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Electromagnetic fields and public health: mobile telephones and their base stations

Mobile telephones, sometimes called cellular phones or handies, are now an integral part of modern telecommunications. In some parts of the world, they are the most reliable or only phones available. In others, mobile phones are very popular because they allow people to maintain continuous communication without hampering freedom of movement.

This fact sheet has been updated in the light of recent reviews of the effects on human beings of exposure to radiofrequency (RF) fields conducted by the World Health Organization (WHO) in November 1999, the Royal Society of Canada (1999), and a review on mobile phones and health by an expert committee in the United Kingdom (IEGMP 2000).

Use of mobile phones

In many countries, over half the population already use mobile phones and the market is still growing rapidly. The industry predicts that there will be as many as 1.6 billion mobile phone subscribers worldwide in the year 2005. Because of this, increasing numbers of mobile base stations have had to be installed. Base stations are low-powered radio antennae that communicate with users' handsets. In early 2000 there were about 20,000 base stations in operation the United Kingdom and about 82,000 cell sites in the United States, with each cell site holding one or more base stations.

Concerns for health

Given the immense numbers of users of mobile phones, even small adverse effects on health could have major public health implications. This fact sheet addresses these concerns.

Several important considerations must be kept in mind when evaluating possible health effects of RF fields. One is the frequency of operation. Current mobile phone systems operate at frequencies between 800 and 1800 MHz. It is important not to confuse such RF fields with ionizing radiation, such as X-rays or gamma rays. Unlike ionizing radiation, RF fields cannot cause ionization or radioactivity in the body. Because of this, RF fields are called non-ionizing.

Exposure levels

Mobile phone handsets and base stations present quite different exposure situations. RF exposure to a user of a mobile phone is far higher than to a person living near a cellular base station. However, apart from infrequent signals used to maintain links with nearby base stations, the handset transmits RF energy only while a call is being made, whereas base stations are continuously transmitting signals.

Handsets: Mobile phone handsets are low-powered RF transmitters, emitting maximum powers in the range of 0.2 to 0.6 watts. Other types of hand held transmitter, such as "walkie talkies", may emit 10 watts or more. The RF field strength (and hence RF exposure to a user) falls off rapidly with distance from the handset. Therefore, the RF exposure to a user of a mobile phone located 10s of centimetres from the head (using a "hands free" appliance) is far lower than to a user who places the headset against the head. RF exposures to nearby people are very low.

Base stations: Base stations transmit power levels from a few watts to 100 watts or more, depending on the size of the region or "cell" that they are designed to service. Base station antennae are typically about 20-30 cm in width and a metre in length, mounted on buildings or towers at a height of from 15 to 50 metres above ground. These antennae emit RF beams that are typically very narrow in the vertical direction but quite broad in the horizontal direction. Because of the narrow vertical spread of the beam, the RF field intensity at the ground directly below the antenna is low. The RF field intensity increases slightly as one moves away from the base station and then decreases at greater distances from the antenna.

Typically within 2-5 metres of some antennae mounted on rooftops, fences keep people away from places where the RF fields exceed exposure limits. Since antennae direct their power outward, and do not radiate significant amounts of

energy from their back surfaces or towards the top or bottom of the antenna, the levels of RF energy inside or to the sides of the building are normally very low.

Other RF sources in the community: Paging and other communications antennae such as those used by fire, police and emergency services, operate at similar power levels as cellular base stations, and often at a similar frequency. In many urban areas television and radio broadcast antennae commonly transmit higher RF levels than do mobile base stations.

Health effects

RF fields penetrate exposed tissues to depths that depend on the frequency - up to a centimetre at the frequencies used by mobile phones. RF energy is absorbed in the body and produces heat, but the body's normal thermoregulatory processes carry this heat away. All established health effects of RF exposure are clearly related to heating. While RF energy can interact with body tissues at levels too low to cause any significant heating, no study has shown adverse health effects at exposure levels below international guideline limits.

Most studies have examined the results of short-term, whole body exposure to RF fields at levels far higher than those normally associated with wireless communications. With the advent of such devices as walkie-talkies and mobile phones, it has become apparent that few studies address the consequences of localised exposures to RF fields to the head.

WHO has identified research needs to make better health risk assessment and promoted the research to funding agencies. Briefly, at present time this research indicates:

- **Cancer:** Current scientific evidence indicates that exposure to RF fields, such as those emitted by mobile phones and their base stations, is unlikely to induce or promote cancers. Several studies of animals exposed to RF fields similar to those emitted by mobile phones found no evidence that RF causes or promotes brain cancer. While one 1997 study found that RF fields increased the rate at which genetically engineered mice developed lymphoma, the health implications of this result is unclear. Several studies are underway to confirm this finding and determine any relevance of these results to cancer in human beings. Three recent epidemiological studies found no convincing evidence of increase in risk of cancer or any other disease with use of mobile phones.
- **Other health risks:** Scientists have reported other effects of using mobile phones including changes in brain activity, reaction times, and sleep patterns. These effects are small and have no apparent health significance. More studies are in progress to try to confirm these findings.
- **Driving:** 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.
- **Electromagnetic interference:** 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.

EMF guidelines

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.

What WHO is doing

In response to public concerns, WHO established the International Electromagnetic Fields (EMF) Project to assess the scientific evidence of possible health effects of EMF. Specific studies have been identified to address the problem of localised exposure. The project has established a formal mechanism for reviewing the research results and conducting risk assessments of RF exposure. It is also developing public information materials, and bringing together standards groups worldwide in an attempt to harmonise international exposure standards.

WHO is also conducting RF research. A large epidemiology study is being co-ordinated in over 10 countries by the International Agency for Research on Cancer (IARC) -- a specialised cancer research agency of WHO -- to identify if there are links between use of mobile phones and head and neck cancers. The study is anticipated to be completed in 2003.

Conclusions and recommendations

None of the recent reviews have concluded that exposure to the RF fields from mobile phones or their base stations causes any adverse health consequence. However, there are gaps in knowledge that have been identified for further research to better assess health risks. It will take about 3-4 years for the required RF research to be completed, evaluated and to publish the final results of any health risks. In the meantime, WHO recommends:

- **Strict adherence to health-based guidelines:** International guidelines have been developed to protect everyone in the population: mobile phone users, those who work near or live around base stations, as well as people who do not use mobile phones.
- **Precautionary measures**
 - Government: If regulatory authorities have adopted health-based guidelines but, because of public concerns, would like to introduce additional precautionary measures to reduce exposure to RF fields, they should not undermine the science base of the guidelines by incorporating arbitrary additional safety factors into the exposure limits. Precautionary measures should be introduced as a separate policy that encourages, through voluntary means, the reduction of RF fields by equipment manufacturers and the public. Details of such measures are given in a separate WHO Background document.
 - Individuals: Present scientific information does not indicate the need for any special precautions for use of mobile phones. If individuals are concerned, they might choose to limit their own or their children's' RF exposure by limiting the length of calls, or using "hands-free" devices to keep mobile phones away from the head and body.
- **Obey local restrictions on mobile phone use to avoid EMF interference:** Mobile phones may interfere with certain electromedical devices, such as cardiac pacemakers and hearing aids. In hospital intensive care departments mobile phone use can be a danger to patients and should not be used in these areas. Similarly mobile phones should not be used in aircraft as they may interfere with its navigation systems.
- **Driving safety:** In moving vehicles there is a well established increase in the risk of traffic accidents while the driver is using a mobile phone, either a conventional handset or one fitted with a "hands free" device. Motorists should be strongly discouraged from using mobile phones while driving.
- **Simple protective measures:** Fences or barriers or other protective measures are needed for some base stations (principally, those located on building rooftops) to preclude unauthorised access to areas where exposure limits may be exceeded.
- **RF absorbing devices:** Scientific evidence does not indicate any need for RF-absorbing covers or other "absorbing devices" on mobile phones. They cannot be justified on health grounds and the effectiveness of many such devices in reducing RF exposure is unproven.
- **Consultations with the community in siting base stations:** Base station sites must offer good signal coverage and be accessible for maintenance. While RF field levels around base stations are not considered a health risk, siting decisions should take into account aesthetics and public sensibilities. Siting base stations near kindergartens, schools and playgrounds may need special consideration. Open communication and discussion between the mobile phone operator, local council and the public during the planning stages for a new antenna can help create public understanding and greater acceptance of a new facility.
- **Providing information:** An effective system of health information and communications among scientists, governments, industry and the public is needed to raise the level of general understanding about mobile phone technology and reduce any mistrust and fears, both real and perceived. This information should be accurate, and at the same time be appropriate in its level of discussion and understandable to the intended audience.

Further reading

IEGMP (2000) Independent Expert Group on Mobile Phones, *Mobile Phones and Health*, National Radiological Protection Board (UK) 2000.

Royal Society of Canada (1999). *A review of the potential health risks of radiofrequency fields from wireless telecommunications devices*. Expert panel report prepared by the Royal Society of Canada for Health Canada. Ottawa, Royal Society of Canada, RSC.EPR 99-1.

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