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Abstract submission deadline approaching!

Authors wishing to present papers at the BEMS 32nd Annual Meeting in Seoul, Korea (June 14-18, 2010) should submit a short 100-word summary and a 2-page abstract electronically to http://bems2010.abstractcentral.com/ on or before January 15th, 2010.

In order to provide notification of paper assignments early enough for all authors to obtain discounted travel arrangements, there will be no extension of this deadline. Any abstracts received after the deadline might be considered, at the discretion of TPC Chairs, only for poster presentation.

To view the current program, please visit the meeting website at: www.bioelectromagnetics.org/bems2010

OCCUPATIONAL EXPOSURE TO ELECTROMAGNETIC FIELDS:
PAVING THE WAY FOR A FUTURE EU INITIATIVE

This conference was held as part of the process of wording the revised version of EU Directive 2004/40/EC on occupational exposure to electromagnetic fields (EMF), originally intended to be implemented in the member states by the 30th of April 2008, now postponed until 30th of April 2012. The postponement was mainly due to 1) strong opposition from the MRI (Magnetic Resonance Imaging) users and 2) the European Parliament and the Council were made aware of new scientific studies on the impact on health of exposure to electromagnetic fields that were made public after the directive was adopted. These studies shed another light on some difficult issues regarding how to deal with the exposure in specific situations such as those experienced by workers near a MRI-scanner.

The conference was organized by the Swedish EU Presidency in association with the European Commission and was arranged by the Swedish Work Environment Authority (SWEA) and Umeå University. The goal was to open a discussion with stakeholders well in advance of the decision to be taken by the Parliament and by the Council. The specific program for the meeting was discussed and set up by the scientific organising committee for the meeting:

- Kjell Hansson Mild, UmU, chair
- Georges Herbillon, EC
- Roland Gauthy, ETUI-REHS
- Janez Marinko, SWEA
- Birgitta Melin, SWEA
- Jimmy Estenberg, SSM
- Alastair McKinlay, HPA
- Eric van Rongen, NL
- Paolo Vecchia, IT

Representatives of the Member States, branch organisations and the stakeholders were invited to attend the conference. The 126 registered participants came from 20 different countries including EU member states, Australia, Japan, Norway and the USA. The meeting had 11 sessions with a total of 36 presentations by speakers representing academia, industry, social partners, governmental and other regulatory agencies. It included sections on:
Key speakers and persons considered amongst the most experienced experts from all over the world were invited to contribute. Ample time was given in each session for discussion.

Results

Five areas of concern, with respect to the Directive, were identified during the meeting:

1. **Exposure Limit Values and Action Values**

   The recommendations from IEEE/ICES and ICNIRP differ in the low- and intermediate frequency range. The reasons for this difference are not obvious. The two organizations were asked to identify and explain the reason for the differences and, if possible, draft a common recommendation.

2. **Assessment, Measurement and Calculation**

   Assessment of EMF by numerical methods is complicated and in the general cases not an option for the employer. Many technical questions are still open.

3. **Guidance for Risk Assessment**

   There is need for advice to employers on risk assessment, especially concerning "workers at risk", medical implants, information and training.

4. **Difficulties for Small and Medium Sized Enterprises (SMEs)**

   Calculation and measurement of exposure as well as training of workers might be expensive for SMEs.

5. **Medical surveillance**

   There is a need for guidance on the performance of health surveillance and on treatment of overexposure. The medical doctors present at the meeting have also made specific comments to this point; see further the conclusions and the Doctor’s statement on the website of the meeting.

   These are further discussed in the Conclusions from the meeting, posted on the web site of the SWEA, http://www.av.se/inenglish/aboutus/eu/electromagnetic.aspx.

   A full report from the rapporteur, Dr Paolo Rossi, Italy, and all of the abstracts and pdf-files of the presentations can also be found on the website, from which they may be downloaded.

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**EDITOR’S NOTE: RESEARCH SUMMARIES**

The Bioelectromagnetics Society recently implemented a "Best Paper" award for the journal. While not directly connected with that award, several recently published authors have submitted summaries of their work for publication in the newsletter (see also newsletter number 207, 208, and 210). We publish these summaries in the order received as space is available. By providing additional focus on the reported research, it is our hope that communication within the Society is enhanced across disciplines and interest areas.

We invite all authors of recently published full research articles in the Bioelectromagnetics Journal to provide a short summary of the background and context of the research documented in their articles. For copyright reasons, these summaries are different from the abstracts and other text published in the journal. Send summaries for publication in this newsletter to bemsnewsletter@gmail.com.

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**RESEARCH SUMMARY: EXPOSURE TO INHOMOGENEOUS STATIC MAGNETIC FIELD CEASES MECHANICAL ALLODYNIA IN NEUROPATHIC PAIN**

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*Summary of article appearing in Bioelectromagnetics, Vol. 30, No. 6, pp 438-445*

Nearly one third of the human population experiences severe chronic pain in some point in life. For many patients, pain continues to produce severe distress, dominating and disrupting the quality of their lives. Much of currently available clinical treatment is only partially effective and may be accompanied by adverse side effects or have abuse potential. The search for reliable, safe and effective treatments for neuropathic pain remains a major challenge, and, not surprisingly, patients have been continuously exploring alternative approaches. Among a number of other treatment strategies, magnetic therapy is increasingly used to alleviate pain.

Magnetic field therapy as a self-care intervention has led to the conduct of more than 50 randomized controlled human trials. Results obtained from studies that tested the analgesic efficacy of static magnetic field (SMF) therapy in chronic pain are inconsistent. However, since the parameters of the applied SMFs and the pain models that were supposed to be treated varied from investigation to investigation, results obtained from these earlier studies are far from being reliable and hardly comparable.
To avoid the obvious problems in the interpretation of the results of earlier studies, we investigated the effectiveness of SMF exposure in pain attenuation by utilizing a fully controllable, reproducible, and thus reliable experimental approach. First, we used an apparatus for the generation of an inhomogeneous SMF, the parameters of which has been carefully tested and adjusted to whole-body exposure of experimental animals. Secondly, we tested the effectiveness of SMF exposure on a well-established animal model of neuropathic pain (partial nerve ligation in mice), and studied how the whole-body exposure to SMF may influence pain responsiveness in the experimental animals. Our results showed that exposure to inhomogeneous SMF in the first postoperative week could not prevent the development of pain. However, the effectiveness of a daily exposure to inhomogeneous SMF was much more prominent, when it was applied between postoperative days 15 and 28. In this case, pain threshold was already noticeably increased after the first treatment and it practically reached the control values by the end of the fortnight long exposure period.

Although we can not identify the mechanisms and sites of action at the moment, it is likely that whole-body SMF exposure may have an influence on the chemical reorganization mechanisms of pain processing neural circuits. It may act on the pain processing apparatus of the central nervous system after the development of central sensitization, and inhibit processes that maintain the increased sensitivity to external stimuli in neuropathic pain.

This work is an MTHR (UK Mobile Telecommunications Health Research)-funded study to determine the reproducibility and robustness of the effects we had earlier reported, where low-intensity continuous-wave (CW) microwave fields apparently up-regulated heat-shock gene expression in the model nematode C. elegans (de Pomera et al., 2000, Nature 405, 417-8).

In our previous study, published 3 years ago (Dawe et al., 2006, Bioelectromagnetics 27, 88-97), we established that power leakage causing a very slight rise (0.1-0.2°C) in the temperature of exposed but not sham samples was the most likely explanation for the observed increase in hsp-16.1 reporter expression at a nominal exposure temperature of 26.0°C. The present paper follows this up with a survey of global gene-expression changes in wild-type C. elegans following exposure to similar (in fact, somewhat lower) CW microwave fields. In an effort to promote good practice (as per MIAME guidelines (Editor’s note: MIAME stands for a standards effort to identify the Minimum Information required to unambiguously specify critical details About a Microarray Experiment)) for future gene-array studies in this field, we have made our gene-array data publicly accessible through the NCBI (National Center for Biotechnology Information) GEO (Gene Expression Omnibus) database (accession number GSE10787), and have also used a statistical correction for false discovery rate.

Our overall conclusion is that no genes show reproducible and statistically convincing changes in expression level across 5 replica microwave-exposed arrays as compared to 5 sham arrays. By contrast, when comparing 2 arrays from worms subjected to mild heat shock at 30°C against the 5 original sham arrays, >1500 statistically significant changes were recorded, including very major (up to 95-fold) changes in heat-shock gene expression. The up-regulation of one of these heat-shock genes has been confirmed independently using an hsp-16.2::GFP reporter, whereas two similar reporters (cap-34a9::GFP and daf-16::GFP) were not up-regulated, broadly confirming the gene-array results for both genes. This reinforces our previous conclusion that weak microwave irradiation does not induce a heat-shock response nor any significant changes in gene expression in the nematode C. elegans; our earlier work suggesting such a response appears to reflect a subtle thermal artefact (see Dawe et al., 2006).

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**RESEARCH SUMMARY: LOW-INTENSITY MICROWAVE IRRADIATION DOES NOT SUBSTANTIALLY ALTER GENE EXPRESSION IN LATE LARVAL AND ADULT CAENORHABDITIS ELEGANS.**

AS Dawe¹, RK Bodhicharla², NS Graham³, ST May³, T Reader², B Loader⁴, A Gregory⁴, M Swicord⁵, G Bit-Babik⁵ and DI de Pomera²

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**RESEARCH SUMMARY: HYPERSENSITIVITY TO RF FIELDS EMITTED FROM CDMA CELLULAR PHONES: A PROVOCATION STUDY**

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With the rapidly increasing number of cellular phone users, the number of people with self-attributed electromagnetic hypersensitivity (EHS) who complain of various subjective symptoms, such as headache, insomnia, nervousness, distress, fatigue, and short-term memory loss, has increased as well. In a population based survey, the prevalence of EHS was reported to be 1.5% in Sweden, 3.2% in California, 4% in the UK, 5% in Switzerland, and 8-10% in Germany. EHS could not only deteriorate the quality of individual patients’ lives, but also cause an increase of social expenses for health care. Therefore, the objective of our research was to determine whether EHS results from actual physiological changes or psychological causes.

What was already done about this topic prior to this research?

For EHS related studies, three general methods have been utilized to investigate the origins of the EHS. The first is to measure the physiological variables such as heart rate, respiration rate or and blood pressure etc. during sham and real exposures for the EHS or and non-EHS group. The second is to survey those subjective symptoms during sham and real exposures for the EHS or and non-EHS group. The third method is to determine perception accuracies during sham and real exposures for the EHS or and non-EHS group. Most research has been carried out using one or two methods with GSM phones, but not with Code Division Multiple Access (CDMA) phones.

What did this work contribute to the subject?

We simultaneously investigated the physiological parameters, subjective symptoms, and EMF perception accuracy using CDMA phones for the EHS and non-EHS groups. We concluded that 300 mW exposures from CDMA phones for one half-hour did not have any effects on physiological variables such as the heart, respiration rate, or low frequency power/high frequency power (LFP/HFP), which was used as an index for the balance of autonomic nervous system in either group. It also did not produce any subjective symptoms in either group. As for EMF perception, there was no evidence that the EHS group’s perception of EMF was better than the non-EHS group. The possibility of a delayed exposure effect in the EMF perception was observed in the EHS group, but not in the non-EHS group.

We found two additional important findings in our study. While responding to questions regarding symptoms and EMF perception, 10 of the 37 subjects showed considerably varied skin conductance because of increased sweat secretion during sham exposure resulting from an excited sympathetic nervous system. Despite this, we still believe that it is a good parameter for investigating the autonomic nervous system if there are no such inquiries for subjective symptoms or EMF perception involved in the test.

Second, even though the experiments were performed during the day, drowsiness was observed in approximately half of all subjects because the subjects were in comfortable postures for more than an hour in a quiet room. If the examiner noticed a subject’s drowsiness, he made a noise to wake the subject up, resulting in sleep deprivation. We observed monotonically increased LFP/HFP at each exposure stage during sham exposure in both groups. Such a continuous increase is assumed to have been caused by sleep deprivation during the 64-min experiment. It has been reported that sleep deprivation could increase LFP and LFP/HFP. The usage of heart rate or HRV with unwanted drowsiness may falsely indicate the effects of RF radiation by mobile phones on the autonomic nervous system.
dominate in formation, stability, development, and functioning of all living systems. We considered that studying modulated EMF could be done by subjecting the object simultaneously to a set of harmonic signals. By selecting type and frequencies of modulation we may be able to differentially influence particular systems of a cell or an organism.

Earlier, using various cellular models in vitro, we showed that pulse-modulated, extremely high-frequency electromagnetic radiation (EHF EMR) can essentially modify cellular functions, with the effects being critically dependent on combination of carrier and modulation frequencies. Modulated EHF EMR (42.2±0.2 GHz, incident power density of 0.1 mW/cm², modulation frequency of 0.095±0.005 Hz) inhibited a motor activity of unicellular protozoa Paramecium caudatum [Gapeyev et al., 1994]. The effect was named a "double resonance", as it had a quasi-resonance dependence on both carrier and modulation frequencies, and was not observed under the influence of continuous EHF EMR. Modulated EHF EMR (41.95 GHz, 0.05 mW/cm², 20-min exposure duration) inhibited or activated the production of reactive oxygen species by isolated peritoneal neutrophils of mice depending on modulation frequencies [Gapeyev et al., 1998]. We suggested that calcium-dependent intracellular signal transduction pathways activated at neutrophils' respiratory burst are selective to both carrier and modulation frequencies of EHF EMR.

The present study was performed to determine features of biological effects of low-intensity modulated EHF EMR using a model of acute non-specific inflammation in laboratory mice of NMRI outbreed stock. Our recent data showed that the model of acute zymosan-induced paw edema in mice is very sensitive to the influence of low-intensity EHF EMR. Single whole-body exposure of animals to continuous EHF EMR for 20 min reduced the edematous edema of inflamed paw on average by 20% compared to the control at intensities of 0.1-0.7 mW/cm² and frequencies from the range of 42.2-42.6 GHz [Gapeyev et al., 2008]. We have now demonstrated that application of different modulation frequencies from the range of 0.03-100 Hz did not lead to considerable changes in the effect level caused by effective carrier frequency of 42.2 GHz. When specific combinations of "ineffective" carrier frequencies of 43.0 and 61.22 GHz, and modulation frequencies of 0.07-0.1 and 20-30 Hz were applied, the anti-inflammatory effect showed synergistic enhancement in narrow ranges of modulation frequencies.

Considering an increasing level of anthropogenic complex-modulated EMF, the results we obtained showing synergistic enhancement of EHF EMR effects at the certain combination of carrier and modulation frequencies have special importance. In narrow bands of modulation frequencies, certain carrier frequencies become biologically active, which by themselves did not previously cause appreciable biological action. This could mean that in a real environment of biological systems, considering the nonlinear interaction of inherent oscillation modes, there can be the combination of frequencies selectively influencing certain systems of cells and an organism as a whole. The efficacy and direction of such action is ambiguous, as it strongly depends on the functional status of a biological object that can be changed by application of various pharmacological treatments. In some cases, there are additive and synergistic effects that strengthen the action of medical drugs [Gapeyev et al., 2008]. This has undoubted potential advantage for clinical application through possibly lowering a dosage of applied drugs to reduce their side effects. It is obvious that the further detailed studies are necessary for the purpose of determining key molecular and cellular mechanisms responsible for realization of effects of multiple-frequency and modulated EMFs.

The work was supported by the Russian Foundation for Basic Research (project # 08-04-90000) and the Russian Science Support Foundation.

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**Research Summary: Application of a Temperature-Dependent Fluorescent Dye (Rhodamine B) to the Measurement of Radiofrequency Radiation-Induced Temperature Changes in Biological Samples**

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**Summary of research published in Bioelectromagnetics, Vol. 30, No. 7, pp 583-590.**

The computed Specific Absorption Rate (SAR) in both in-vitro and in-vivo preparations has often been used as an indicator of whether observed radiofrequency (RF) effects can be due to a thermal or a non-thermal mechanism. However, because of the high variation in SAR in many of these preparations, the diffusion or convection of heat makes the local changes in temperature difficult to estimate. This is particularly true in complex tissue samples such as brain slices or in whole brain. Although it is possible to penetrate tissue with fluoroptic probes, this produces damage and can only measure from a limited number of locations.

The method described in this paper involves a commonly-used fluorescent dye, Rhodamine B, which is readily taken up by tissue and whose fluorescent intensity is markedly decreased as temperature rises. The intensity is mapped in 3D by confocal microscopy, which, in essence, produces a 'stack' of 2D 'slices' at successive depths within the sample. By taking images at various times before, during, and after RF exposure, the change of temperature at various locations in the sample was followed. The paper also reports on initial calibration of the dye in non-living or fixed samples against temperature estimated by fluoroptic probes. From this calibration, the fluorescent intensity fell by 3.4±0.2 % per degree Celsius. The RF energy was supplied to a purpose-built exposure chamber in which simultaneous confocal images are obtained and in which the SAR distribution has previously been extensively modeled. Changes in fluorescence reveal a temperature gradient within the sample (which was approximately 0.6 x 0.6 x 0.1 mm, with a 'stack' of 15 x 2D images each 6.5 microns thick), which was not anticipated from SAR measurements.

We anticipate that this work will contribute to a better understanding of SAR in relation to localized changes in
temperature in biological samples. Ongoing work is examining the use of Rhodamine B in fresh (non-fixed) tissue to determine the initial rate of temperature rise in the first few seconds after the RF power has been turned on compared with what is predicted by thermal modeling.

**RESEARCH SUMMARY: THE ROLE OF THE CONCENTRATION AND DISTRIBUTION OF WATER IN THE COMPLEX PERMITTIVITY OF BREAST FAT TISSUE**

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*Summary of research published in Bioelectromagnetics, Vol. 30, No. 8, pp. 669-677.*

This paper is a theoretical study of a complex problem, predicting the dielectric properties of breast fat tissue in terms of its gross composition. Currently, microwave imaging has offered hope for safer diagnostic and tumor detection; however further experimental work is still needed.

Experimental studies of breast tissue permittivity in literature are available only at frequencies below 20 GHz and only at a few discrete selected frequencies. Debye and Cole-Cole relaxation models are frequently used to extrapolate the measurement to provide continuous data at higher microwave frequencies. Relaxation models serve essentially to parameterize the dielectric data without interpreting wide variations in the measurement data from one sample to another.

The approach used in this paper is an attempt to partly explain the wide variations in the measured complex permittivity data for breast fat tissue at microwave frequencies. In the microwave frequency region, tissue permittivity can be determined mainly using the data on the free water. Past research has focused on the variation of dielectric properties of a biological tissue as a function of its water content. But the distribution of water in the tissue is also a strong contributor to the effective permittivity of the tissue. In this study we take into account both the concentration and distribution of water to model the dielectric permittivity of the tissue. This is an important area of study because water content and distribution is an indicator of tissue health.

Motivated by the overall need to improve breast cancer detection and characterization and our standing interest in advancing medical microwave imaging, we have proposed computational models of the dielectric permittivity of breast fat tissue varying with water content and distribution. In our study, we look at 1-D (fat layers interspersed with layers of water), 2-D (water tubules and fat tubules coated with water), and 3-D (water globules and fat globules coated with water) all of which show variations in dielectric permittivity for the same volume content of water. The 1-D and 2-D models may find application for different types of tissues such as skin, muscle or collagenous tissues.

The T-matrix multiple scattering formalism has been successful to compute effective properties of inhomogeneous media for arbitrary inclusion geometry. It is a good method to predict the effective permittivity of a heterogeneous material when either the concentration or the size of the suspended constituents is large. It has not been applied to model the dielectric permittivity of biological tissues. This paper proposes an application of this theory to fat/water mixtures to explain the dependence of the complex permittivity on water content as well as water distribution. The effective permittivity, obtained for different shape of water inclusions, is compared with experimental data from literature. Our results indicate that water distribution is another factor that contributes to the differences in the dielectric permittivity of samples of fat that have the same water content. Our model is a small but positive step to develop robust models for microwave biomedical diagnostics.

**RESEARCH SUMMARY: EFFECT OF RADIOFREQUENCY ELECTROMAGNETIC FIELD EXPOSURE ON IN VITRO MODELS OF NEURODEGENERATIVE DISEASE**

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The incidence of neurodegenerative diseases is progressively increasing, partially due to the increase in life expectancy. However, pathogenesis of many neurodegenerative diseases including Alzheimer disease (AD) is still obscure. Among potential environmental risk factors for AD, exposures to electromagnetic fields (EMF) have received much attention, particularly extremely low frequency electromagnetic fields (ELF-EMF). The main approach in these studies has been the systematic review and meta-analysis of published epidemiological studies.

In this, and in related studies (Neuroscience Letters, 2009, 455:173-7), we investigated the effect of continuous exposure to a global system for mobile telecommunications (GSM) modulated 900MHz signal on in vitro neuronal systems, with the specific aim to investigate if exposure to RF-EMF might act as co-stressor of well known neurotoxic agents.
We believe that co-administration of potential stressors is still a poorly explored field for both bioelectromagnetism and biology of neurodegenerative diseases. Therefore, we based our approaches to the exposure of cell systems to well-established chemical neurotoxic challengers together with RF-EMF. In order to compare the co-stressor effect on cell populations which differ in vulnerability to chemical neurotoxic challengers, we also used more than one neuronal in vitro system. We investigated beta-amyloid toxicity, as a model for AD, glutamate toxicity, as a model for excitotoxic lesion operating in many conditions, and H\textsubscript{2}O\textsubscript{2} toxicity, as a model for oxidative stress. The studies have been carried out in a SN56 cholinergic cell line and in rat primary cortical neurons. In vitro continuous exposure to 900MHz GSM–EMF guaranteed an average SAR of 1W/kg.

Compared to other studies focused on neural in vitro systems, we used a highly controlled exposure system provided with specific software to guarantee blind experiments, continuous monitoring and feedback regulation of net power and recording of all exposure and temperature data. RF exposure affected neither proliferation in control culture nor cell death due to glutamate or 25-35 beta-amyloid fragment. On the contrary, cell death rate due to oxidative stress (H\textsubscript{2}O\textsubscript{2}) was increased by RF co-exposure in SN56 cells, but not in primary neurons. Cholinergic neurons derived from the medial septum as SN56 cells, are intrinsically more sensitive than primary cortical neurons to nitric oxide excess, which is induced by in vitro culturing. These data support the view that oxidative stress might be the underlying mechanism responsible for the reported cellular effects of RF radiation. They also indicate that RF radiation could be dangerous in selected conditions and on specific neuronal populations.

**RESEARCH SUMMARY: CURRENT DENSITY IN A MODEL OF A HUMAN BODY WITH A CONDUCTIVE IMPLANT EXPOSED TO ELF ELECTRIC AND MAGNETIC FIELDS**

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In our study we used numerical modeling to calculate the current density distribution inside a human body with an intramedullary nail simultaneously exporing ELF (50 Hz) electric and magnetic fields. We used an intramedullary nail in the femur because it is one of the longest implants used in humans. Thus, it is expected to alter the current density distribution significantly. The exposure conditions were corresponding to the reference levels for general public. To evaluate the influence of the implant, the current density distribution in the model with the implant was compared with the current density distribution in the model without the implant.

The results show that for the worst case exposure situation (the electric field is in the inferior to superior direction and the magnetic field in posterior to anterior direction) the implant increases the current density up to 10 times: from 0.9 mA\textsubscript{m}\textsuperscript{2} in the model without the implant to 9.5 mA\textsubscript{m}\textsuperscript{2} in the model with the implant in the region where the implant is in contact with soft tissue. This increase is significant since, in spite of complying with ICNIRP reference levels for general public, the basic restrictions on current density for general public are exceeded nearly five times. The region, where significant increase in the current density is observed, is however limited: in less than 8 cubic centimeters, ICNIRP basic restrictions are exceeded twice (current density higher than 4 mA\textsubscript{m}\textsuperscript{2}).

The high increase of the current density means that the existing safety limits do not necessarily protect persons with implants to the same extent as they protect people without implants. The current density might consequently exceed ICNIRP basic restrictions even though exposure is in compliance with ICNIRP reference levels. Cardiologists, traumatologists and other physicians who implant such implants and patients receiving them should attach importance to understanding of the electric and magnetic field distribution changes inside the human body due to conducting implants. In addition, the knowledge about the possible effects of the implants on the safety of the exposed patients is important for those preparing guidelines and standards about risk assessment and all involved in risk assessment in the working environment, where specific risks due to the effect of the implant should also be taken into account.
RESEARCH SUMMARY: A LORENTZ FORCE MODEL IN BIOLOGICAL SYSTEMS

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Summary of research published in Bioelectromagnetics, Vol. 30, No. 6, pp. 462-488:

- Part I - Thermal noise is an essential component of AC/DC effects on bound ion trajectory (p 462-475)
- Part II - Secondary transduction mechanisms and measures of reactivity (p 476-488)

These papers add to our previous studies (Bioelectromagnetics, 1996;17:89-99, Bioelectrochem Bioenerg., 1994;35:71-9), which showed how the Lorentz force could affect the dynamics of an ion bound in a molecular cleft in the presence of thermal noise as a possible explanation of weak static magnetic field bioeffects. Those publications were inspired by Edmonds (Bioelectrochem Bioenerg., 1993;30:3-12) who proposed Larmor precession as a mechanism for the detection of static and alternating magnetic fields, but did not include the effects of thermal noise. However, it really all started with a paper published in 1984 in Science by Liboff et al. which quite conclusively demonstrated that magnetic fields, per se, could affect the rate of division of living cells in culture.

To rationalize these findings, Abe Liboff proposed the Ion Cyclotron Resonance (ICR) model, which was closely followed by the Parametric Resonance (IPR) model developed by Lednev. Both models predicted certain combinations of very weak AC/DC magnetic fields would have peak effects at resonances based upon the charge to mass ratio of the suspected target ion. Although both the ICR and IPR models have been criticized on theoretical grounds, resonances predicted at or near the cyclotron frequency have been observed. In fact, an effective bone growth stimulator, designed to help heal recalcitrant bone fractures, was developed using ICR predictions. It is in use today.

The Lorentz force model presented in these papers attempts to provide an alternate, and perhaps more physically realistic, explanation of weak AC/DC magnetic field bioeffects. Here, the solution of the equation of motion for a charged particle bound in a binding potential showed that the thermal component of the motion itself undergoes angular rotation around the magnetic field axis at the Larmor frequency. Thus, thermal noise does not destroy the coherence of the oscillator motion and render the dynamics random. Rather, thermal noise appears to play an essential role in the biological detection of weak magnetic fields. Charged ions in binding sites undergo thermally induced oscillations in the infrared frequency range, with the resultant velocities sufficient for a Lorentz force effect from weak AC/DC magnetic fields. The resulting trajectory of the bound ion is thus determined by the magnetic field environment in the presence of thermal noise, offering a means to modulate biochemical reactions. We have suggested a geometric method for a measure of reactivity based upon the classical oscillator trajectory, and applied the results to parallel and perpendicular AC/DC field combinations, with differing resonance regimes found for each. Resonances were shown to be dependent upon the ensemble of initial conditions and binding lifetime and were obtained through averaging over incident AC phases. AC resonance frequencies were shown to be dependent upon the ratio of AC/DC amplitudes and biochemical kinetics via binding lifetime, and were predicted to occur both at the Larmor frequency, and also at other frequencies.

Several approaches to testing the model were presented. Among these, scanning AC amplitude at fixed frequency and DC amplitude provided an acceptable description of experimental data reported for a test of the IPR model on Ca2+ membrane flux. A measure of reactivity based upon the angular position of the bound oscillator results in an AC/DC amplitude response closely fitting experimental observations and predictions of the IPR model. Other physically meaningful measures are discussed, none of which require the assumptions most often employed in the ICR and IPR models, such as multiple ionic targets, hydrogen triggering or arbitrary combinations of Bessel functions. The only required parameter is the desorption rate constant of the assumed ion target, which can normally be obtained from the literature.

There are clearly many measures of reactivity which may be employed in the Lorentz model, and we are continuing to pursue the more promising approaches. For example, a purely geometric measure of reactivity predicts previous experiments, and yields a close fit to IPR results. The Bessel function expansion of this geometric measure consists of coefficients determined uniquely by the classical orbit, rather than chosen arbitrarily, as in the IPR model, suggesting a more parsimonious explanation of weak AC and DC magnetic field bioeffects. In the final analysis, the underlying mathematics is a straightforward analysis of the classical dynamics of a bound particle in a magnetic field.

We note that the biological effects of weak electromagnetic fields result from signaling. This means there is unlikely to be a linear relationship between a field effect on ion binding and the end biological effect (e.g., ion transport, differentiation, proliferation, tissue repair, pain relief) which is usually many, many steps downstream of the site of action of the magnetic field. For this reason, verification of any model purporting to predict weak AC/DC magnetic field effects must be performed with great care to isolate the primary target of interaction. This could be accomplished by performing studies as a function of the concentration of the ion target, which has only been reported in very few studies.

RESEARCH SUMMARY: SELF-REPORT OF PHYSICAL SYMPTOMS ASSOCIATED WITH USING MOBILE PHONES AND OTHER ELECTRICAL DEVICES
Obtained using the qualitative method. For example, other groups can compare their results to our results, for other researchers. The aim of our paper was to present the working-age population's self-reported physical symptoms associated with using mobile phones and other electrical devices. We used the qualitative method to analyze the answers to an open-ended question in a questionnaire, which included questions about the possible influence of new technical equipment on health. Our aim was to also create subgroups of respondents for different self-reported symptoms which are associated with mobile phones and other electrical devices.

Before we started the study, some people told us that they experienced headaches or other symptoms when they used mobile phones. In addition, some researchers in other countries had published compilations of symptoms connected with the use of electrical devices reported by subjects in their studies. In our earlier studies we had also noticed problems with the usability of those devices.

When we designed the questionnaire, we only wanted to ask about symptoms which are generally known in medicine. Therefore, we did not ask about electric hypersensitivity in the formulated questions. We thought that it was better to use "open questions" in which the subjects can explain in their own words what possible symptoms they got from the mobile phones.

The questionnaire was sent to 15,000 addresses. A total of 6121 (41%) responses were received and 1300 respondents (about 21%) answered the open-ended question "other observations concerning technology and health." We identified from the open-ended questions three categories: (1) subjects with different self-reported symptoms which they associated with using mobile phones (headache, earache, or warmth sensations), (2) subjects who had skin symptoms when they stayed in front of a computer screen, (3) subjects who mentioned physical symptoms associated with using mobile phones and other electrical devices. The total prevalence of self-reported physical symptoms associated with using mobile phones and other electrical devices was 0.7%. Although this percentage cannot be compared directly to the results of other studies, it is significantly less than what has been reported by other researchers.

This paper is important to bioelectromagnetics research because many subjects have doubts that their symptoms are related to electromagnetic fields from mobile phones or other devices. It is important to study how they describe the symptoms and the connection to the devices. Then it might be possible to find out the reasons for their symptoms and to do appropriate studies. Our paper can provide new ideas and knowledge for other research groups in the same area. For example, other groups can compare their results to our results, obtained using the qualitative method.
Location: Bordeaux, France

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**32nd Annual Meeting of the Bioelectromagnetics Society**

**Date:** 13-18 June 2010  
**Location:** Seoul KyoYuk MunHwa HoeKwan (Also known as: SEOUL EDUCATION CULTURAL CENTER), South Korea

**Conference co-chairs:** Dariusz Leszczynski and Nam Kim

See note in this newsletter about abstract submissions and conference website.

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**Progress In Electromagnetics Research Symposium (PIERS) 2010**

**Date:** 5-8 July 2010  
**Location:** Cambridge, MA (USA)

**Important Dates**
- 20 February, 2010 --- Full-length Paper Submission Deadline  
- 20 February, 2010 --- Pre-registration Deadline  
- 20 March, 2010 --- Preliminary Program will be available online  
- 20 April, 2010 --- Advance Program will be available  
- 20 May, 2010 --- Final Program will be available

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**Date:** 16-19 August 2010  
**Location:** Berlin, German  
**Conference website:** [http://www.cem.tf.uni-kiel.de/emts2010/](http://www.cem.tf.uni-kiel.de/emts2010/)

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**MobiHealth 2010, International ICST Conference on Wireless Mobile Communication and Healthcare**

**Date:** 18-20 October 2010  
**Location:** Ayia Napa, Cyprus  
**Note:** BEMS Journal editor, Jim Lin, is part of the steering committee for this meeting.  
**Conference website:** [http://mobihealth.name/orgncomm.shtml](http://mobihealth.name/orgncomm.shtml)

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**14th International Congress of Radiation Research (14th ICRR 2011)**

**Date:** August 28 - September 1, 2011  
**Location:** Warsaw, Poland  
**Contact:** Prof. Marek K. Janiak, MD, PhD, Chair, Organizing Committee via Ewa Nowosielska (ewan14@wp.pl)