June 23-27, 2002, Québec City, Canada

The BEMS in Numbers

by Otto Petrowicz

Preface

The 24th Annual Meeting of the Bioelectromagnetics Society (BEMS 2002) took place outside the United States in Québec City, Canada. In their address to the annual meeting, this year's president, Asher Sheppard, and the chair of the program committee, Frank Prato, spoke about a new orientation of the meeting putting the emphasis on health-promoting effects of non-ionizing radiation and aiming at a better integration of students (undergraduates and graduates). Two plenary sessions would deal with the question how non-ionizing radiation effectively could be used for diagnosis and treatment of diseases, how this type of radiation had helped to gain new neurophysiological knowledge, and what future applications could be expected.

In fact, when looking at the meeting's program, you notice at once that new foci were established and risk-related issues such as „ELF magnetic field effects from high-voltage power lines" or „mobile communications" were pushed into to the background.

Compared with the Annual Meeting 2001 in St. Paul (Minnesota, USA) and other past conferences, it also was done on a smaller scale, as can be seen in the table under the paragraph „Statistics".

Table 1 lists single contributions subdivided into the categories symposia/workshops, plenary lectures, lectures and poster presentations from the 1994 meeting in Copenhagen up to this year's event in Québec. The trend of the past 4 meetings to include less lectures was confirmed.

Table 2 is meant to give an overview of the various scientific activities undertaken in different countries in the field of bioelectromagnetics.

As expected, 1/3 of the contributions came from the United States, followed by Japan with 12% and Germany with 10% of overall contributions; compared to 2002, that was an increase of 3%. Thus, the number of contributions from the EU member countries with a total of 82 was distinctly above that from the United States, a remarkable trend of research done in one year.

It was the first time that a peer review was done when selecting the abstracts and, even more so, lectures. Even members of the BEMS whose contributions (also as co-authors) previously had been accepted, were turned down. This proceeding met with strong protest which was expressed during member assembly. Critics said that, according to BEMS statutes, the association, and thus study presentation, should be open to everybody and that all member abstracts should be included. There was the accusation that, by this strategy, other opinions (than that of the program committee) were disqualified as „junk science". In the personal view of the rapporteur,

though, this measure has been overdue for a long time. Many other scientific societies have done so to improve scientific quality, as is the aim of the BEMS.

Topic foci

As mentioned above, compared to previous meetings, there was a change of foci. Table 3 seeks to demonstrate this by listing topics and contributions.

More clearly emphasized were the students' contributions (graduate and undergraduate) which were presented in two separate sessions devoted to the late Mary Ellen O'Connor. With overall 52 contributions, the quota of students was about 20% of all presentations.

One of the organizers' goals was successfully met. The bad habit of attendees to first enrol and announce a contribution (lectures and mostly posters) and then stay away, more or less was stopped by accepting contributions to the abstract book only after payment of meeting fees was made. So there were very few cancelled presentations (lectures, posters) compared to previous annual meetings.

Apart from the plenary sessions, following main topics are the focus of this report:

- radiofrequency fields and cognition
- in vivo human studies
- emerging therapies and medical applications
- epidemiology.

USAF Laboratory workshop

As a pre-meeting, on Sunday, June 22, 2002, traditionally a workshop of the US Air Force Laboratory took place dealing with the topic „Setting of scientifically based safety thresholds for human exposure to RF-EMF fields".

As an introduction, IEEE procedures for the setting of IEEE standards were presented, followed by topics associated with different, partially controversially discussed interaction mechanisms.

- thermoregulatory effects from RF energy absorption

Table 1
BEMS statistics – overview BEMS 1994 to 2002

	1994	1995	1996	1997	1998	1999	2000	2001	2002
	Copenhagen	Boston	Victoria	Bologna	St. Pete	Long Beach	Munich	St. Paul	Quebec
Mini symposia/ workshops	2	2	2	28 with 179 lectures	3	3	1	IEEE COMAR Air Force	IEEE USAF Lab.
Plenary lectures		4	12	2 with 9 lectures	11	3	3	4 with 3 presentations each	
Tutorials		2							
Lectures	198	122	94	168	86	98	107	92	115
Posters	201	280	238	304	203	170	227	139	138

Symposia/workshops, plenary lectures and poster presentations from 1994 in Copenhagen to this year's event in Quebec.

Table 2
Overview of contributions by countries

Country	plenary lectures	lectures	posters	total
USA	4	48	29	81
Japan	1	10	19	30
Germany	1	18	6	25
Italy		7	11	18
Russia		1	5	6
Canada	3	4	7	14
Un. Kingdom	1	4	5	10
China			9	9
Finland		4	3	7
France		4	8	12
Schwitzerland	1	1	3	5
Sweden	1	2	2	5
Norway		1	2	3
Mexiko			2	2
Austria		3	1	4
Taiwan	1	1	2	4
Hungary		1		1
Australia		1	2	3
Spain		1	1	2
Israel	1		1	2
Netherlands		1		1
Belgium			3	3
Soth Afrika		2		2
Ukraine			1	1

Out of 138 announced posters, only 120 were accepted into the abstract book and/or presented.

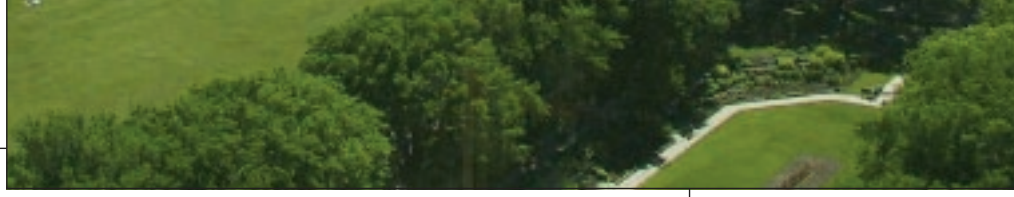
- behavioral and cognitive effects from microwaves
- radiofrequency EMF and calcium efflux
- radiofrequency EMF and cancer, mutagenesis and genotoxicity
- viability and cancer in laboratory animals after RF exposure
- effects of microwaves on the nervous system
- ocular effects from RF exposure
- perception of pulsed HF fields in humans
- epidemiological studies
- effects of HF radiation on homoestasis and metabolism
- RF EMF related to teratogenesis and developmental anomalies
- biological effects from radiofrequency radiation – in vitro studies with in vivo correlations.

The workshop did not succeed in presenting fundamentally new insights. Instead, an overview of to-date knowledge was given. Further, an overall evaluation of effects from high-frequency fields, dependent on frequency, intensity (SAR), and signal type (modulation), was done by thoroughly analyzing published studies performed in different research areas.

In the view of the lecturers, the following effects may serve as criteria for defining standards: thermoregulatory responses from HF and microwave radiation corresponding to exposure to other radiation

Table 3
Number of contributions by topic foci

Topic	plenary lectures	lectures		posters		
			students		students	total per topic
• Transcranial stimulation	3					3
• Pain – etiology and treatment	3					3
• Epidemiology	3	6		5		14
• Mechanisms	3	6	1	5	8	23
• *in vitro*		12	2	41	21	76
• RF fields and cognition		9		9	3	21
• *in vivo* human studies		6				6
• *in vivo* animal studies		12	3			15
• RF dosimetry		14	2	17		33
• Emerging therapies		14				14
• medical applications		6	1	8	1	16
• EMF exposure and other agents		8				8
• REFLEX: results (EU project)		8				8
• Instrumentation			3	8	5	16
• ELF effects			1			1
• RF effects			1			1
• Informatik + Analyse				4		4
• Standards				3		3
Total per column	12	101	14	100	38	265



and heating sources (in comparable studies). Under most environmental conditions (spatial temperature, etc.), exposure at <1 W/kg is seen as harmless. To date, exposure standards for humans can only be based on evidence of thermal effects.

„Behavioral and cognitive effects" from microwaves are a highly complex issue. There is no scientifically validated knowledge about this (see homepage and the paper „IEEE White Paper – Behavioral and Cognitive Effects of Microwave Radiation", both mentioned in the final report of the workshop).

In the past, a number of studies has been published on CA++ transport finding efflux effects. However, other laboratories could not confirm this findings. On balance, though the effect of electromagnetic radiation on Ca++ efflux is of scientific interest, its health-relevance is not obvious. Future research effort should focus on the question whether there is a functional significance or health-relevance, being the basis of scientific studies on C++ efflux and other research in this field.

There is a huge number of reviews on the topics of mutagenicity and toxicity. In this context, also an overview was given comparing studies with positive findings to the many others not providing any evidence for mutagenicity and toxicity. Available results cannot be seen as proof of a direct or indirect association between radiofrequency exposure and cancer initiation and/or promotion, or of synergistic interaction between RF exposure and other carcinogenic agents.

Overall, the literature published in recent years on long-term studies investigating viability and cancer is seen to confirm that RF exposure with SARs not leading to a significant increase in body temperature have no effect on biological systems.

Apart from cognitive and behavioral effects, effects on the nervous system are observed and should be discussed. It seems difficult to draw specific conclusions from literature data. Experimental parameters, endpoints, species and RF intensities are too different. It cannot be excluded either that electric brain activity is affected by conducting electrodes. Neurochemical alterations can occur in an anatomically discreet way. Moreover, distribution of energy absorption can vary between test animals. Overall, it is seen as difficult to evaluate many of the reported findings without external test and result replication.

During the workshop, an overview of the literature available on the topic of electromagnetic field exposure and eye damages was given. A number of localizations were looked at such as the lense, cornea, bulbus, and the vascular system. The differentiation between near- and farfield exposure seems to be relevant here, too. Verifiable alterations in the eye from HF radiation definitely are „thermal effects". The focus is on the initiation of lense alterations (cataracts). These occur at absorption rates from about 42 W/kg (rabbits), dependent on species and dose. Protein precipitation in the lense requires temperatures of around 41°C developing over a few days. Cataract development under near- and farfield conditions was reported to require RF exposure with SAR intensities of around 150 W/kg over a period of more than 30 min at the above mentioned temperature in and around the eye lense (on the other side, this SAR as a whole-body SAR over this period is immediately lethal for the animal).

Perception of pulsed radiofrequency fields is a well-examined phenomenon comparable with other sound perceived by the auditory system of different sound

characteristics. The sound of pulsed HF fields is low and can only be perceived in an otherwise very quiet environment. The following findings can be summarized:

- The perception of pulsed HF fields is based upon the same principles as sound perception. The site of HF energy transformation into sound pressure, however, is located in the environment of the cochlea.
- To perceive this HF induced sound, there has to be the ability to perceive sound of the kHz range, and HF pulse exposure has to be in the MHz range.
- The sound phenomenon is dependent on impulse energy, not on the average power density.
- The auditory phenomenon is caused by the thermoelastic expansion in the head, that is, head areas are heated by RF absorption by about 5 x 10^{-6}° C releasing a pressure wave. Direct stimulation of the CNS is excluded based on to-date knowledge.

To-date available epidemiological studies on cancer initiation from high-frequency fields show no increased risk of cancerogenesis. Evidence provided by most studies is weak and does not allow for clear interpretation with regard to causes and effect. Also, the evidential value often is questionable because of inconsistencies and faulty study design, the lack of information on further influential factors or factors that are a source of bias (confounders). In spite of that, an association between high-frequency exposure and cancer can neither be safely claimed nor excluded on the basis of to-date available data. The focus regarding cancer localizations is on leukemia, in adults as well as children, and brain tumors from the use of mobile phones. Thus, future epidemiological research is justified and necessary.

Effects of high-frequency fields on homoestasis and metabolism refer to human physiological regulatory systems and those of other exothermic living organisms. The following single organs are the subject of examination:

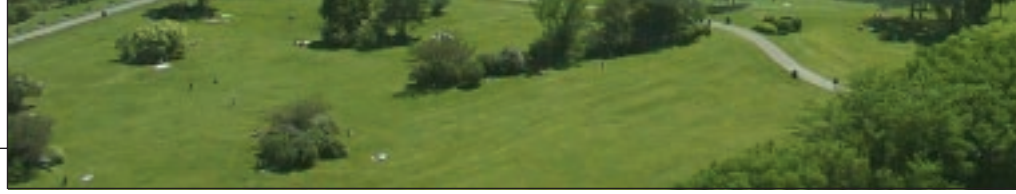
- hypophysis and its functions
- corticosteroids
- growth and thyroid gland
- pineal gland
- heart and circulatory system
- immune functions.

Our knowledge about effects of RF fields of higher frequencies up to microwaves on homoestasis is limited to tissue heating. Here, thresholds were identified below which no effects are observed, at 3 to 4 W/kg in most mammals and primates. At medium frequencies and below, other effects can occur that are not explained by heating and result from interaction with currents.

With regard to teratogenic effects of chronical RF EMF exposure in pregnant laboratory mammals, intensities not leading to significant temperature rises were reported to not be teratogenic for the fetus. Reported teratogenic effects are caused by a significant core temperature rise in the mother animals.

A moderate maternal temperature increase can be linked to slight growth delays in utero, an effect that can also be achieved at normal temperature by other sources. Thus, teratogenic activity as a thermal phenomenon seems to be confirmed.

Under the headline „In vitro correlations on the basis of in vitro findings“, in vitro effects found at different frequencies and modulation types were discussed.



However, in vivo no correlations were observed in effects (including cell death, DNA damages, chromosome aberrations, phenotypical mutations, and cell transformations). Thus, portability of in vitro findings across organisms, animals as well as humans, was questioned.

Early in the workshop, it was pointed out that lecturers had been asked to make their scripts available to the USAF Laboratory Board and thus to the general public (electronic version). For most topics, this was done, so further information can be found on the web site http://Grouper.ieee.org/groups/scc28/sc4.

Plenary sessions

Transcranial magnetic stimulation

This general session gave an introduction into the method of transcranial magnetic stimulation (TMS). At first glance, it seems quite surprising that this topic was the first focus of this year's event considering the previous predominance of high-frequency field effects. Nevertheless, it is justified as the activity of the Bioelectromagnetics Society is not exclusively about research undertaken to investigate mobile communication effects, but seeks to cover the whole spectrum of electromagnetism up to infrared radiation.

TMS has been developed over the past two decades based upon the application of external magnetic fields which are produced by coils (simple or figure-eight shaped) and applied at the skull. These strong pulsed magnetic fields up to 1 T have a pulse width of 0.1 to 0.2 ms and a repetition rate of 0.2 to 10 Hz producing transient fields in the brain (eddy fields). Also, at a sufficient intensity, they can excitate nerves, that is, have a stimulating effect.

The following applications are most important:

- functional brain-mapping: the vectorial orientation of the TMS technique allows to visualize part of the anatomical and functional areas of the cortex
- local nerve excitation (stimulation) – here, the position of the exogenous applicator and target area is of relevance both concerning

– the spatial distribution of the functions to be activated and
– the localization of corresponding neuronal structures

- the application during cognitive tests together with other methods for cerebral diagnosis, so, for example,

– the electroencephalogram (EEG)
– functional magnetic resonance imaging (fMRI) and
– positron emission tomography imaging (PET)

(EEGs provide information on the time course of observed effects. Both fMRI and PET show a higher spatial resolution also deep in the brain, rTMS (r = repetitive) allows different general applications performed alone or in correlation with the other mentioned methods.)

– effects on cortical stimulation capacity
– support of brain activity at special tasks
– interaction with other, external inputs such as anestetics, medicines, etc.
– effects also deep in the brain, especially controlled by EEG, fMRI and PET

- supporting healing processes in the brain, mainly of hippocampal neurons (to date only in animal experiments)

Mentioned examples of applications for therapy were:

- depression

– rTMS
– daily treatment with several intensities and stimulus sequences
– an average improvement of 30% of depression scores
– further results on applications were announced

- locomotor disturbances
- Parkinson's disease
- dystonia
- Tourette's syndrome

Overall, TMS is seen as an outstanding method for direct stimulation of human brain activity providing a new tool for research and clinical application in correlation with other methods of current brain diagnostics.

Pain: Etiology and treatment

The first contribution dealt with pain perception etiology describing objective methods for pain threshold localization. The focus was on the technigue of functional magnetic resonance imaging (fMRI). Brain activity is shown by a visualization of hemodynamic processes in the brain following dc and thus MRI signal intensity alterations. fMRI is described as a method for taking quantitave measurements of brain activity caused by stimuli. It is a non-invasive technique that does not affect the system to be measured. It is appliable both to humans and animals allowing for good portability.

During tests performed in subjects, brain areas could be localized affecting both acute as well as chronic physiological pain perception. This could open up the possibility to find a new therapeutical approach for non-pharmacological treatment of chronic pain by brain region modulation.

The second contribution as well dealt with pain perception etiology using experimental pain induction by physical quantities such as heat, pressure, current, but also by chemical agents. For measurement, in addition to fMRi, positron emission tomography (PET) was applied. Remarkably, there were differences between male and female pain sensitivity. Women

are slightly more sensitive to experimental pain stimuli (that is, acute pain); but women were shown as well to be more sensitive to chronic pain, for example musculoskeletal pain.

The last plenary contribution focused on magnetic field therapy methods for pain treatment as an alternative for pharmacological treatment and its many health-related and socio-economic consequences. Related numbers from the United States were presented. Acute und chronic pain is equally distributed across age, cultural status, and gender. Per adult costs of 10,000 to 15,000 $ for treatment are assumed, without considering the 30,000 people annually in need of treatment after aspirin-induced stomach disorders.

Naturally, the search for alternative methods of pain treatment was the focus of discussion. An increasingly important method is the application of pulsed low-frequency magnetic fields (PEMF). Commonly used magnetic field techniques and hypothesized effects were presented in detail. Effects on cognitive and behavioral processes are well-documented by animal experiments. However, positive effects on pain perception were explained by placebo effects.

Epidemiology

Maria Feychting of the Karolinska Institutet, Stockholm, introduced the methods of to-date epidemiology as applied when examining environmental issues. She defined epidemiology as a science of disease incidence and distribution in human populations. Epidemiology provides the most effective evidence of environmental factor risks as long as the studies make sense, are well-planned, and all potential influences are considered. Thus, knowledge about essentials and the sources of uncertainty is indispensable for study assessment.

Apart from the different study designs both based upon past data (retrospective case-control studies) and data to be raised in future (prospective cohort studies), potential error sources were addressed. These can roughly be divided into three categories:

- **selection bias** can occur when the probability to be included into a study depends on both factors, exposure as well as the disease. This is less critical in prospective cohort studies, but can be an important limitation in retrospective case-control studies (not only dependent on control selection but also on participant rate)
- **misclassification** probably concerns most studies occurring when collecting data, such as on exposure size or dose-effect patterns
- **confounders** falsely are seen as the most serious source of bias concerning other risks of the same disease. However, this problem is often exaggerated.

Apart from essentials of study performance and evaluation, issues were addressed that are of special importance when selecting cases, controls and cohorts: the meaning of specificity and sensitivity, of differential exposure misclassification and statistical test power depending on the number of exposed cases.

As a whole, this lecture on epidemiological studies and related problems was very informative but could not be easily understood without respective special knowledge and experience.

The second contribution was held by L.I. Kheifets of the WHO. Her observations referred to ELF magnetic fields and public health. Subject of the contribution was the cancer hazards identification by the International Agency for Research on Cancer (IARC), as well as a report of an Expert Advisory Group of the National Radiation Protection Board in the United Kingdom on neurodegenerative diseases. At the start, the basics of risk assessment (how epidemiological and toxicologic and/or animal experimental data can be used alone or in correlation) were dealt with.

IARC classification for cancerogenity of an agent was also presented:

- group 1: is carcinogenic to humans
- group 2A: probably is carcinogenic
- group 2 B: possibly is carcinogenic
- group 3: not classifiable
- group 4: is probably not carcinogenic

A number of agents being part of the different groups was mentioned:

group 1: asbestos, alcoholic drinks, benzene, mustard gas, radon gas, sun exposure, tobacco smoke inhalation, passive as well as active, x-rays, and gamma radiation

group 2A: diesel fumes, formaldehyde, PCB

group 2B: ELF electromagnetic fields, coffee, glass wool, styrenes, petrol fumes, etc.

This list shows that this classification evaluates the risks of using daily life objects, and that well-accepted matters and consumption goods have a similar or even higher risk than exposure to ELF fields. It was emphasized that this assessment was made based upon epidemiological data, not on animal experimental studies.

Subsequently, some more recent studies were commented on, as well as the results of two studies (Ahlbohm et al. 2000; Greenland et al. 2000) summarized in a pooled analysis. Here, the risk factor OR (odds ratio) was demonstrated to be dependent on magnetic field strength showing a nonlinear course:

Field strength	OR	95 % CI
< 0,1 µT	1	0.9 – 1,1
0.1 – 0.2 µT	1,1	0.7 – 1,3
0.2 – 0.4 µT	1,2	0.6 – 1,5
> 0.4 µT	2	1.2 – 3,3

At > 0.4 µT, the risks seems to double.

In conclusion, the future development and course of WHO risk assessment were outlined:

- ideas for new epidemiological studies on child leukemia and what these can contribute to the general discussion
- how WHO criteria for environmental issues may be further developed
- scientific method development for more exact risk assessment, especially of ELF magnetic field exposure
- how uncertainties should be dealt with

The last plenary contribution of this session focused on epidemiological practice providing a summary of data from epidemiological studies emphasizing potential health risks from mobile communications. The contribution consisted of three parts:

1. the role of epidemiological research related to radiofrequencies and microwaves
2. summary and evaluation of study validity aiming at examining cancer initiation and promotion
3. the future role of epidemiology in risk assessment.

Earlier studies were discussed and compared to newer investigations (Inskip 2000; Hardell 2001; and others). The majority of earlier epidemiological studies was rated as providing limited evidence. Mainly, methodological shortcomings and uncertain assessments of actual exposure are responsible for this. More recent studies could not find higher risks or statistical trends at different exposure levels.

Thus, the current state of knowledge is summed up as follows:

- To date, there is no clear and/or consistent evidence for a causal relation between RF/microwave exposure and cancer.
- There are limitations because of uncertain exposure levels and periods (further, until now observation periods – follow up – are too short, and valid control groups are hard to recruit).

A future IARC study (Interphone Study) will try to counter these limitations. Another important goal for the future is to correlate causal effects on the basis of biological and experimental study results.

Mechanisms of interaction

The last plenary session taking place towards the end of the meeting dealt with the general topic of different physical and biochemical interaction mechanisms. On the one side, a theoretical discussion pro-

viding the basis to describe and understand interactions of electromagnetic fields with biological systems, is necessary. On the other side, many were sceptical about this. Lectures and other contributions focused on different theories and, partially seen as established, mechanisms such as:

- radical pair mechanisms that, according to earlier studies with ELF, are relevant in the mT range. However, more recent studies suspect these effects already in the mT range. Here, new physical models are required on the following issues:
- ion resonance in the millisecond range
- biological electron transfer and tunneling
- Navigation skills of animals presently are a well-established model. In spite of that, the question remains if these models also are relevant for assumed bioeffects from EMF exposure.
- Transcranial magnetic stimulation (TMS) as a therapeutical method for behavioral disorders and epilepsy. In this case, the physical mechanism seems not to be the focus of interest, since induced electrical fields are assumed to stimulate neurons.

The relevance of hypotheses from theoretical and experimental investigations was emphasized. Many experiments are based upon underlying hpotheses, and only if a hypothesis is disproved by the experiment and a convincing alternative hypothesis is develop, progress is made.

Whereas the first contribution was a rather general discussion of known or assumed interaction mechanisms presently being the focus of investigations, the second contribution particularly referred to transduction mechanisms. The three phases of electromagnetic field interaction were dealt with in detail:

- perception
- conversion of a time-dependent signal (demodulation)
- conversion of the signal into a chemical reaction
- stimulus response – reaction of the generic system (subcellular structures, cell and/or organism)

Theories on these phases related to signal transduction were presented since long supported by the working group around Martin Blank.

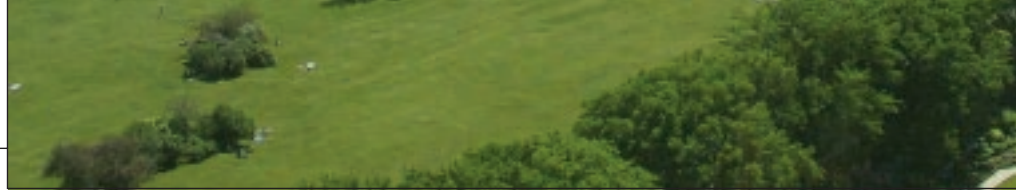
The third lecture again denied a direct effect on biological processes since such signals were overlayed by environmental noise.

Special issues

Radiofrequency fields and cognition

Effects of high-frequency exposure on learning capacity, behavior, memory, the EEG, etc., were one of the foci of the meeting. The contributions on this topic were presented in two sessions. In recent years, this issue has gained importance. For quite some time now, there is established knowledge about thermal effects. In animal tests, the threshold for behavioral and cognitive alterations is given as being about 2° C above normal body temperature. Effects on cognition and memory task performance in humans already are expected below 2° C above body temperature. However, this temperature threshold cannot be generalized since it varies according to task, age and gender of test persons.

Based upon established knowledge, present HF safety standards were called the right step in the right direction for they consider the critical threshold where behavioral and cognitive disorders set on. But what about the ranges that cannot be characterized as thermal? In his more theoretical contribution, Ross Adey of the



Linda Loma University, California, United States, in his well-known manner presented his theories on the potential influence of even the most weak signals, orders of magnitude smaller than the energy threshold kT inferring a possible effect of HF fields on cognition and some other effects on the EEG, especially during cognitive and memory test performance. However, at present underlying mechanisms are unclear. To-date reproduced effects are:

1. During behavioral tests reaction time is accelarated.
2. The time needed for mental arithmetic and working memory tasks is shortened.
3. EEG frequencies around 8 Hz are affected in their amplitude.

Health-relevance of observations made related to non-thermal exposure is very difficult to understand without knowing about interaction mechanisms.

In the context of the application of handheld devices used in mobile communiations, an overview of relevant investigations done by the Motorola research laboratory, that is, by J.J. Morrissey and M.L. Swicord, should be pointed to. 21 studies from the WHO database (http://www-nt.who.int/peh-emf/database.htm) are presented referring to the EEG, sleep disorders, and brain potentials in humans. Further 7 studies deal with cognitive capacity. Overall, the authors see these reports as inconsistent. Half of the studies report effects; the other half shows no evidence of effects. Findings of different working groups are often contradictory and cannot be replicated. Reported effects are seen as slight and to be of unclear physiological relevance. They show no clear correlation with the SAR and thus are not comparable. When observed as a whole, found effects do not support each other as would be expected at a given actual interaction mechanism. As a consequence, in this special research field further comprehensive and well-controlled studies are required.

Reports in literature on effects of mobile phone radiation on cognition and sleep behavior in humans can be summarized as follows:

- It is difficult to pool studies. Reasons are different test designs and exposure systems.
- Multiple confirmation of an increase of the EEG a-band is not seen as an input of the ELF.
- There is some evidence for an improved processing at more complex tasks.
- A limitation is that most study populations consist of young and healthy people.

Another contribution less directly related to cognition and behavior examining hippocampus should be mentioned in short. The hippocampus has to do with short-term memory, with learning capacity, spatial orientation, and epilepsy. Thin slices of animal hippocampus were prepared and applied as an in vitro model for different physiological, pharmacological and toxicologic investigations on, among others, interaction of HF fields with brain function.

Another contribution was remarkable dealing with the effects of terrestrial trunked radio (TETRA) signals on cognitive functions in humans. Results were as follows:

- Simulated TETRA signals do not produce effects (such as sometimes are described for analogous and GSM 900-MHz mobile radio signals).
- Additional effects at 17.6 Hz modulation neither were observed.

In vivo human studies

The lectures hold on in vivo human studies differed profoundly. Model studies and experimental measurements conducted on the human skin heating from millimeter waves were described. The aim was to determine temperature differences on the skin and to compare model results to experimental data. Basically, these studies were intended to provide a sufficiently safe assessment of the SAR at the skin surface and in epidermis.

Another literature survey of the Motorola Florida Research Labs on bioeffects from HF radiation in children was presented and relevant studies identified that should be considered when deciding about the limited use of mobile phones by children as well as about future research. These studies do not support the hypothesis of W. Steward claiming risks for children from the use of mobile phones.

Eleanor R. Adair presented her tests in participants using a frequency of 100 MHz (this contribution is mentioned in the paragraph on the USAF workshop report; the complete report is found on the web site).

An important research area was covered by studies on HF field exposure and melatonin in humans. J. Juutilainen of the University of Kuopio, Finland, presented an analysis of investigations from 2000 already introduced during the last annual meeting. Study subject were women garment factory workers with occupational exposure to magnetic fields. The following combinations were investigated:

- light at night (LAN), no MF exposure
- LAN and MF exposure
- no LAN, no MF exposure
- no LAN, but MF exposure

The lowest melatonin levels occurred at „LAN and MF exposure“, followed by „no

LAN, but MF exposure". There was no difference between melatonin levels of „LAN" or „no LAN, no MF exposure".

The posters were subdivided into ELF- and HF-related contributions. The first group reported on effects of magnetic field exposure (2 hs, pulses 200 to 300 µT, 50 Hz) on the melatonin profile over 2 hours dependent on circadian time. Further, there was a report on analgesia induced by pulsed magnetic fields, and a study on the cortisol level in occupationally exposed workers (static and 50-Hz magnetic fields). However, there was no proof of magnetic field effects on the cortisol level. Based upon studies investigating 50-Hz field effects on the immune system already presented during the BEMS 2000 in Munich, extended findings in persons living in the environment of transformer stations were reported confirming earlier results.

Effects on the EEG from specific pulsed 200-µT fields were reported from a still ongoing study. Final results are not available yet. The last contribution dealing with ELF was the study of the working group Reißenweber/David of the University Witten/Herdecke investigating circularly polarized 50-Hz magnetic fields of about 100 µT on skin microcirculation. There was found no effect in test persons, and neither in persons hypersensitive to EM fields.

Among the HF contributions was a highly questionable report from a questionnaire study of a French research group performed in people living in the vicinity of mobile radio base stations. Test persons were distinguished by the distance from the station. There were no controls. As expected, test parameters were different for people living nearest to the stations from those with distances of 200 to 300 m. The approach of this group is inacceptable, the results thus being irrelevant.

Other contributions dealt with subjective symptom intensification depending on daily use of mobile phones and observed alterations of physiological brain parameters shown by modifications of sleeping state EEG and heart frequency. They were contradicted by other posters that could neither detect dependencies nor effects of TETRA hand-held phones on cognition and well-being.

Emerging therapeutical methods and medical applications

A total of 30 lectures and 5 posters were devoted to this topic which was the special focus of this year's annual meeting. The sessions dealing with this topic area were closely linked to the plenary session on „Pain – etiology and treatment" mainly dealing with pain treatment using static and low-frequency pulsed magnetic fields. The following reports were of relevance here:

- biological simulation technologies in orthopaedics
- static magnetic field therapy alleviating chronic pelvis pain – a double-blind study
- first results of a phase-2 study on therapeutic electromagnetic field therapy (TEMF) treatment of pain in the area of lumbar vertebrae
- pain treatment using a static magnetic field applicator
- osteoarthritis treatment using a new wide-band PEMF signal
- static magnetic fields in the treatment of human malignancy
- antitumoral effects from magnetic fields
- intensive daily PEMF exposure suppresses tumor growth and angiogenesis (vascular regeneration)
- PEMF effects on postmastectomy arm-lymphedema (surgical removal of the mamma)

- pilot study on PEMF application for hair loss reduction in cancer patients
- modulation effects of static magnetic fields on microcirculation and systemic circulation in animal tests
- frequent treatment with millimeter waves reduces symptoms of neuropathic pain in mice
- nocturnal therapeutical electric stimulation treatment of children with myelomeningocele (congenital disorder; spinal cord segments protrude out of a vertrebra)
- application of turbulent magnetic fields (TMF) for lymphorrhea (escape of lymph from injured lympathic vessels) after surgical treatment of local breast cancer foci

This list illustrates the general trend of applications of, mainly low-frequency, magnetic fields in medicine. The individual contributions considerably differed concerning their quality; here, the reorientation of the program commission towards a higher qualitative level of contributions seemed to not have taken effect yet. A number of contributions were inspired by commercial interest. Thus, sometimes you got the impression of attending a publicity event.

Other highly questionable reports dealt with static magnetic fields applied for pain treatment. Called „double-blind studies", they showed positive results in favor of Verum. However, test subjecty easily could deblind the study (simply by using a piece of metal). Naively, the lecturer speaking about one of these studies even had interviewed patients asking what group they suspected to be in. In the placebo group, 46 % were right. In the Verum group, 98% were right. These results are self-explanatory.

According to current knowledge, interaction mechanisms being responsible for the mentioned effects are still unclear and speculative. Well-controlled studies on this issue in fact point to a positive effect, however, the cause for this remains unknown.

A few of the contributions also dealt with the lack of knowledge carefully separating scientifically safe knowledge from speculation or even what is called „junk science". The safe basis is very small, and there is still much work to be done to identify as well as experimentally determine a scientific basis of interaction mechanisms. (For the time being, perhaps a „magnadreampad" might be of use for you – http://www.magnadreampad.com - recommended by known experts such as Betty Sisken, President of the BEMS from 1998 to 1999; see Medical Testimonials about Magnetic Therapy.)

But this session also presented serious work such as theoretical papers on interaction mechanisms, and a research report on a wholly different application area of magnetism in gene therapy seeking to reach higher efficiency of gene transfer within the cell by superparamagnetic nano particles supported by magnetic field application.

The presentation of a planned 2.45-GHz hyperthermia therapy system was also important. The aim was to perform a feasibility study on the basis of computerized models and animal experiments. The focus of the application was the response, for example, in the urethral prostrate area. Some papers from the late 70ies and the early 80ies, however, suggest difficulties linked to such efforts, since temperature control at the site is difficult to perform and unwanted damages in the environmental tissue cannot be excluded.

Overall, the decision to focus this year on „medical applications in diagnosis and therapy" was right. The program commission would be well-advised to hold on to this focus but, simultaneously, to strive for higher scientific quality.

Epidemiology

In addition to the plenary session on epidemiology, a session offering several lectures and some poster presentations on this topic was held dealing with different issues. The following contributions were noteworthy:

- Domestic and occupational exposure to ELF magnetic fields; a study performed in Norway between 1980 and 1996. No verifiable association between occupational or domestic exposure to magnetic fields and hematological cancer localizations such as leukemia, lymphoma and myeloma could be found. Statistically non-significant increases of the odds ratio were calculated for chronic lymphatic leukemia both at domestic and occupational exposure. A combined occupational and domestic influence provided no evidence for an additive effect.
- Sleep disorders and depression symptoms in women living in the vicinity of 735-kV cables: Potential effects from electric and magnetic fields of 735-kV cables on sleep disorders, especially in older people, could not be explained by the melatonin level. Further, there was no distinct dose-effect link to magnetic fields. A main result was that people being exposed to more than 0.4 µT over 24 hs suffered from disrupted sleep. Overall, results could not be explained by other risk factors (confounders) that should be considered.
- As part of the „Germany study", the working group from Mainz reported on the leukemia risk in children living near electrified railroads. Here, magnetic fields of overhead cables with 15 kV and currents up to 2 kA and 110-kV transmission

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have to be distinguished. (Operational frequeny is at 16 2/3 Hz.) There was no indication of an association between 16 2/3 peak values of the magnetic field and a risk for child leukemia. A slight increase of the risk was detected when observing average fields. Magnetic field components produced by the trains were neglected but appeared to be only of slight relevance for the results of the 50-Hz study concerning child leukemia.

• A report of the Health Council of the Netherlands should also be mentioned. This report was not necessarily an epidemiologic contribution but is noteworthy all the same, because it offered a very consistent and objective summary of to-date knowledge about field effects of mobile communication in adults and especially in children. The authors saw no reason to recommend limited use of mobile phones by children.

Poster presentations included other contributions with more or less epidemiological contents. One poster dealt with studies on survival rates of children with leukemia in the vicinity of television transmitters. This study included 123 diagnosed cases of acute lymphatic leukemia. An association between the distance from television transmitters and life duration of ill children was found. However, the poster lacked data on social status and domestic situation, traffic density, and other known and much-discussed influence factors which make this simple interpretation seem highly uncertain and preposterous.

Some first results of the „Childhood Cancer, Leukemia and Electromagnetic Field" study (CCLEF) from the United Kingdom were published in advance as a poster. However, we should wait for the study to be completed. The authors themselves addressed some shortcomings of their study.

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