the calls short.
3. Buy a phone with a long 'talk time'. It is more efficient, with less powerful emissions.
4. Don't use your phone when the reception is weak, the phone then needs more power to communicate with the base station and so the radio wave emissions are higher.
5. Try to use the phone outdoors rather than inside, or move close to a window to make a call.

6. Send text messages whenever possible. Then mobile phone is at greater distance from the head.
7. Use a mobile phone with a low SAR value which exposes the user's head to rather low fields. Refer <http://www.bfs.de/de/elektro>.
8. Use mobile phone headsets. The field intensity decreases strongly with the distance to the antenna. A headset serves to increase the distance between the head and the antenna of the mobile phones so that the user's head is exposed to lower fields during phone calls.
9. Wait until the connection has been established. The GSM mobile phone uses maximum transmitting power while connecting. Do not hold the mobile phone to your ear while you are waiting for the connection to be established. In this case it is advisable to use phone that can display answering condition.
10. Keep the phone away from areas of the body such as eyes, testicles, breasts and internal organs.
11. Limit usage as much as possible if pregnant.
12. Switch off your phone when not in use.
13. Use hands-free to decrease the radiation to the head.
14. Do not use telephone in a car without an external antenna and crossing road.

5. Conclusion

Globalization is the new mantra. In this age, it is very difficult not to have technology. But as shown in this study, with every technology invented to facilitate human beings, there come certain hazards. long term use of mobile phone will cause different disease, such as Alzheimer, migraine, infertility, cancer, eye defect, electromagnetic hypersensitivity and interface etc and also it can affect psychology anxiety, insomnia, depression etc. So customers should be prudent regarding on the use of mobile phone. Consumer policy has become more cautious and governmental security and regulatory institutions function on behalf of citizens. The other way to beat these negative aspects of new technologies is again, a new but better technology. Electromagnetic radiation is everywhere. More and more wireless communication services are expected, so is the artificial electromagnetic radiation. It seems that there is no way to reverse this trend. Scientists and engineers must develop better and safer wireless systems and devices. Smaller cell size, better base station antennas and other more advanced technologies will allow future cell phones to radiate much lower power and make technology a real boon. And also mobile phone users should be minimizing long term use.

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