

POTENTIAL HEALTH IMPLICATIONS FROM
MOBILE TELECOMMUNICATION SYSTEMS**Watchdog Report**
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Chairman:
Prof. Dr. N. Leitgeb
Inst. of Biomed. Eng.
Inffeldgasse 18
A-8010 Graz, Austria

Scient. Secretary:
Dr. Gerd Friedrich
FGF
Rathausgasse 11a
D-53111 Bonn
Germany

COST Action 281 started its activities in September 2001. It constitutes a network of leading European research groups in the field of biologic effects of electromagnetic fields. For the time being, 23 European countries formally decided to participate in this action. Among other activities this watchdog report is the first of a series of annual reports intended to give a comprehensive overview to decision makers and the public on the progress in the field of potential health implications from mobile communication systems made during the past year.

Watchdog group:

Leitgeb, N.,	A
D'Inzeo, G.	I
Hietanen, M.	SF
McManus, T.	IRL
Verschaeve, L.	B
Wiert, J	F

Abstract

During the past 12 months there have been no major new studies that justify increased concern about adverse health effects below the recommended exposure limits. The new epidemiological studies could not demonstrate an extended cancer risk from mobile phone use. Previous indications for possible risks in several aspects could not be confirmed by actual laboratory investigations. No major challenge for the existing limits has arisen, however, several contradictory results made it evident that the need for replication and confirmation of inconclusive studies has increased. COST Action 281 proposes to combine efforts in international meta-studies based on commonly agreed protocols. In regard to the still unsolved questions and the dynamic development of new technologies and the widespread use of mobile telecommunication technology, the need for further research is clearly indicated and adequate resources need to be allocated also within the 6th European Framework Program. Aside research, COST Action 281 identifies a considerable deficit in adequate risk communication to executives as well as to the public which goes beyond issuing written information.

Social Aspects

There is still ongoing public concern about possible health effects of electromagnetic fields (EMF) from mobile communication systems, in particular from basestation antennas, which finds growing resonance as a political issue. This is going to be enhanced by the start of the rollout of the next generation of mobile communication systems (UMTS) this year and by the introduction of other emerging technologies in the near future.

Basic research

The debate on the existence of health relevant non-thermal interaction mechanisms is still going on¹. There were no dramatic steps made towards verification of interaction mechanisms which were already proposed in the past. Some new papers on modelling² and on

¹ R.K. Adair: "Vibrational Resonances in Biological Systems at Microwave Frequencies". *Biophysical Journal*, 82: 1147-1152 (2002)

A.I. Vistnes, K. Gjitterud: "Why Arguments Based on Photon Energy may be Highly Misleading for Power Line Frequency EMF", *Bioelectromagnetics*, 22: 200-204 (December 2002)

² F. Apollonio, M. Liberti, G. D'Inzeo: "Theoretical Evaluation of GSM/UMTS EMF on Neuronal Network Response". *IEEE Trans. Microwave Theory and Techniques*, 50: No 12 (2002)

RD Astumian: "Protein conformational fluctuations and free-energy transduction". *Applied Physics A*

possible interaction mechanisms³ have been presented and attention was directed towards membrane channel effects⁴, on membrane compartments and on networks of neurons⁵. An experimental test for detecting nonlinear behaviour of cells has been proposed⁶. In its London workshop COST 281 concluded that the debate on non-thermal effects is obscured by uncritical claims of

some authors in lack of adequate dosimetry, and that reported effects at exposures to fields below the limits are not necessarily non-thermal, since inhomogenous absorption patterns with hot spots within probes and switching temperature intervals of thermal equilibration systems can cause temperatures and temperature gradients high enough not to be neglected.

Materials Science And Processing. 75 (2): 193-206 (2002).

R. Goodman, M. Blank: "Insights into Electromagnetic Interaction Mechanisms". *J. Cellular Physiol.*, 192: 16-22 (2002)

TY Tsong, TD Xie: "Ion pump as molecular ratchet and effects of noise: electric activation of cation pumping by Na,K-ATPase". *Applied Physics A Materials Science And Processing*. 75 (2): 345-352 (2002)

³ D.J. Panagopoulos, A. Karabarbounis, L. H. Margaritis: "Mechanism for Action of Electromagnetic Fields on Cells". *Biochemical and Biophysical Research Communications* 298: 95-102 (2002)

F. G. A Reina, L. A. Pascual: "Influence of a Stationary Magnetic Field on Water Relations. Lettuce Seeds. Part I: Theoretical Considerations" *Bioelectromagnetics* 22: 589-595 (2001)

⁴ G.L. Hu, H. Chiang, Q.L. Zeng, And Y.D. Fu: "ELF Magnetic Field Inhibits Gap Junctional Intercellular Communication and Induces Hyperphosphorylation of Connexin43 in Nih3t3 Cells" *Bioelectromagnetics* 22: 568-573 (2001)

H. Mino, W. M. Grill: "Effects Of Stochastic Sodium Channels on Extracellular Excitation of Myelinated Nerve Fibers", *IEEE Transactions on Biomedical Engineering*, 49: No. 6, (June 2002)

E. Ottaviani, D. Malagoli, A. Ferrari, D. Tagliacuzzi, A. Conte, F. Gobba "50 Hz Magnetic Fields of Varying Flux Intensity Affect Cell Shape Changes in Invertebrate Immunocytes: The Role of Potassium Ion Channels" *Bioelectromagnetics* 23:292-297 (2002)

K. Varani, S. Gessi, S. Merighi, V. Iannotta, E. Cattabriga, S. Spisani, R. Cadossi, P.A. Borea, "Effect of Low Frequency Electromagnetic Fields on A2a Adenosine Receptors in Human Neutrophils", *British Journal of Pharmacology* 136: 57-66 (2002)

⁵ O. Kwon, H-T Moon: "Coherence Resonance In Small-World Networks Of Excitable Cells" *Physics Letters A* 298: 319-324 (2002)

⁶ Q. Balzano, "Proposed Test for Detection of Nonlinear Responses in Biological Preparations Exposed to RF Energy", *Bioelectromagnetics* 23: 278-287 (2002)

In vitro investigations

A number of major research projects within the 5th EU framework program (REFLEX, PERFORM B, CEMFEC) to gain better understanding of basic biological EMF interaction were started, however no specific outcome can be reported yet. The former indication of increased incidence of cellular micronuclei following RF- EMF exposure (continuous or pulsed) was supported by studies of resting cells^{7,8}. Other genetic effects were not found. However, since these findings could indicate a possible effect on chromosome segregation resulting in chromosome loss they are considered very important. Another investigation⁹ found indications for effects on numerous yet largely unidentified cellular proteins following an 1h weak field exposure to GSM signals, in particular an activation of the enzyme hsp27. Since this may affect the blood

⁷ Bisht, K. S., Moros, E.G., Straube, W. L., Roti Roti, J. L. (2002): The effects of 835,62 MHz FDMA or 847,74 MHz CDMA modulated radiofrequency radiation on the induction of micronuclei in C3H 10T(1/2) cells. *Radiation Research* 157, 506-515

⁸ Tice, R. R., Hook, G. G., Donner, M., McRee, DI, Guy, A. W. (2002): Genotoxicity of radiofrequency signals. I. Investigation of DNA damage and micronuclei induction in cultured human blood cells. *Bioelectromagnetics* 23, 113-126

⁹ Lesczynski, D., Joenvaara, S., Reivinen, J., Kuokka, R. (2002): Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human epithelial cells: molecular mechanisms for cancer- and blood-brain-barrier-related effects. *Differentiation* 70, 120-129

brain barrier and could facilitate the development of brain cancer, this issue merits further attention. In its Löwenstein workshop COST 281 proposed to perform an international meta-study based on commonly agreed protocols with several leading institutes involved to clarify the genotoxicity of RF fields.

In-vivo investigations

An important publication was the long-term study on transgenic mice¹⁰ with an improved protocol which could neither find an increase in lymphoma incidence nor a dose dependence on 898,4MHz GSM exposure and therefore failed to confirm the 2-fold increase of lymphoma initially reported in 1997.

Epidemiology

Epidemiological studies have been reviewed previously by several international multidisciplinary groups like IEGMP (Independent Expert Group on Mobile Phones, UK), RSC (Royal Society of Canada), AGNIR (National Radiation Protection Board Advisory Group on Non-Ionising Radiation, UK). It had been concluded that the epidemiological studies do not indicate that radiofrequency EMF affect the risk of cancer. The most recent assessments have been made by the SSK¹¹ (German Radiation Protection Board), GR¹² (Health Council of the Netherlands) and SSI¹³ (Swedish Radiation Protection Authority) concentrating on possible cancer risk from cellular phone use, coming to similar

conclusions. Recent epidemiological studies conducted in Denmark¹⁴, Finland¹⁵ and USA¹⁶ have investigated the association of cellular phones use and the cancer risk without indicating a causal relationship. Controversial conclusions were drawn from a Swedish epidemiological study¹⁷ by the authors and assessing bodies. Clarification is expected from the ongoing international epidemiological study (INTERPHONE) involving over 6.000 cases and a similar number of controls. The results of this project are expected for the year 2004.

A few, although inadequate, attempts were made to perform epidemiological studies on GSM basestations and non-specific health symptoms with inconclusive results. Following an official Swiss request, COST Action 281 issued an official scientific comment concluding from a scientific point of view there is insufficient basis for performing epidemiological studies on the health impact of mobile telecommunication basestations. A number of limitations would not allow to resolve small risk factors, should they exist, nor would it be possible to demonstrate the absence of a health risk. If for political reasons such studies would be considered as a tool in the risk communication process, there is a high probability of such an approach being counterproductive in communicating risk to the public (details

¹⁰ Utteridge, T.D., Gebiski, V., Finnie, J., Vernon-Roberts, B., Kuchel, T. R.: Long-Term Exposure of Eμ-Pim1 Transgenic Mice to 898,4 MHz Microwaves does not Increase Lymphoma Incidence. *Radiat. Res.* 158, (2002)

¹¹ Grenzwerte und Vorsorgemaßnahmen zum Schutz der Bevölkerung, Verlag Urban & Fischer, München 2001

¹² Knottnerus et. al.: *Mobile Phone and Health*. NL Gezondheidsraad 2002/01E

¹³ Boice Jr., J., McLaughlin, J. K. (2002): *Epidemiologic Studies of Cellular Telephones and Cancer Risk*. *SSI Rapport* 2002:16

¹⁴ Johansen, C., Boice, J. D., McLaughlin, J. K., Olsson J. H. (2001): *Cellular telephones and cancer- a nationwide cohort study in Denmark*. *J. Natl. Cancer Inst.* 93: 203-207

¹⁵ Auvinen, A., Hietanen, M., Luukkonen, R., Koskela, R. S. (2002): *Brain tumors and salivary gland cancers among cellular telephone users*. *Epidemiology* 13: 356-359

¹⁶ Muscat, J. E., Malkin, M. G., Shore, R. E., Thompson, S., Neugut, A. I., Stellman, S. D., Bruce, J. (2002): *Handheld cellular telephones and risk of acoustic neuroma*. *Neurology* 58: 1304-1306

¹⁷ Hardell, L., Hallquist, A., Hansson Mild, K., Carlberg, M., Phalson A. Lilja, A. (2002): *Cellular and cordless telephones and the risk for brain tumors*. *Eur. J. Cancer Prev.* 11:377-386

can be downloaded from www.COST281.org).

Dosimetry

Responding to concerns about adverse health effects from handset use by children COST Action 281 organised a specific workshop held in May 2002 where the need for specific dosimetric efforts was identified. The discussion showed in fact that recent research had concentrated on adults and that simple downsizing of head structures is not adequate for accounting for children. The need for specific research on young children was identified including analysis of tissue parameters and of the specific anatomical and physiologic differences compared with adults. A task force group was established within COST 281, additional work is going on in Japan and USA.

Specific attention has been directed to the dosimetric problem how to account for the ear in estimating local brain heating during handset use. A head phantom (SAM) has already been standardised in Europe by CENELEC, IEEE will follow soon. The differences in averaging over 10g (Europe) compared with 1g (USA) remain existing. Further dosimetric issues identified were the need for support in discussions on microthermoregulation¹⁸ and a more sophisticated exposure assessment for epidemiological handset studies which accounts for adaptive power control, discontinuous transmission mode, handset type and local handset placement. Studies have been carried out by Sweden, France, Italy, Japan and by IARC¹⁹, but further work need to be done including development of harmonised protocols for assessment of the environmental exposure to mobile telecommunication EMFs both in terms of spot measurements and ongoing monitoring.

¹⁸ WHO meeting in Cape Town

¹⁹ International Association for Research on Cancer

Exposure limitation

Within the last 12 months there has been a substantial amount of activity among national and international bodies developing standards and guidelines for limiting public and occupational exposure to EMF. ICNIRP has given advice how to assess pulsed magnetic fields and how to interpret its guidelines.

In Europe the Commission reported on the implementation of the Council Recommendation on limiting public EMF exposure by the member states and first steps have been made towards finalising a revised draft directive covering occupational exposure now based on the related ICNIRP guidelines.

Progress on worldwide harmonisation was demonstrated by the adoption of ICNIRP's recommendation by several European countries including France; Australia and New Zealand have issued a joint ICNIRP-based EMF standard which replaces their individual regulations, while Russia and China is still discussing.

Discussions on whether and how to adopt the precautionary principle as defined in the EU Commission's statement from 1999 and whether precautionary emission limits for individual sources should supplement the exposure limits were ongoing. WHO issued a document on this topic²⁰ warning against undermining the credibility of the science and exposure limits by introducing another precautionary limits, and giving helpful advice for risk communication.

This is contrasted by some CENELEC product standards (e.g. EN 50366 for household appliances) which are going even beyond ICNIRP's recommendations and misuse public exposure limits for limiting the emission of single sources leaving no more emission tolerance for existing environmental fields and other appliances nor for future developments.

²⁰ WHO: *Establishing a Dialogue on Risks from Electromagnetic Fields*. Geneva 2002