

# MOBILE PHONE RADIATION AND HEALTH

**Mobile phone radiation and health** concerns have been raised, especially following the enormous increase in the use of wireless mobile telephony throughout the world (as of August 2005, there were more than 2 billion users worldwide). This is because mobile phones use electromagnetic waves in the microwave range. These concerns have induced a large body of research (both epidemiological and experimental, in non-human animals as well as in humans). Concerns about effects on health have also been raised regarding other digital wireless systems, such as data communication networks.

The World Health Organization has concluded that serious health effects (e.g. cancer) are very unlikely to be caused by cellular phones or their base stations, and expects to make recommendations about mobile phones in 2007–08.

However, some nation's radiation advisory authorities, including those of Austria, Germany, and Sweden, recommend their citizens to minimize radiation. Examples of recommendations are:

- Use hands-free to decrease the radiation to the head.
- Keep the mobile phone away from the body.
- Do not telephone in a car without an external antenna.

Still, the use of "hands-free" is not recommended by the British Consumers' Association

## Health hazards of handsets

Part of the radio waves emitted by a mobile telephone handset are absorbed by the human head. The radio waves emitted by a GSM handset, can have a peak power of 2 watts, and a US analog phone had a maximum transmit power of 3.6 watts. Other digital mobile technologies, such as CDMA and TDMA, use lower output power, typically below 1 watt. The maximum power output from a mobile phone is regulated by the mobile phone standard it is following and by the regulatory agencies in each country. In most systems the cellphone and the base station check reception quality and signal strength and the power level is increased or decreased automatically, within a certain span, to accommodate for different situations such as inside or outside of buildings and vehicles.

The rate at which radiation is absorbed by the human body is measured by the Specific Absorption Rate (SAR), and its maximum levels for modern handsets have been set by governmental regulating agencies in many countries. In the USA, the FCC has set a SAR limit of 1.6 W/kg, averaged over a volume of 1 gram of tissue, for the head. In Europe, the limit is 2 W/kg, averaged over a volume of 10 grams of tissue. SAR values are heavily dependent on the size of the averaging volume. Without information about the averaging volume used comparisons between different measurements can not be made. Thus, the European 10-gram ratings should be compared among themselves, and the American 1-gram ratings should only be compared

among themselves.

## **Thermal effects**

One well-understood effect of microwave radiation is dielectric heating, in which any dielectric material (such as living tissue) 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. Premature cataracts are known as an occupational disease of engineers who work on high power radio transmitters at similar frequencies. Premature cataracts however, have not been linked with cell phone use, possibly because of the lower power output of mobile phones.

It has been claimed that some parts of the human head are more sensitive to damage from increases in temperature, particularly in anatomical structures with poor vasculature, such as nerve fibers. More recent results from a Swedish scientific team at the Karolinska Institute (Lonn, Ahlbom, Hall and Feychting) have suggested that continuous use of a mobile phone for a decade or longer can lead to a small increase in the probability of getting acoustic neuroma, a type of brain tumor. The increase was not noted in those who used phones for less than 10 years.

## **Non-thermal effects**

The communications protocols used by mobile phones often result in low-frequency pulsing of the carrier signal.

Some researchers have argued that so-called "non-thermal effects" could be reinterpreted as a normal cellular response to an increase in temperature. The noted German biophysicist Roland Glaser, for example, has argued that there are several thermoreceptor 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.

Swedish researchers from the University Lund, Salford, Brun, Perrson, Eberhardt and Malmgren, have studied the effects of microwave radiation on the rat brain. They found a leakage of albumin into brain via a permeated blood-brain barrier.

## **Genotoxic effects**

Research from Greece towards the end of 2006 found a direct causal relationship between mobile phone radiation and DNA damage. In December 2004 a pan-European study named REFLEX (Risk Evaluation of Potential Environmental Hazards from Low Energy Electromagnetic Field (EMF) Exposure Using Sensitive in vitro Methods), involving 12 collaborating laboratories in several countries showed some compelling evidence of DNA damage of cells in in-vitro cultures, when exposed between 0.3 to 2 watts/kg,

whole-sample average. There were indications, but not rigorous evidence of other cell changes, including damage to chromosomes, alterations in the activity of certain genes and a boosted rate of cell division.

## **Mobile phones and 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 over 20 years and showed no increased risk of cancer. The German Federal Office for Radiation Protection (BfS) consider this report as inconclusive.

In order to investigate the risk of cancer for the Mobile Phone user, a cooperative project between 13 countries has been launched called INTERPHONE. The idea is that cancers need time to develop so only studies over 10 years are of interest.

The following studies of long time exposure have been published:

- A Danish study (2004) that took place over 10 years and found no evidence to support a link.
- A Swedish study (2005) that draws the conclusion that "the data do not support the hypothesis that mobile phone use is related to an increased risk of glioma or meningioma."
- A British study (2005) that draws the conclusion that "The study suggests that there is no substantial risk of acoustic neuroma in the first decade after starting mobile phone use. However, an increase in risk after longer term use or after a longer lag period could not be ruled out."
- A German study (2006) that states "In conclusion, no overall increased risk of glioma or meningioma was observed among these cellular phone users; however, for long-term cellular phone users, results need to be confirmed before firm conclusions can be drawn."
- A joint study that draws the conclusion that "Although our results overall do not indicate an increased risk of glioma in relation to mobile phone use, the possible risk in the most heavily exposed part of the brain with long-term use needs to be explored further before firm conclusions can be drawn."

Other studies on cancer and mobile phones are:

- Tumour risk associated with use of cellular telephones or cordless desktop telephones, that states: "We found for all studied phone types an increased risk for brain tumours, mainly acoustic neuroma and malignant brain tumours".
- A Swedish study (2004) concludes: "Our findings do not indicate an increased risk of acoustic neuroma related to short-term mobile phone use after a short latency period. However, our data suggest an increased risk of acoustic neuroma associated with mobile phone use of at least 10 years' duration."

## **Electromagnetic hypersensitivity syndrome**

Some users of mobile handsets have reported feeling several unspecific symptoms during and after its use, such as burning and tingling sensations in the skin of the head and extremities, fatigue, sleep disturbances, dizziness, loss of mental attention, reaction times and memory retentiveness, headaches, malaise, tachycardia (heart palpitations) and disturbances of the digestive system. Some people, implying a causal relationship, have named this syndrome as a new diagnostic entity, EHS or ES (electrosensitivity). The World Health Organization prefers to name it "idiopathic environmental intolerance", in order to avoid the implication of causation.

## **Health hazards of base stations**

Another area of worry about effects on the population's health have been the radiation emitted by base stations (the antennas on the surface which communicate with the phones), because, in contrast to mobile handsets, it is emitted continuously and is more powerful. On the other hand due to the attenuation of power with the square of distance, field intensities drop rapidly with distance away from the base of the antenna. A 2002 survey study by Santini et al. found a variety of self-reported health effects for people who reported that they were living within 1,000 feet (325 meters) of cell towers in rural areas; or within 300 feet (100 meters) of base stations in urban areas. Fatigue, headache, sleep disruption and loss of memory were among the effects found.. However a study conducted at the University of Essex concluded that mobile phone masts were unlikely to be causing these short term effects in a group of volunteers who complained of such symptoms..

As technology progresses and data demands have increased on the mobile network, towns and cities have seen the number of towers increase sharply, including 3G towers which work with larger bandwidths. The buildup of networks has sparked protests over health concerns, of which examples can be seen from headlines around the world: locals pulling down base station masts, or even, in some countries, physically attacking installation crews, communities lobbying against the rollout of cell networks, protest banners, demonstrations near hospitals, houses and local schools.

Many measurements and experiments have shown that transmitter power levels are relatively low - in modern 2G antennas, in the range of 20 to 100 watts, with the 3G towers causing less radiation than the already present 2G network. An average radiation power output of 3 watt is used. The use of 'micro-cell geometries' (large numbers of transmitters in an area but with each individual transmitter running very low power) inside cities has decreased the amount of radiated power even further.

The radiation exposure from these antennas, while generally low level, is continuous. Some scientists believe that chronic, low-level radiation exposure may, over time, may be as harmful as higher-level, acute radiation exposures.

There are recent (Sept 2007) long-range epidemiological studies published, showing harmful health effects of people living or working near radio and base stations in Switzerland (Schwarzenburg), France, Spain, , and, Germany , Austria and Egypt. There is yet no study reporting no effect at all on people living around base stations in WHO EMF database .

## **Occupational health hazards**

Telecommunication workers who spend time at a short distance from the active equipment, for the purposes of testing, maintenance, installation, etc. may be at risk of much greater exposure than the general population. Many times base stations are not turned off during maintenance, because that would affect the network, so people work near "live" antennas.

A variety of studies over the past 50 years have been done on workers exposed to high RF radiation levels: Studies including radar laboratory workers, military radar workers, electrical workers, amateur radio operators. Most of these studies found no increase in cancer rates over the general population or a control group. Many positive results could have been attributed to other work environment conditions, and many negative results of reduced cancer rates also occurred.

## **Safety standards and licensing**

In order to protect the population living around base stations and users of mobile handsets, governments and regulatory bodies adopt safety standards, which translate to limits on exposure levels below a certain value. There are many proposed national and international standards, but that of the International Committee for Non-Ionizing Radiation Protection (ICNIRP) is the most respected one, and has been adopted so far by more than 80 countries. For radio stations, ICNIRP proposes two safety levels: one for occupational exposure, another one for the general population. Currently there are efforts underway to harmonise the different standards in existence.

Radio base licensing procedures have been established in the majority of urban spaces regulated either at municipal/county, provincial/state or national level. Telcos are required to obtain construction licenses, provide certification of antenna emission levels and assure compliance to ICNIRP standards and/or to other environmental legislation. Posterior alterations in the level of emission, number of active antennas or technology standards used in an installed antenna array might require new licensing procedures.

Many governmental bodies also require that competing telcos try to achieve sharing of towers so as to decrease environmental and cosmetic impact. Regarding this issue, it is an influential factor of rejection of installation of new antennas and towers in communities. In some cases, camouflaging the towers like tree trunks and other more visually acceptable structures has been tried.

The safety standards in the U.S. are set by the Federal Communications Commission (FCC). The FCC has based its standards primarily on those standards established by the Institute of Electronics and Electrical Engineering (IEEE), specifically Subcommittee 4 of the "International Committee on Electromagnetic Safety".

## **Lawsuits**

In the USA, a small number of personal injury lawsuits have been filed by individuals against cellphone manufacturers, such as Motorola, NEC, Siemens and Nokia, on the basis of allegations of causation of brain cancer and death. Many of these cases have been decided in a federal court, where it is required that

expert testimony relating to science must be first evaluated by a judge, in a Daubert hearing, to be relevant and valid before it is admissible as evidence.

## Precautionary principle

In 2000, the World Health Organization (WHO) recommended that the precautionary principle could be voluntarily adopted in this case. It follows the recommendations of the European Community for environmental risks. According to the WHO, the "precautionary principle" is "a risk management policy applied in circumstances with a high degree of scientific uncertainty, reflecting the need to take action for a potentially serious risk without awaiting the results of scientific research." Other less stringent recommended approaches are prudent avoidance principle and ALARA (*As Low as Reasonably Achievable*). Although all of these are problematic in application, due to the widespread use and economic importance of wireless telecommunication systems in modern civilization, there is an increased popularity of such measures in the general public. They involve recommendations such as the minimization of cellphone usage, the limitation of use by at-risk population (such as children), the adoption of cellphones and microcells with ALARA levels of radiation, the wider use of hands-off and earphone technologies such as Bluetooth headsets, the adoption of maximal standards of exposure, RF field intensity and distance of base stations antennas from human habitations, and so forth.

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