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BIOLOGICAL EFFECTS OF ELECTRO MAGNETIC FIELD ON HUMAN HEALTH

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ABSTRACT:
Magnetic fields which are produced by electrical appliances, power lines, electromagnets includes RF fields, IF fields, ELF and static fields show biological effects on human health. The manifestation of the magnetic effects can be seen in psychological behavior. Magnetic fields can show therapeutic applications such as soft tissue healing appliances, hyperthermis for cancer treatment, diagnostic applications like MRI. Some industrial applications of IF fields like induction, heating and welding. Bone growth stimulation is used as therapeutic application in the ELF range. A very prominent application is MRI. Different types of tissue in the human body can be identified and located by using static magnetic fields.

Key words: Radio frequency, Static magnetic field, Power density, Specific absorption rate.

INTRODUCTION:

Magnetic fields[1] are produced by electrical appliances, power lines, electromagnets and everything that carries electric current. A much more important question regards the possible health risks associated to static and ELF magnetic field exposure. A magnetic field is an invisible force field created by a magnet or as a consequence of the movement of electric charges (flow of electricity).

The magnitude (intensity) of a magnetic field is usually measured Tesla (T or in mT), but it can also be measured in Gauss (G). The intensity of the field decreases with distance from the field source.

Neurological effects are caused by changes in the nervous system. Factors that act directly or indirectly on the nervous system causing morphological, chemical or electrical changes in the nervous system can lead to neurological changes. The final manifestation of these effects can be seen in psychological changes.

RADIO FREQUENCY FIELDS (RF Fields)

Sources and distribution of exposure in the population:

The sources of RF Fields are mobile communication, broadcasting or medical and industrial applications. The existing RF sources are operated in different frequency bands and can be sub divided in several categories: Many devices of this type are mobile RF transmitters[2]. One of the examples is mobile phones; more than 1.5 billion people are using mobile phones worldwide. The most common mobile communication technologies in EUROPE are the digital technologies GSM 900, GSM 1800 and UMMTS, analogue technologies. The limit for mobile phone use is the specific absorption rate (SAR) of 2 W/Kg for the human head.

The maximum peak power level of a DECT system is 250mW,of a WLAN system 200mW.It has to be taken into account also in this case that the average power is much lower than the peak value.

Sources operated far away from the human body

Such sources are typically fixed installed RF transmitters. An example is base stations that are an essential part of mobile communication networks necessary to establish link between the mobile telephone and the rest of the network. The range of exposure of the general population due to GSM signals is typically between some hundred nW/sq.m and some tens of mW/sq.m. The reasons for this large variation are both technical and environmental factors including distance. For UMTS, the available measurements are limited and so far the traffic is rather low compared to GSM. In some countries digital audio broad casting systems are already in operation. Other examples of sources relevant for far field exposure of the general population are civil and military radar systems, private mobile radio systems, or new technologies like WiMax.

Medical applications[3]

These include heating of tissue or burning cells. Diagnostic applications, like magnetic resonance imaging (MRI), are allowed to exceed the basic restrictions of Council Recommendation 1995/519/EC as there is a benefit for the patient.

Cancer

Studies on cancer in relation to mobile telephony have focused on intracranial tumours because deposition of energy from RF fields from a mobile phone is mainly within a small area of the skull near the handset .When whole body exposure is considered, as in some occupational and environmental studies, also other forms of cancer have been investigated.

Epidemiology

The few studies on residential exposure to RF fields from transmitters had serious methodological limitations. In total, about 30 papers of original studies on mobile phone use and cancer were published in the last 5 years. With regard to brain tumours, results from the first four components of the Interphone study suggest no risk increase for meningioma or glioma. Acoustic neuromas, benign tumours that develop very slowly, arise from the Schwann cells, which enfold the vastibulocochlear nerve (8th cranial nerve).

Discussion

Limitation in the current studies, long-term mobile phone users have had hardly more than 10years of regular use of mobile phones, which still may be relatively short latency period, particularly for slowly growing benign tumours. Prospective long term follow up studies over come both the limitations of retrospective exposure assessment and the latency problem and are recommended as a powerful long-term surveillance system for variety of potential end points, including cancer, to fill current gaps in knowledge.

Symptoms

A variety of non specific symptoms (for example neuro vegetative symptoms like headache, fatigue dizziness and concentration difficulties) has been suggested to be triggered by exposure to RF fields. These possible health effects have been discussed and studied mainly from two different aspects:

1. A possible increase in symptoms in populations living close to mobile communication base stations.
2. Reports from individuals that exposure to RF from mobile phones (and sometimes also base stations) triggers symptoms.

Nervous system effects[4]

Five aspects are usually considered in toxicology regarding the nervous system : morphology, brain function, electro-physiology, behavior and development. The most surprising effect was that very low SAR values (mW/kg) caused increased permeability of the Blood-Brain-Barrier (BBB) in rats.

Human studies

In humans, transitory minor effects (both positive and negative) have been observed on ECG patterns, sleep structure, and cognitive processes. Results from earlier studies on learning and memory at non- thermal RF levels have not been corroborated. No

morphological effects have been observed below thermal threshold.

Miscellaneous effects on human
Initial observations of a blood pressure decrease after mobile phone exposure have not been replicated. The only effects on cardio-vascular functions that have been replicated are increased blood-flow in the external ear.

Reproduction and development
The end points studied include spontaneous abortions, birth weight, gender ratio, and congenital malformations although positive findings have been reported.

Sensitivity in childrens
RF penetration is greater relative to head size, and they have a greater absorption of RF energy in the tissues of the head at mobile telephone frequencies.

INTERMEDIATE FREQUENCY FIELDS (IF FIELDS)[5]
Intermediate frequencies are, in the frame of this report, defined as frequencies between 300 Hz and 100 Hz. They involve two different mechanisms, namely induced currents and dielectric absorption. Those two phenomena depend on the kind of field, electric or magnetic, and on the frequency.

Sources and distribution of exposure in the population
Applications are induction hobs and hotplates, electric engines and badge readers. Some industrial applications like induction heating and welding need to be mentioned. Some medical applications exist in the IF range, one such example is electro surgery used very commonly in hospitals.

Health effects
Groups that have been studied include VDU (video display units) users and radio and telegram operators. The studied out comes include ocular effects, cardiovascular effects, cancer, and reproductive effects.

EXTREMELY LOW FREQUENCIES[6]
The most prominent frequencies are 50 and 60Hz and their harmonics, often called power frequencies. The major sources are household appliances, nearby power and high voltages transmission lines, and domestic installations. In some cases trains have to be considered, too. Looking at occupational exposure, installations of the electric power industry, welding, induction heaters and electrified transporting systems are important examples of ELF exposure sources.

Exposure of the general population
Prominent examples are high voltage transmission lines operated between 110 and 400 KV at 50 or 60Hz.The exposure due to magnetic flux density depends on the actual current on the line; fields up to 40 μT are possible but are usually lower. The highest magnetic flux densities can be found close to several domestic appliances that incorporate motors, transformers, and heaters. Such exposure levels are very local and decrease rapidly with the distance.

Exposure of workers
Examples of industrial applications in the ELF range are induction and light arc ovens or welding devices.

Medical application
Bone growth stimulation is used as a therapeutic application in the ELF range. In this case coils are applied where the fracture is located to stimulate the healing process. Other application include transcranial magnetic stimulation, wound healing, or pain treatment. A diagnostic application is the bioimpedance measurement for cancer detection.

Cancer[7]
Epidemiology
The justification states limited evidence in humans based on consistent results from sound epidemiological studies showing an association with an increased leukaemia risk in children at field strengths above 0.3/0.4.Melatonin might play a role in the development of breast cancer.

Symptoms
A variety of symptoms like dermatological symptoms such as redness, tingling & burning sensation as well as neurovegitative

symptoms such as fatigue, headache, concentration difficulties, nausea, heart palpitation have been suggested to be caused by ELF field exposure.

Other health effects
Epidemiology
Reproduction & Development
ELF exposure might affect the risk of cardiovascular disease and some initial epidemiologic results supported this.ELF magnetic fields on the embryonic development of birds and other non-mammalian species, but the results are inconsistent.

Endocrine system
This is limited evidence of effects on melatonin production in experimental animals exposed to ELF magnetic fields.

Other effects
No consistent evidence have been found for cardiovascular or immune system effects of ELF fields.

STATIC FIELD
Sources and distribution of exposure in population[8]
Static magnetic fields up to some mT are found to in certain occupational settings, e.g., in aluminium & chloralkali industries, in arc-welding processes, and certain railway and underground systems. A very prominent application is MRI: different types of tissue in the human body can be identified and located by using static magnetic fields, magnetic gradients and RF fields.

Health effects
Known effects of magnetic fields are orientation of forces applied on biological molecules with magnetic properties: haemoglobin, rhodopsin (visual pigment), free radicals, nitric oxide; these effects are detectable at field levels of about 1 T, without known health consequences.

ENVIRONMENTAL EFFECTS[9]
Species that are strongly dependent on magnetic fields for orientation/migration (e.g. sharks and rays)
Species with a high vulnerability to stress due to poorly developed or impaired defence mechanisms.
In the last few years an increasing number of studies on the effects of EMF have concentrated on the measurement of more sensitive biomarkers.
These include:

- Antioxidant status/antioxidant enzyme measurements
- Stress markers e.g. alanine (plants) heat shock proteins(animals)
- Changes in cell growth(e.g. meristems in plants)
- DNA changes(e.g. using the comet assay)

CONCLUSION
About RF fields: The overall epidemiologic evidence suggests that mobile phone use of less than 10 years does not pose any increased risk of brain tumour or acoustic neuroma. For longer use, data are sparse, since only some recent studies have reasonably large numbers of long-term users. The technical development is very fast and sources of RF exposure become increasingly common. Yet, there is a profound lack of mechanistic understanding of effects below the guidelines and of information on individual RF exposure and the relative contribution of different sources to the overall exposure.

About IF fields: The extension to long term effects is based on weak grounds and on possibly unjustified assumptions about frequency dependence of effects. Proper evaluation and assessment of possible health effects from exposure to IF fields is essential because human exposure to such fields increases due to new and emerging technologies.
About ELF fields: ELF magnetic fields are possibly carcinogenic. This conclusion was based on epidemiological results indicating that ELF exposure might be a cause of childhood leukaemia. Some other diseases, such as neurodegenerative disease & brain cancer, the issue of a link to ELF fields remains open & more research is called for.

About static fields: Adequate data for proper risk assessment of static magnetic fields is

almost totally lacking. The advent of new technology, and in particular MRI equipment, makes it a priority for research.

COMMITTEE OPINION

Radio Frequency Fields (RF fields)[10]

A relatively large series of laboratory studies has not provided evidence of genotoxicity.

Intermediate Frequency Fields (IF fields)

Assessment of acute health risks in the IF range is currently based on known hazards at lower frequencies. Proper evaluation and assessment of possible health effects from long term exposure to IF fields are important because human exposure to such fields is increasing due to new and emerging technologies.

Extremely Low Frequency Fields (ELF fields)

Combined analysis of the epidemiological studies on the association between exposure to ELF and childhood leukaemia have strengthened the evidence of an association. Thus the overall evidence for 50/60Hz magnetic fields to produce childhood leukaemia must be regarded as being limited**.**

Static fields

Adequate data for proper risk assessment of static magnetic fields are very sparse. Developments of technologies involving static magnetic fields, e.g. with MRI equipment require risk assessments to be made in relation to the exposure of personnel.

Environmental effects

The continued lack of good quality data in relevant species means that there is insufficient data to identify whether a single exposure standard is appropriate to protect all.

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