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Secretary
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C-2013-2354862

Dear Mrs. Chiavetta:

Enclosed are six articles to add to my submission of Exceptions to the April 29, 2013 letter from the PUC, detailing the health hazards I will be exposed to by a smart meter.

PUC, PECO, and the General Assembly have ignored all research and studies on the adverse health effects of smart meters and their attendant radiation. There is no authority for installation of devices hazardous to my health on my residence. There has been no study done by government or industry of the detrimental health effects of exposing a bio-electric organism to the radiation that is planned for the smart grid.

I refuse installation of a smart meter on my house because of the adverse physical effects on human cells, neuro-systems, and hormone systems caused by the received and broadcast military-weapons-grade-radiation.

Sincerely,

Thomas A. McCarey

Thomas A. McCarey

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enc
cc: Shawane L. Lee

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RISKS OF CARCINOGENESIS FROM ELECTROMAGNETIC RADIATION OF MOBILE TELEPHONY DEVICES

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Intensive implementation of mobile telephony technology in everyday human life during last two decades has given a possibility for epidemiological estimation of long-term effects of chronic exposure of human organism to low-intensive microwave (MW) radiation. Latest epidemiological data reveal a significant increase in risk of development of some types of tumors in chronic (over 10 years) users of mobile phone. It was detected a significant increase in incidence of brain tumors (glioma, acoustic neuroma, meningioma), parotid gland tumor, seminoma in long-term users of mobile phone, especially in cases of ipsilateral use (case-control odds ratios from 1.3 up to 6.1). Two epidemiological studies have indicated a significant increase of cancer incidence in people living close to the mobile telephony base station as compared with the population from distant area. These data raise a question of adequacy of modern safety limits of electromagnetic radiation (EMR) exposure for humans. For today the limits were based solely on the conception of thermal mechanism of biological effects of RF/MW radiation. Meantime the latest experimental data indicate the significant metabolic changes in living cell under the low-intensive (non-thermal) EMR exposure. Among reproducible biological effects of low-intensive MWs are reactive oxygen species overproduction, heat shock proteins expression, DNA damages, apoptosis. The lack of generally accepted mechanism of biological effects of low-intensive non-ionizing radiation doesn't permit to disregard the obvious epidemiological and experimental data of its biological activity. Practical steps must be done for reasonable limitation of excessive EMR exposure, along with the implementation of new safety limits of mobile telephony devices radiation, and new technological decisions, which would take out the source of radiation from human brain.

***Key Words:* tumor, radiofrequency radiation, microwaves, mobile phone, risk assessment, non-thermal effects.**

Apparently, any technical device was not introduced in everyday human life so fast and so close as mobile phone. Starting from first commercial mobile phone network in Japan in 1979 the number of active users of mobile telephony increased to over 3 billion all over the world. In developed countries the number of mobile phone users today is close to saturation. The initial age of youngest users of mobile phone is estimated as 3 years old [1]. The distinguishing feature of the mobile telephony technology is immediate vicinity of source of electromagnetic radiation (EMR) — handset to the human brain. These specificities lead to public concern about the safety of this technology for human health. From scientific point of view the main problem of a mobile telephony technology can be formulated as the lack of research on biological effects of low-intensive EMR, especially long-term studies, on the moment of active implementation of technology. It suffice to say that safety limits for mobile telephony are based only on thermal effects of EMR [2]. At the same time a principally new data about non-thermal biological effects of non-ionizing EMR have been revealed during the last years. These data are not taken into account by mobile phones manufacturers and most authorities for today. That is why some scientists call the situation with intensive implementation of mobile phone technology the biggest biophysical experiment in human history.

In 1996 World Health Organization started the wide-ranging epidemiological research on the risk of development of some cancer types in mobile phone users. The research was carried out in term of Interphone project and was substantially supported by industry. The project included national researches in 13 countries, and was finished in 2005, but until now the final report was not published [1]. At the same time project data published in some countries and data of the epidemiological studies of independent research groups have indicated statistically significant increase in the risk of development of brain tumors in chronic users of mobile phone.

It is clear that safety problem of mobile telephony technology must be a special concern of industry and authorities. This problem must be also the special concern of profile experts and researchers. In this review the main attention is drawn to published data on potential risk of cancer development, and the aim of the review is to discuss the recent publications on the topic and pay attention to the "harmful" effects of EMR. In most cases we used peer-reviewed journal publications. For more comprehensive insight into the problem of biological effects of RF EMF we can recommend some other reviews (see, for example [3–9]).

MAIN PHYSICAL CONCEPTS OF MOBILE TELEPHONY TECHNOLOGY

Mobile telephony technology utilizes electromagnetic waves of radio frequency (RF) for connection between base station and mobile phone (handset). The frequencies of electromagnetic waves (frequency of electromagnetic field oscillations) used in most modern mobile phones are

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Abbreviations used: AM – amplitude modulation; EMR – electromagnetic radiation; HSP – heat shock proteins; MDA – malondialdehyde; NO – nitric oxide; OR – odds ratio; ROS – reactive oxygen species; RF – radio frequency; SAR – specific absorption rate; SIR – standardized incidence ratio; SOD – superoxide dismutase.

850–1900 MHz. These waves actually belong to extreme part of radiofrequency which calls microwaves (MWs). The useful (voice) information is carried by small modulation of electromagnetic wave frequency. This range of electromagnetic waves is a non-ionizing radiation because it has not enough energy for ionizing molecules.

Thus, both base station and mobile phone irradiates EMR. The levels of radiation are different from base station and handset, and for handset it depends significantly on the state of the system. The radiation power of base station antenna is about 60 W, and the intensity of radiation depends on the geometry of irradiated beam. The pick power of mobile phone handset radiation is up to 2 W. But the intensity of radiation (power density) near a user head is much more from handset than from base station due to the big difference in distance from the sources of radiation. For example, the power density in the main beam of base station at the distance of 150–200 m from antenna is about tenths of a μW/cm^2 [10]. At the same time the power density in immediate vicinity to handset can be tens μW/cm^2. The biggest level of irradiation mobile phone produces during the connection process (calling), smaller (lower) — during the talk, and minimal (close to zero) in a stand by position. Modern international safety limits for the level of power density of non-ionizing EMR are set approximately up to 100 μW/cm^2 [2].

The level of EMR energy absorbed by human body is estimated by index of specific absorption rate (SAR), which indicates the EMR energy absorbed per mass unit of tissue. The safety limit for this index is 1.6 W/kg for USA and 2 W/kg for most other countries. This index is mandatory technical passport index for each model of mobile phone for today. SAR is estimated and calculated on the models of human head and body. It is important that real SAR value depends on the structure of tissue and, for example, can be much more for child head than for adult [11]. Least-emitting models of mobile phone give SAR just a few tenths of W/kg.

PRE-MOBILE-PHONE DATA (MILITARY, BROADCASTING AND OCCUPATIONAL STUDIES)

One of the first publications about the possible link between anthropogenic non-ionizing EMR and cancer risk was published by Wertheimer and Leeper in 1979 [12]. The authors have indicated the association of children cancer with "excess of electrical wiring configuration" in Colorado, USA in 1976–1977. Children lived close to high-current configuration had twice more cases of leukemia and 1.6 times more cases of lymphoma as compared with the control population. Later the same authors have found less but still significant association between high-current environment and cancer in adults [13]. It was proposed that low frequency magnetic fields from high-current wiring could be the risk factor of cancer development.

The military data indicate the influence of radiofrequency and microwaves radiation on the development of cancer. So, among Polish soldiers of 20–29 years old exposed to microwave and radar during 1970–1979 the cancer incidence rates were 5.5 times higher then in non-exposed soldiers [14]. Greatest excess of cancer cases were in blood-forming organs and lymphatic tissues (ratio = 6.7). Examination of 40,000 US naval personnel served during the Korean War (1950–1954) has indicated almost two times more cases of cancer in the high-exposed personnel compared with the low-exposed one [15].

In Honolulu (1978–1981) in broadcasting towers' locations (100–150 feet from the towers) the standardized incidence ratio (SIR) for total cancer cases was indicated 1.88 compared with 1.07 in the locations without towers [3]. For leukemia SIR was 2.08 and 0.59 for the locations with and without broadcasting towers [3]. Increased incidence in childhood leukemia was also detected near the low-frequency radio tower (23.4 KHz) in Hawaii (1979–1990) [16]. The odds ratio (OR) for people lived within 2.6 miles of the radio towers before diagnosis was 2.0 as compared with unexposed residences of Hawaii. South Korean study (1993–1999) of leukemia and brain cancer patients under 15 years age has revealed the OR = 2.15 for all types of leukemia among children resided within 2 km of the nearest amplitude modulation (AM) radio transmitter as compared with those resided more than 20 km from it [17]. Brain cancer and infantile cancer were not associated with AM radiofrequency radiation in this research.

Analysis of occupational studies which was done by Savitz and Calle [18] revealed that the highest risk ratio for any occupational group for acute myelogenous leukemia was in telegraph, radio and radar operators (2.6). It's significant that among the members of American Physical Therapy Association (females), who used microwave or radiofrequency diathermy for treatment of patients, the percent of miscarriages occurring before the seventh week of gestation was 47.7% in comparison with 14.5% in non-exposed control women [19].

THE USAGE OF MOBILE PHONES AND TUMOR RISK ASSOCIATION

During the last few years data about the association of long-term usage of mobile phone with tumor risk have been published. The most researches were focused on possible association of mobile phone usage and brain tumors development, because brains are mostly exposed to irradiation by mobile phone. In series of epidemiological studies by Swedish oncologists (Dr. L. Hardell group) a significant increase of some types of brain tumors risk in long-term (10 years or more) users of mobile and cordless phones has been detected [20–26]. As to the short-term users of mobile phone, similar effects were absent or less expressive [6]. It must be indicated that Sweden was one of the first countries, where commercial mobile networks were implemented. Analogue mobile phones were used in Sweden since 1981 and digital system (GSM; Global System for Mobile Communication) were introduced in 1991 [1]. The risk of meningioma increased among Swedish users of mobile and cordless phones with term of usage over 10 years. Case-control OR for analogue mobile phones was 1.6, 95%, for digital mobile phones 1.8, 95%, for cordless phone 1.8, 95%. For acoustic neuroma the risk of development increased with increasing period of usage of mobile phone, and it was the highest for users of analogue phone with term of usage over 15 years, OR = 3.5, 95% [22].

In recent publication by L. Hardell *et al.* [4] the authors analyzed the majority of published case-control studies on possible association of the usage of mobile phones with tumor risk for long-term users. For acoustic neuroma the analysis of 9 case-control studies has revealed the increasing risk for over 10 year users of mobile phone (OR = 1.3, 95%) and further increase of risk in cases of ipsilateral exposure (OR = 1.6, 95%). Similar results were revealed for glioma. The risk of glioma significantly increased for 10 year users (OR = 1.3, 95%) and especially for ipsilateral usageof mobile phone (OR = 1.9, 95%). It was indicated the highest risk of malignant brain tumors OR = 2.7, 95% for users of mobile phone with first use less 20 years age. It correlates with previous published data of L. Hardell group about highest OR = 5.9, 95% of brain tumour in 20-29 years age ipsilateral users of analogue mobile phone among different age groups [27].

Parotid gland is another potential target for mobile phone handset radiation. Israel team study in term of Interphone research indicated an association between the mobile phone use and parotid gland tumor [28]. The study included 402 benign and 58 malignant cases of parotid gland tumor diagnosed in Israel at age over 18 years in 2001-2003. The OR in the highest category of cumulative number of calls for ipsilateral use was 1.58, 95%. It is important that previous study performed in Finland detected the OR = 5.0, 95% for salivary gland cancers among Finland digital mobile phone subscribers compared with control population (used mobile phone just for 1-2 year) [29].

As was shown by L. Hardell group, for non-Hodgkin's lymphoma (NHL) of T cell, cutaneous and leukemia types, the ORs for analogue phone users were found to be 3.4, 95%; for digital phone users — 6.1, 95%; for cordless phone users — 5.5, 95% [30]. American researchers found that for NHL the OR for $\geqslant 8$ years users of mobile phone was 1.6, 95%, and the risk was increasing with number of years [31].

Regarding the uveal melanoma, the analysis of 118 cases of this pathology and 475 controls in Germany has indicated the OR = 4.2, 95% for people probably/certainly exposed to mobile phone [32]. The OR = 1.8, 95% was shown for seminoma for men keeping the mobile phone during stand by in one trousers pocket, and OR = 1.0, 95% — in different pockets [33]. The results were based on 542 cases study of seminoma performed in Sweden.

MOBILE PHONE BASE STATIONS AND TUMOR RISK

Starting from early 1990s tens of thousands of mobile phone base stations have been mounted over the world. So fast and extensive implementation of new technology base stations naturally had induced public concerns. But the World Health Organization International EMF Project had a priority to study effects of mobile phone and discouraged the base stations effects studies (except 2003-2006, when WHO recommended studies of base station possible effects) [5]. That is why only a few publications on the topic could be found, and two are about the association with cancer risk [34, 35].

The comparison of cancer cases among population living up to 400 m near mobile phone base station and further then 400 m from base station was carried out in Germany (1994-2004) [36]. The increase of cancer cases among people from area close to base station over the control population was 1.26 times during the first five year period (1994-1998), and 2.11 times during the second five year period (1999-2004). For the second period of analysis the increase of cancer cases among people living near base station was statistically significant both compared to the population from further area and to the expected background incidence.

Even more expressive results were obtained in Israel, Netanya [37]. People living in the area near (up to 350 m) to mobile phone base station (850 MHz, 1500 watt of full power) during 1 year of station operation (n = 622) and matched individuals from other area (n = 1222) participated in this study. There were 4.15 times more cases of cancer in base station close area than in the control area. Relative cancer rate for females from close to base station area was 10.5, relative rate was 0.6 for control area as compared with the whole town of Netanya female population (relative rate equals 1). Cancer incidence of women in close to base station area was significantly higher ($p < 0.0001$) compared with the control area and the whole city area. Authors emphasized the enormously short latency period (only 1 year) for such dramatic increase of cancer incidence in the area [37].

ANIMAL MODEL STUDY

Just a few studies have been designed to estimate an association of non-ionizing EMR exposure and cancer development on animal models. In one study mice with high incidence of spontaneous breast cancer and mice treated with 3,4-benzopyrene (BP) were irradiated by 2,450 MHz microwaves in an anechoic chamber at 5 or 15 mW/cm^2 (2 h daily, 6 sessions per week, 3 months) [38]. Irradiation with MWs at either 5 or 15 mW/cm^2 resulted in acceleration of the development of BP-induced skin cancer (285 days in control, 230 days for 5 mW/cm^2 and 160 days for 15 mW/cm^2). Microwaves-exposed mice with high incidence of spontaneous breast cancer had breast tumors earlier than control (332 days in control, 261 days for 5 mW/cm^2 and 219 days for 15 mW/cm^2). Authors had indicated that the acceleration of cancer development and lowering of natural antineoplastic resistence was similar in mice exposed to MWs at 5 mW/cm^2 or to chronic stress caused by confinement, but differed significantly from the results obtained on animals exposed at 15 mW/cm^2, where local thermal effects were possible.

The most cited study was performed by Repacholi, *et al.* [39] on transgenic mice moderately predisposed to develop lymphoma spontaneously. One group of mice (101 females) was exposed during two 30-min periods per day for up to 18 months in plane-wave electromagnetic fields of 900 MHz with pulse repetition frequency of 217 Hz and a pulse width of 0.6 ms, incident power densities were 2.6–13 W/m^2 and average SAR 0.13–1.4 W/kg. Another group of mice (100 females) was an unexposed control. Lymphoma risk was significantly higher in the exposed mice than in the control (OR = 2.4, 95%). And follicular lymphoma was the major contributor to the increased tumor incidence.

POSSIBLE PATHWAYS OF BIOLOGICAL ACTIVITY OF LOW-INTENSIVE EMR

One of the strong evidences that living cells perceive low-intensive EMR as a stress factor is a heat shock proteins (HSP) overexpression under the exposure. So, effective experiment with low-intensive microwaves irradiation of transgenic nematode *Caenorhabditis elegans* carrying reporter-gene constructs regulated by homologous HSP16 heat-shock promoters has revealed non-thermal-induced overexpression of HSPs [40]. Nematodes were exposed overnight to continuous-wave radiation (750 MHz, calculated SAR = 0.001 W/kg). Expression of HSP16 reporter rose steeply through 24.5 to 25.5 °C ($p < 0.001$) in exposed nematodes. Meantime in non-exposed control nematodes heat-induced reporter expression increased sharply only above 27 °C. There was a disparity of 3 °C between exposed and control induction profiles and authors of research rejected thermal explanation for this disparity.

RF radiation from GSM digital system (1800 MHz, SAR = 1.5–2 W/kg, exposure duration 22 or 72 h) induced a significant upregulation of mRNA levels of the HSP70 in p53-deficient pluripotent embryonic stem cells differentiating *in vitro*, paralleled by a low and transient increase of c-jun, c-myc, and p21 levels in p53-deficient cells, but not in wild-type cells [41]. One-hour non-thermal exposure of human endothelial cells changed the phosphorylation status of numerous proteins. One of the affected proteins was identified as HSP27 [42]. Authors underlined that changes in protein phosphorylation is an early sign of cell response to a stress factor.

Series of studies of researchers from Columbia University, USA on *HSP70* gene expression induced by low frequency EMR was performed [43–49]. Specific DNA sequence in gene *HSP70* promoter sensitive to EMR was identified. The EMR sensitive region on the *HSP70* promoter was not sensitive to increased temperature. The EMR domain contained three nCTCTn myc-binding sites at −230, −166 and −160 positions relatively to the transcription initiation site and upstream of the binding sites for the heat shock (nGAAn) and serum responsive elements. The sensitivity of the DNA sequences nCTCTn to EMF exposures has been demonstrated by transfecting these sequences into CAT and Luciferase reporter genes. Authors have indicated that the *HSP70* promoter contains different DNA regions that are specifically sensitive to different stressors, thermal and non-thermal [44].

Some studies suggest the possibility of DNA damage under the RF EMR exposure. So, it was reported the increase in DNA double-strand breaks and micronucleation in lymphocytes obtained from mobile phone users [50]. The number of single and double-strand breaks of DNA in brain cells of rat exposed to 2.450 MHz RF radiation (SAR = 0.6–1.2 W/kg of whole body) for 2 h was shown to be increased [51]. The same the exposure of mice to 2,450 MHz radiation (power density 1 mW/cm^2, 2 h per day over 120–200 days) has led to breakage of DNA in testis and brain [52]. The exposure of human fibroblasts or rat granulose cells to mobile phone radiation (1800 MHz, SAR = 1.2 or 2 W/kg, 4, 16 or 24 h) has induced single- and double-strand breaks of DNA after 16 h of exposure [53]. Molt-4 human lymphoblastoid cells exposed to TDMA (Time Division Multiple Access) and iDEN (Integrated Digital Enhanced Network) mobile phone radiation (2.4–26 μW/g, 2–21 h) had opposite effect on DNA breakage depending on the type of signal, intensity and duration of the exposure [54].

A few studies were devoted to the RF EMR exposure effects on apoptosis. So, yeast cells of wild-type and cdc-48-mutant were exposed to 900 or 872 MHz radiation (SAR = 0.4 or 3.0 W/kg) with or without exposure to ultraviolet radiation (UV) [55]. It was found that amplitude modulated RF exposure significantly enhanced UV induced apoptosis in cdc-48-mutated cells, but not in cells exposed to unmodulated radiation. The exposure of human epidermoid cancer KB cells to non-thermal RF EMR (1950 MHz) induced time-dependent apoptosis (45% after 3 h) [56]. The exposure induced a differential activation of stress-dependent pathways with an increase of JNK-1 activity and expression of HSP70 and HSP27 and decrease of p38 kinase activity and HSP90 expression.

In other study primary cultures of neurons and astrocytes were exposed to GSM mobile phone radiation (1900 MHz) for 2 h in "on" and "stand-by" mode [57]. Up-regulation of caspase-2, caspase-6 and *Asc* (apoptosis associated speck-like protein) gene expression occurred in both "on" and "stand-by" modes in neurons, but only in "on" mode in astrocytes.

Free radical processes could mediate many noxious effects in living cell. It's important that series of studies demonstrated the change of the level of reactive oxygen species (ROS) and antioxidant enzymes' activity in cells after the EMR exposure. So, rat exposed to 900 MHz radiation (SAR = 0.016 W/kg for whole body, applied 30 min/day, for 10 days using an experimental exposure device) had significantly increased level of malondialdehyde (MDA) and nitric oxide (NO) in renal tissue while superoxide dismutase (SOD), catalase and glutathione peroxidase activities significantly decreased [58]. In myocardial tissue of exposed rats the increased levels of MDA and NO were detected too, while SOD, CAT and GSH-Px activities were reduced [59]. Caffeic acid phenethyl ester treatment of rats reversed these effects. In other research rabbits were exposed to 900 MHz GSM mobile phone irradiation (0.02 mW/cm^2, 30 min/day, 7 days) [60]. Serum SOD activity increased, and serum NO level significantly decreased (more then twice) in exposed animals.

A significant increase in the MDA and carbonyl group concentration in Wistar rat brain tissue was registered during exposure of animals to a mobile test phone (SAR = 0.043–0.135 W/kg) during 20, 40 and 60 days. Decreased activity of catalase and increased activity of xanthine oxidase (XO) remained after 40 and 60 days of exposure to mobile phones. Melatonin treatment significantly prevented the increase in the MDA content and XO activity in the brain tissue after 40 days of exposure [61].

It was found that treatment of rats immediately before and after irradiation exposure (2450-MHz, power density 2 mW/cm^2, average whole body SAR = 1.2 W/kg, 2 h) with either melatonin or the spin-trap compound N-tert-butyl-alpha-phenylnitrone (PBN) blocks an increase in DNA single- and double-strand breaks in brain cells [62]. Since both melatonin and PBN are efficient free radical scavengers, authors hypothesized that free radicals are involved in exposure-induced DNA damage in the brain cells of rats.

Only one-hour exposure of men semen samples by standard mobile phone has led to significant decrease of semen mobility and viability, increase in ROS level and decrease in ROS-TAC (total antioxidant capacity) score [63].

50 Hz magnetic fields induced free radical formation in mouse bone marrow-derived promonocytes and macrophages [64]. It was demonstrated that mainly superoxide anion radicals were produced after 50 Hz magnetic field exposure, and the NADH-oxidase pathway to produce superoxide anion radical was activated, but not the NADPH pathway. Treatment with Trolox or iron chelator blocked the effects of exposure of rats to a 60 Hz magnetic field (0.01 mT, 24 h) caused a significant increase in DNA breaks [65]. Authors suggested that magnetic field initiates an iron-mediated process (Fenton reaction) that increases free radical formation in brain cells, leading to DNA damages.

Well-composed experimentally determined mechanism of radiofrequency radiation effect on living cell was proposed by Israel researchers [66]. They used the signaling inhibitors in irradiated to 875 MHz, 0.07 mW/cm^2 electromagnetic waves Rat1 and HeLa cells. It was found that the first step in EMR interaction with cell structures is mediated in the plasma membrane by NADH-oxidase, which rapidly (during the minutes) generates ROS. ROS directly stimulate matrix metalloproteinases and allow them to cleave and release heparin-binding epidermal growth factor (EGF). This secreted factor activates the EGF receptor, which activates the extracellular-signal-regulated kinase (ERK) cascade and thereby induces transcription and other cellular processes. Authors underlined that intensity of radiation applied in the study was well below the average intensity of a regular mobile phone (approximately 0.45 mW/cm^2 in Israel), and no changes in temperature were detected in the medium during irradiation.

Among very primary physical mechanisms of non-ionizing EMR interaction with biological systems the mobile charge interaction model of M. Blank should be noted. Model is based on the magnetic field interaction with moving charges (Lorentz force). If charge flow is associated with biological function in living cell, the function may be altered [67]. Magnetic field-induced changes in enzyme activities of Na, K-ATPase and cytochrome oxidase, proportional to charge flow, was demonstrated [67]. Moreover the effect of acceleration of the Belousov-Zhabotinski reaction by low frequency electromagnetic fields was demonstrated Blank and Soo [68]. Authors affirmed that the effect apparently was due to electromagnetic field interaction with electrons transferred during the reaction.

Another biophysical model for the action of oscillating electromagnetic fields on cell is based on mechanism of forced-vibration of all the free ions on the surface of a cell's plasma membrane, caused by an external oscillating field [69]. Representative data was published recently [70] where low-strength magnetic fields (0.1 mT, 0.2 ms) triggers onset and offset evoked potentials, indicating that the detection process was a form of sensory transduction. Authors [70] hypothesized that the evoked potentials were initiated by a force exerted by the induced electric field on an ion channel in the plasma membrane.

CONCLUSION

Recent studies in the field of electromagnetic biology have given sufficient grounds for more strict experts' estimation of possible association of cancer development and radiation of mobile telephony devices. First of all the results of epidemiological studies indicated significant increase of tumor development risk in long-term (over 10 years) users of mobile phone [4, 20–22, 24, 27, 30, 33]. It's significant that first expressive epidemiological data were revealed in Sweden, country with one of the longest history of mobile telephony. It is significant too that essential increase of risks was detected for brain tumors and salivary gland tumour. It means that direct association of tumor development and the location of EMR exposure exists. Two studies from developed countries (Germany and Israel) indicated a significant increase of cancer cases in population living near mobile base stations [36, 37]. Just a one year operation of powerful (1500 W) base station in Israel has led to dramatic increase of cancer cases among people living in base station area. Such significant increase of cancer incidence in mobile phone base station area correlates with previous data on significant increase of leukemia rate in habitants of broadcasting tower areas in Honolulu [3] and Hawaii [16].

These data arouse the concern about adequacy of safety limits for mobile telephony, which are now solely based on the conception of thermal mechanism of biological activity of RF radiation. Bulk of recent publications demonstrated the significant metabolic changes in living cells under the low-intensive EMR. The strong conception of mechanism of non-thermal biological effects of RF (MW) radiation remains to be developed. Preliminary studies indicate that typical metabolic pathways at list partially are involved in mediating the effect of EMR on living systems. It includes NADH-oxidase activation [64, 66] and overproduction of free radicals in cell [58, 59, 64, 66], subsequent activation of extracellular-signal-regulated kinase cascade [66] or free radical damage of DNA [62]. Some pathways may lead to apoptosis of exposed cells [56, 57]. On other hand some high-specific mechanisms of low-intensive EMR interaction with cell structures were revealed, such as the existence of EMR sensitive region on the HSP70 gene promoter [43]. The very first step of non-ionizing EMR interaction with living cell must include its physical interaction with electrical charges (electrons, ions). A few biophysical models were proposed for explanation of transformation of this interaction to biological response [67, 69, 70].

There is great insufficiency in animal studies of the potential carcinogenic effect of low-intensive EMR. From epidemiological studies it is clear that possible terms for effective experiments may last up to 10 years. Animal models should be used to shorten the period of studies and give insights to the role of EMR in tumor development.

Most discussions of potential hazards of EMR of mobile telephony devices have ended with the recommendation of the further study and the necessity of precautionary principle implementation. Of course, we insistently support both of these recommendations. But we see that the bulk of published data for today allows researchers to recommend significantly more strict limitations for excessive and often needless using of mobile telephony devices, especially for children. Authorities must recommended to restrict the level of MWs radiation from mobile telephony devices through the implementation of more strict safety limits, new technological decisions (moving off the source of radiation from human brain), and constant awareness activity.

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Survey Study of People Living in the Vicinity of Cellular Phone Base Stations

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ABSTRACT

A survey study was conducted, using a questionnaire, on 530 people (270 men, 260 women) living or not in proximity to cellular phone base stations. Eighteen different symptoms (Non Specific Health Symptoms–NSHS), described as radiofrequency sickness, were studied by means of the chi-square test with Yates correction. The results that were obtained underline that certain complaints are experienced only in the immediate vicinity of base stations (up to 10 m for nausea, loss of appetite, visual disturbances), and others at greater distances from base stations (up to 100 m for irritability, depressive tendencies, lowering of libido, and up to 200 m for headaches, sleep disturbances, feeling of discomfort). In the 200 m to 300 m zone, only the complaint of fatigue is experienced significantly more often when compared with subjects residing at more than 300 m or not exposed (reference group). For seven of the studied symptoms and for the distance up to 300 m, the frequency of reported complaints is significantly higher ($P < 0.05$) for women in comparison with men.

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Significant differences are also observed in relation to the ages of subjects, and for the location of subjects in relation to the antennas and to other electromagnetic factors.

Key Words: Cellular phone base stations; Bio-effects.

INTRODUCTION

Chronic exposure to ultra-high-frequency electromagnetic fields or microwaves brings on bioeffects in man such as headaches, fatigue, sleep, and memory disturbances (Bielski, 1994; Santini, 1999). These biological effects, associated with others (skin problems, nausea, irritability) constitute what is known as "Non Specific Health Symptoms" (NSHS) that characterize radiofrequency sickness (Johson Liakouris, 1998). Cellular mobile phone technology uses microwaves (frequencies of 900 or 1800 MHz in France) pulsed with extremely low frequencies (frequencies <300 Hertz) (Linde and Mild, 1997). However many of the biological effects resulting from mobile phone use are relatively well-known and bring to mind those described in radiofrequency sickness (Mild et al., 1998; Santini et al., 2002).

We are reporting here the results concerning 530 people living in France, in the neighborhood or not, of cellular phone base stations, in relation to their exposure conditions to antennas, their sex, and their age.

MATERIALS AND METHODS

Questionnaire Used

A questionnaire similar to that developed for the study on mobile phone users (Santini et al., 2002) was sent to people wishing to participate in the study. Subjects were enrolled through information given by press, radio, and web sites, about the existence of a study on people living near cellular phone base stations. The questionnaire was filled out by subjects without the presence of a person in charge of the study and was returned (generally by mail) to a person responsible for the study.

General questions pertained to age, sex, estimated distances from base stations (less than 10 m, 10–50 m, 50–100 m, 100–200 m, 200–300 m, more than 300 m) and their location in relation to the antennas (facing, beside, behind, beneath in the case of antennas placed on rooftops). The exposure conditions of subjects were also defined by the length of time living in the neighborhood of base stations (less than 1 year, 1–2 years, 2–5 years, more than 5 years).

Participants were asked to indicate the presence or not of electrical transformers (at less than 10 m), high or very high tension electric power lines (at less than 100 m) and *radio and television transmitters (at less than 4 km). The questionnaire sought* information on computer use (more than 2 hours per day) and cellular telephone use (more than 20 minutes per day).

The level of complaints for the studied symptoms was expressed by the study participants using a scale of: 0 = never, 1 = sometimes, 2 = often, and 3 = very often. Of 570 questionnaires received, 40 were not used because of lack of information on the distance from the base stations or on the level of the complaints experienced. Among the 530 questionnaires studied, 270 came from men (45 years ± 20) and 260 from women (47 years ± 19). Eighteen symptoms referenced in the NSHS were found in the questionnaire; one of which, premature menopause, concerned only women.

Analysis of Results

The results obtained, concerning the frequency of the complaints experienced in relation to responses with 0 = never, were analyzed by the chi-square test with Yates correction (Dabis et al., 1992) by means of a software program (STATITCF, 1987, France). Results were compared with the frequency of complaints of the reference group (subject exposed at >300 m or, living in the vicinity of nonoperating base stations) for incidences of distance and age. The comparisons were done with the frequency of complaints expressed by subjects exposed up to 300 m for length of exposure (comparison to <1 year), for location of subjects (comparison of locations among themselves) and for sex. A $P < 0.05$ was considered significant.

We are presenting here the results tallied with: (1) the influence of subject's exposure conditions to base stations (distance, length of exposure, location in relation to the antennas other electromagnetic factors), and (2) the influence of sex and age of subjects.

RESULTS

Influence of Exposure Conditions

Distance

The 530 study subjects were distributed in the following manner: 19.6% were less than 10 m from cellular phone base station antennas, 26.2% between 10 and 50 m, 13.8% between 50 and 100 m, 9.6% between 100 and 200 m, 10.1% between 200 and 300 m, and 20.7% were at more than 300 m or not exposed; these last subjects were chosen as the reference group.

In comparison with the reference group, the complaints are experienced in a significantly higher way by the subjects located in the distance zones of <10 m to 300m from base stations. Certain symptoms are experienced significantly more often ($P < 0.05$) only in the immediate vicinity of base stations (up to 10 m) and not beyond that: Nausea, loss of appetite, visual disturbances, and difficulty in moving. Significant differences ($P < 0.05$) are observed up to 100 m from base stations for symptoms such as: Irritability, depressive tendencies, difficulties in concentration, loss of memory, dizziness, and lowering of libido. In the zone 100 m to 200 m from base stations, the symptoms of headaches, sleep disruption, feelings of discomfort, and skin problems are again experienced significantly more often ($P < 0.05$) in comparison with the reference group. Beyond 200 m, only the symptom of fatigue is reported at a significantly high frequency ($P < 0.05$) (Table 1). By contrast, no significant effect is demonstrated in relation to distance for the symptom of premature menopause. A significant lowering of libido was reported by subjects living at the distances of less than 10 m, 10–50 m, and 50–100 m from base stations.

Table 1. Influence of distances from cellular phone base stations on the percentages of complaints

	Distances from base stations in meters (m)											
	< 10 m		10–50 m		50–100 m		100–200 m		200–300 m		> 300 m	
Symptoms	2	3	2	3	2	3	2	3	2	3	2	3
Fatigue	76*	72*	63.5*	50.9*	60.6	56.6*	64.2	41.1	66.6*	43.7	40.7	27.2
Irritability	32.8	23.2*	41.7*	25.7*	47.2*	44.1*	25.8	4.1	25	9	18	3.3
Headaches	51*	47.8*	40*	26.1*	40.6*	36.7*	60.7*	31.2*	19.3	0	15.6	1.8
Nausea	14.5*	6.9	8.4	3	5.7	3.8	2.4	4,6	0	2.3	2,1	1.1
Loss of appetite	20.4*	8.3	8	5.5	5	5	6.9	0	4.2	0	3.3	3.3
Sleep disturbances	41.3*	57.1*	41.4*	57.5*	46.9*	58.5*	45.8*	50*	33.3	35.5	13.8	21.1
Depressive tendencies	16,9	26.8*	21.6	19.7*	11.6	24*	16.2	3.1	13.6	2.5	10.3	3.7
Feeling of discomfort	28*	45.4*	25.2*	18.9	30.6*	12.8	15.7*	0	9.7	5.1	2.4	8.1
Difficulties in concentration	39.3	28.8*	37.5	16.6	34.2	26.4*	25	12.5	43.3	5.5	26.7	7.1
Memory loss	27.8	25.4*	29.4	26.6*	37.1*	29*	25	15.6	17.2	11.1	17.9	5.8
Skin problems	18.1*	17.1*	6.6	10.8	11.1*	11.1	13.9*	7.5	8.7	0	1.2	4.6
Visual disturbances	14.5	24.3*	23	13.5	22	7.1	2.5	4.9	15	2.8	13.6	4.1
Hearing disturbances	33.3*	17.4	17.7*	12	8.3	15.5	7.7	7.7	11.6	9.5	5.6	8.7
Dizziness	10	12.5*	17.3*	7,5*	9.6	9.6*	12.2	2.7	7.7	5.2	6.2	0
Movement difficulties	5.6	7.7*	8.2	1.7	3	3	0	0	2	0	2.9	1
Cardiovascular problems	10.1*	13*	15.3*	9.6	12.3*	7.4	8.7	0	8.5	6.5	1	3

for 16 non Specific Health Symptoms experienced by 530 people (270 men + 260 women).

* = $P < 0.05$ in comparison to the reference group (> 300 m) for the responses 2 = often and 3 = very often.

Length of Exposure

There is no significant difference in the frequency of symptoms expressed by subjects living up to 300 m from cellular phone base station, according to the length of time (<1 year to more than 5 years) they have lived in the neighborhood of base stations.

Location of Subjects

The location of subjects in relation to the antennas (facing, beside, behind, beneath) taken alone has little impact on the frequency of symptoms reported. When comparisons are made in relation to the different distance zones, significant increases of complaints ($P < 0.05$) are observed for some distances and for some symptoms in the facing position: visual disturbances for distance <10 m as compared with beneath, *fatigue for distance 10 to 50 m as compared with beneath, headache for distance 10* to 50 m as compared with beside, memory loss for distance 50 to 100 m as compared with beside. When comparisons are made for all subjects exposed at a distance of up to 300 m from base stations, it is only observed a significant increase in headaches ($P < 0.05$) for subjects in the beneath position as compared with subjects in the facing position.

Table 2. Influence of sex on the percentages of complaints

Symptoms	Men (%)	Women (%)
Fatigue	41.4	57.5
Irritability	17.9	28.3
Headaches (3)	14.4	45.6*
Nausea (3)	0	5.9*
Loss of appetite (3)	1.9	8*
Sleep disturbances (3)	45.4	61*
Depressive tendencies (3)	9.8	26.7*
Feeling of discomfort (3)	15	25.4*
Difficulties in concentration	18.4	21.6
Memory loss	18	27.7
Skin problems	8	13.1
Visual disturbances (2)	12.2	22*
Hearing disturbances	9.6	19
Dizziness	6	9.8
Movement difficulties	3.3	2.7
Cardiovascular problems	8.3	8.8
Lowering of libido	18	12

for 17 Non Specific Health Symptoms reported by 420 people (205 men vs. 215 women) living in the vicinity of cellular phone base stations (all distances from <10 m to ≤300 m).
* = $P < 0.05$ for level of complaints in parenthesis, 2 = often and 3 = very often.

Exposure to Other Electromagnetic Factors

The presence of factors such as an electrical transformer, very high tension electric power lines, radio-television transmitters, the use of computers, or cellular phones has little influence on the frequency of symptoms reported by subjects living at a distance of up to 300 m from base stations. However, a significant decrease of sleep disturbance for cellular phone users, and significant increases of discomfort and dizziness with the presence of an electrical transformer, and of difficulties in concentration with the presence of a radio-television transmitter, are observed in comparison with subjects living at a distance of up to 300 m, but not exposed to those factors.

Table 3. Influence of age on the percentages of complaints

	≤ 20 years		21–40 years		41–60 years		> 60 years	
	Distances of subjects from antennas (in meters)							
Symptoms	≤ 300	> 300	≤ 300	> 300	≤ 300	> 300	≤ 300	> 300
Fatigue	56.7	62.5	82.4*	25	81.4*	57.8	73.3*	40
Irritability	16.2	11.1	46.2	18.2	50.5	35.3	52.1*	21
Headaches	42.4	26.3	57.6*	18.2	52*	13.3	49.5*	10
Nausea	2	0	12.9	0	9.9	0	15.6	15.7
Loss of appetite	13.3	8.8	12.7	0	11.8	0	15.9	15
Sleep disturbances	26.1	14.8	53*	12.5	73.9	52.6	68.5*	44.4
Depressive tendencies	10.2	5.7	14	5.8	36	20	41.7	27.7
Feeling of discomfort	4.4	2.9	26.3	6	41.6	16.6	45*	19
Difficulties in concentration	30.3	40	42.1	18.7	45.8	36.8	53.3*	20
Memory loss	7.5	8	21.8	6.6	43	40	64	36.8
Skin problems	16.6	9.3	24.2	6.6	18.3	0	20.4	5.2
Visual disturbances	16.3	12.5	14.7	12.5	26.6	26.3	36.8	17.6
Hearing disturbances	9.4	5.1	15.4	0	29.8	21.7	43.8	31.5
Dizziness	6.2	5.2	3.2	6.6	15.4	4.5	39.3*	9.5
Movement difficulties	0	2.3	0	0	3.5	4	21.4	10.5
Cardiovascular problems	0	2.3	5.1	0	19.2*	0	36.4	15

for 16 Non Specific Health Symptoms experienced by 530 people (270 men + 260 women) in relation to their distances from cellular phone base stations (≤ 300 m vs. > 300 m [reference group]).

* = $P < 0.05$ for levels of complaints 2+3 pooled.

Influence of Sex and Age

Sex

In terms of the different distance zones, two complaints were experienced significantly more often for women ($P < 0.05$): nausea in the zone of less than 10 m, headaches in the zones of 10–50 m, 50–100 m, 100–200 m, and 200–300 m. Men complain significantly more often ($P < 0.05$) than women about lowering of libido in the zone of 50 to 100 m from cellular phone base stations.

When the men/women comparison is made for all subjects exposed at a distance up to 300 m, seven symptoms (i.e., headaches, nausea, loss of appetite, sleep disturbances, depressive tendencies, feeling of discomfort, and visual disturbances) are experienced significantly more often in women ($P < 0.05$) (Table 2). On the contrary, for the subjects of the reference group, there appears to be no significant difference related to sex in the frequency of complaints reported for the different symptoms.

Age

Significant differences are observed in relation to the age of the subjects (from 21 to >60 years) for symptoms such as fatigue, irritability, headaches, sleep disturbances, feeling of discomfort, dizziness, cardiovascular problems when comparisons are made between subjects living up to 300 m vs. subjects of the reference group. For subjects younger than 20 years of age, there is no significant difference in the frequency of symptoms between subjects living at up to 300 m vs. subjects of the reference group (Table 3).

DISCUSSION

This study gives evidence of the fact that NSHS are reported by people at distances up to 200 m to 300 m from cellular phone base stations. The significant increase in the frequency of complaints in relation to the reference group (people exposed at >300 m or not exposed) goes in the direction of the observation found in an Australian governmental report, which had signaled that at 200 m from a base station, some people exposed in their homes are complaining of chronic fatigue and sleep disturbances (Australian Report, 1996). Our results agree with those of a Spanish preliminary study on people living in the vicinity of cellular phone base stations, where symptoms as irritability, headaches, nausea, and sleep disturbances are experienced in a significantly higher way by the subjects located at a distance up to 150 m vs. subjects at a distance >250 m (Gomez-Perretta CI, personnal communication, 2002).

The number of reported symptoms is higher close to base stations, and that number decreases with increased distance from them, in relation to the fact that some symptoms such as nausea, loss of appetite, visual disturbances, and difficulties in movement are no longer experienced in a significant way beyond 10 m.

Symptoms such as fatigue, headaches, and sleep disturbances, which are experienced significantly at considerable distances from base stations, exhibit no notable diminishment in the percentages of complaints experienced with increased distance. But the measurements of electromagnetic fields in the neighborhood of cellular phone base stations show a reduction in strength over distance (Petersen and Testagrosa, 1992; Santini, 1999). One could expect that human sensitivity to electromagnetic waves is such that increased distance from cellular phone base stations has no significant effect on certain NSHS symptoms up to a distance of 200 to 300 m (difference in receptors sensibility to microwaves?). It is also possible that the measurements of electromagnetic fields found around base stations may not be the true representation of populations exposure. In fact, different parameters are likely to interfere to modify the measurements and in particular fluctuations in emission strengths relating to the number of calls handled by base stations, the reflection of electromagnetic waves, etc. (Santini et al., 2000).

No significant decrease was observed in the frequency of symptoms in relation to the length of time living in the neighborhood of base stations (from <1 year to >5 years). This result shows that there is no acclimation of subjects to microwave bioeffects with duration of exposure.

This study shows that for some distances and for some symptoms, the facing location is the worst position, especially for distances of <100 m from cellular phone base stations. This result can be related to the fact that antennas emit microwave at a higher level in front than in other directions (Petersen and Testagrosa, 1992).

The results obtained demonstrate the greater sensitivity of women for 7 of the studied NSHS. One earlier study related to cellular phones users demonstrated an increase in women's sensitivity for the symptom of sleep disturbances (Santini et al., 2002). This sex-related difference is parallel to the particular sensitivity of women to electromagnetic fields (Loomis et al., 1994; Santini, 1998). The results obtained in this study also show the existence of a greater sensibility for some NSHS symptoms, in relation to age, in subjects older than 20 years. This sensibility is particularly high in subjects older than 60 years. This last results agrees with the greater sensibility of the elderly to radiofrequencies (Tell and Harem, 1979).

CONCLUSION

From these results and in applying the precautionary principle, it is advisable that cellular phone base stations should not be sited closer than 300 m to populations and most significantly because exposed people can have different sensitivities related particularly to their sex and their age. The facing position appears to be the worst one for distances from cellular phone base stations <100 m.

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Case Report

How does long term exposure to base stations and mobile phones affect human hormone profiles?

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ABSTRACT

Objectives: This study is concerned with assessing the role of exposure to radio frequency radiation (RFR) emitted either from mobiles or base stations and its relations with human's hormone profiles.

Design and methods: All volunteers' samples were collected for hormonal analysis.

Results: This study showed significant decrease in volunteers' ACTH, cortisol, thyroid hormones, prolactin for young females, and testosterone levels.

Conclusion: *The present study revealed that high RFR effects on pituitary–adrenal axis.*

Introduction

Because of the increase in the usage of wireless communication devices of mobile phones in recent years, there is an anxious concern on the possible hazardous effects of prolonged exposure to radio frequency radiation (RFR) [1]. In considering the biological effects of RFR, the intensity and frequency of the radiation and exposure duration are important determinants of the responses.

It has been reported that exposure to RFR could affect the nervous system [2]. Hardell et al. found that cell phone users had an increased risk of malignant gliomas [3]. Subjecting human spermatozoa to RFR showed decrease in sperms motility and vitality and increase in DNA fragmentation [4]. The authors hypothesize that the high sporadic incidence of the clinical symptoms of the autoimmune multiple Sclerosis disease [5] may be a result of long exposure to RFR from mobiles.

This study is concerned with assessing the effect of RFR emitted from mobile phones and base stations on human hormone profiles, with anticipation to offer recommendations to assure health care and safety for humans continuously exposed to radio frequency radiation.

Design and methods

Study subjects

This study was conducted for 6 years on 82 mobile phone volunteers with age ranges 14–22 years ($n = 41$) and 25–60 years ($n = 41$). Those users were divided into three subgroups according to the time of their exposure to RFR: (weak $n = 19$), (moderate $n = 9$), and (strong $n = 13$) per day, in addition to 20 negative control subjects.

On the other hand, volunteers exposed to RFR emitted from base stations ($n = 34$) were selected with age ranges 14–22 years ($n = 17$), and 25–60 years ($n = 17$) and living at distances 20–100 m and 100–500 m apart from the base station. Additional 10 subjects of each age range living at a distance more than 500 m apart from the base station were considered as negative control group.

The source of the RFR (base stations or mobile phones) was GSM-950 MHz magnetic field and the ICNIRP-Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic field (up to 300 GHz) (International Commission on Non-Ionizing Radiation Protection). The present study was approved by the Ethics Committee of National Research Centre.

Volunteers inclusion criteria

Volunteers participated in the study fulfilled the following inclusion criteria: age 14–60 years, mobile phone users, or living at distances 20–100 m and 100–500 m apart from the base station.

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Blood samples collection

Blood samples of the volunteers were analyzed for estimation of the following hormones: plasma ACTH, serum cortisol, total T_3, T_4, prolactin, progesterone, and testosterone levels. All volunteers followed for 6 years and the blood samples were collected regularly from mobile phone users, volunteers exposed to RFR emitted from base stations, and the controls for time intervals after 1 year, 3 years and 6 years for hormonal analysis. The determination of the hormonal profile was performed on serum samples whereas ACTH was detected in EDTA plasma. The whole blood was collected in EDTA tube.

Blood samples were withdrawn from females to measure serum prolactin and progesterone levels. Whereas, blood samples were withdrawn from males to measure serum testosterone level. Blood samples were withdrawn from both males and females to measure plasma ACTH level, serum cortisol, total T_3 and T_4 levels.

Methods

Plasma ACTH, serum total T_3, and T_4 levels were determined quantitatively using DSL-ELISA Kits provided by (Diagnostic Systems Laboratories Inc.). Measurement of serum cortisol level was carried out using ELISA kit provided by Adaltis Italia SPA Company (Italy). Serum prolactin, progesterone, and testosterone concentrations were measured using ELISA kit supplied by (DRG International, Inc., USA).

Statistical analysis

The data were analyzed using SPSS program (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA, 2001).

Results

Volunteers mean hormone values

Follow up data were available for all volunteers who were exposed to RFR either from mobiles or base stations. The clinical features of all individuals were summarized in tables.

Tables 1 and 2 illustrate that persons of ages 14–22 years or 25–60 years who were exposed, for time intervals extended to 6 years, to RFR either from mobile phones or from base stations suffered significant decreases in their plasma ACTH and serum cortisol levels as compared to the control group. High significant decrease ($P<0.01$) in plasma ACTH and serum cortisol levels was observed for persons exposed to RFR from base stations at distances extended from 20 to 500 m for a period of 6 years as compared to the control group.

Tables 1 and 2, also show that persons of ages 14–22 years and 25–60 years who were exposed, for time intervals extended to 6 years, to RFR either from mobile telephones or from base stations suffered high significant ($P<0.01$) decrease in their serum T_3 and T_4 levels.

Tables 1 and 2 show that young females (14–22 years) exposed to RFR from mobile phones or from base stations at distances 20–100 m and 100–500 m suffered decrease in their serum prolactin level and the rate of decrease significantly rose with increased time of exposure from 1 year up to 6 years. Conversely, the serum prolactin level for adult females (25–60 years) showed significant increase along the time of exposure 1 year up to 6 years.

Table 1 shows that serum progesterone levels in young and adult females exposed to RFR from mobile phones were non-significantly changed through exposure for 1 year up to 6 years as compared to healthy controls.

Table 2 shows that both young (14–22 years) and adult (25–60 years) females exposed to RFR from base stations did not suffer any change in their serum progesterone levels throughout the first year of exposure. However, with increasing exposure periods from 3 up to 6 years they suffered significant decrease in their serum progesterone levels.

Tables 1 and 2 illustrate that both young males (14–22 years) and adult males (25–60 years) exposed to RFR from mobile phones or from base stations experienced gradual decrease in their serum testosterone level with increasing the period of exposure.

Discussion

The intensity and frequency of RFR and exposure duration are important determinants of the cumulative effect that could occur and lead to an eventual breakdown of homeostasis and adverse health consequences. Therefore, greater commitment from policy makers, health care officials and providers is needed to raise public awareness about the hazardous outcomes of long term exposure to RFR.

As mentioned in our results, persons who were exposed to RFR suffered significant decreases in their ACTH and cortisol levels as compared to controls. This result is agreed with the previous study indicating that cortisol levels were decreased after exposure to RF [12]. The current result is in contradiction with a previous study indicating that electromagnetic fields have a slight elevation in human cortisol production [6] and with other previous study suggesting that cortisol concentration as a marker of adrenal gland function was not affected with RFR [11]. Djeridane et al. (2008) added that ACTH was not disrupted by RFR emitted by mobile phones [12].

Our results reveal that persons who were exposed to RFR either from mobile phones or base stations suffered highly significant decrease in their serum T_3 and T_4 levels which agree in case of low T_4 levels and disagree in case of low T_3 concentrations with previous study which suggested that serum T_3 remains in normal range [7].

In the present study, females exposed to RFR from mobile phones or base stations suffered change in their serum prolactin level and the rate of change significantly rose with increased time of exposure which is in converse with previous studies indicating that serum prolactin concentration remained within normal ranges after exposure to radiocellular phones [8,12]. Therefore, it is suggested that the menstrual cycle and the pregnancy will be affected by changing the level of serum prolactin which seems necessary to be optimized in these two processes.

Our study suggested that serum progesterone levels in young and adult females exposed to RFR from mobile phones non-significantly changed from 1 year up to 6 years as compared to healthy controls. So, the menstrual cycle and pregnancy may not be affected by serum progesterone concentration. Previous study revealed that microwaves produced significant increases in serum progesterone level only in pregnant rats [9].

In the present study, both young and adult males exposed to RFR from mobile phones or base stations experienced gradual decrease in their serum testosterone level with increasing the period of exposure which is almost the same as previously recent reported studies suggested that exposure to mobile radiation leads to reduction in serum testosterone and it possibly affects reproductive functions [10,11]. The present study is in converse with a previous study indicating that testosterone was not disrupted by RFR emitted by mobile phones [12].

In conclusion, the present study revealed that high RFR emitted from either mobile phone or base station has tangible effects on pituitary–adrenal axis represented in the reduction of ACTH and consequently cortisol levels. Also, exposure to RFR is associated with decrease in the release of thyroid hormones.

Moreover, our data suggested that each of serum prolactin in young females, and testosterone levels in males significantly dropped due to long-term exposure to RFR. Conversely, the serum prolactin levels for the adult females significantly rose with increasing exposure time. Finally, the degenerative effects of exposure to RFR were more pronounced for persons who used mobile phones for long periods of 6 years. Also, the effect of this type of radiation was more

Table 1
Plasma ACTH, serum cortisol, T3, T4, prolactin, progesterone, and testosterone of volunteers exposed to RFR from mobile phones.

Hormones (mean ± SE)	Groups											
	Controls						Mobile phone users					
	1 Year		3 Years		6 Years		1 Year					
	Age$_1$	Age$_2$	Age$_1$	Age$_2$	Age$_1$	Age$_2$	Age$_1$			Age$_2$		
							S	M	W	S	M	W
Plasma ACTH (pg/mL)	61.1 ± 1.1	63.2 ± 0.1	59.9 ± 0.2	62.3 ± 1.0	59.9 ± 0.3	60.2 ± 1.7	49.1 ± 0.3^{b}	55.0 ± 1.1^{b}	59.2 ± 0.1^{NS}	53.2 ± 1.2^{b}	58.3 ± 0.4^{b}	62.1 ± 1.1^{NS}
Serum cortisol (μg/mL)	30.0 ± 1.2	31.2 ± 0.1	30.0 ± 0.1	31.7 ± 0.3	29.9 ± 0.2	28.8 ± 2.3	20.3 ± 1.1^{b}	27.3 ± 0.1^{a}	30.1 ± 0.3^{NS}	23.9 ± 1.0^{b}	28.2 ± 0.9^{b}	30.3 ± 1.1^{NS}
Serum T_3 (ng/dL)	105.2 ± 1.3	102.0 ± 1.1	101.7 ± 1.2	98.6 ± 2.1	103.6 ± 1.1	99.0 ± 1.4	96.3 ± 1.2^{b}	100.0 ± 0.6^{b}	102.1 ± 1.3^{NS}	93.9 ± 1.1^{b}	98.1 ± 0.3^{a}	99.0 ± 0.7^{a}
Serum T_4 (μg/dL)	7.8 ± 0.6	6.9 ± 1.4	7.7 ± 1.1	6.5 ± 0.7	7.1 ± 0.3	6.6 ± 2.1	6.9 ± 0.1^{NS}	7.0 ± 0.1^{NS}	6.9 ± 0.1^{NS}	$6.3\ 0.8^{b}$	6.2 ± 1.2^{NS}	6.0 ± 1.0^{NS}
Serum prolactin (ng/mL)	17.8 ± 1.1	17.2 ± 1.2	17.3 ± 1.1	16.9 ± 1.3	17.0 ± 2.1	16.8 ± 0.5	14.9 ± 1.4^{a}	14.7 ± 0.3^{a}	17.3 ± 0.2^{NS}	18.3 ± 0.1^{a}	16.9 ± 0.3^{a}	17.1 ± 0.2^{NS}
Serum progesterone (pg/mL)	14.0 ± 1.3	17.1 ± 1.0	13.8 ± 1.2	16.9 ± 0.9	12.9 ± 1.3	16.8 ± 0.2	12.3 ± 1.1^{NS}	12.2 ± 1.2^{NS}	14.1 ± 0.7^{NS}	16.1 ± 1.4^{NS}	17.6 ± 0.3^{NS}	16.5 ± 0.4^{a}
Serum testosterone (pg/mL)	29.5 ± 1.2	25.2 ± 1.6	28.9 ± 1.8	24.3 ± 0.6	28.4 ± 0.3	24.0 ± 0.1	25.2 ± 0.2^{a}	24.9 ± 0.1^{a}	23.7 ± 0.4^{a}	22.7 ± 1.2^{a}	23.8 ± 0.4^{NS}	19.9 ± 0.1^{a}

Age : represents age from 14 to 22 years. Age : represents age from 25 to 60 years.S: represents Strong, M: represents Moderate, W: represents Weak.N Control = 10, N Strong = 13, N Moderate = 9, N Weak = 19.Strong use: more than 60 min/day, Moderate use: between 30–60 min/day, Weak use: less than 10 min/day.NS: non-significant change when comparing mobile phone users with controls.
[a] Significant difference at $P > 0.05$ when comparing mobile phone users with controls.
[b] Significant difference at $P > 0.01$ when comparing mobile phone users with controls.

Table 1 (*continued*)

Hormones (mean ± SE)	Groups											
	Mobile phone users											
	3 Years						6 Years					
	Age$_1$			Age$_2$			Age$_1$			Age$_2$		
	S	M	W	S	M	W	S	M	W	S	M	W
Plasma ACTH (pg/mL)	45.3 ± 0.6^{b}	51.2 ± 1.3^{b}	55.0 ± 1.1^{b}	50.2 ± 0.4^{b}	55.1 ± 1.1^{b}	60.0 ± 0.3^{b}	40.3 ± 0.4^{b}	41.3 ± 1.1^{b}	47.2 ± 0.2^{b}	48.2 ± 0.4^{b}	51.3 ± 1.3^{b}	57.2 ± 1.1^{b}
Serum cortisol (μg/mL)	18.3 ± 1.4^{b}	20.2 ± 1.1^{b}	25.1 ± 0.1^{b}	20.3 ± 1.1^{b}	25.9 ± 0.9^{b}	20.3 ± 1.2^{b}	18.0 ± 0.1^{b}	17.3 ± 1.1^{b}	20.3 ± 0.2^{b}	17.0 ± 0.2^{b}	22.0 ± 0.4^{b}	24.1 ± 0.2^{b}
Serum T_3 (ng/dL)	87.2 ± 1.3^{b}	90.2 ± 1.6^{b}	94.3 ± 1.1^{b}	89.8 ± 1.1^{b}	92.9 ± 1.3^{b}	95.0 ± 1.1^{b}	80.3 ± 1.1^{b}	84.2 ± 0.5^{b}	85.7 ± 1.1^{b}	83.2 ± 1.3^{b}	80.3 ± 1.1^{b}	90.2 ± 0.7^{b}
Serum T_4 (μg/dL)	7.9 ± 1.1^{b}	7.6 ± 1.7^{NS}	7.1 ± 1.3^{NS}	6.4 ± 0.3^{NS}	6.3 ± 0.8^{NS}	6.1 ± 0.3^{NS}	10.5 ± 0.1^{b}	9.5 ± 1.1^{NS}	8.9 ± 0.4^{b}	7.4 ± 0.9^{NS}	7.7 ± 1.3^{NS}	8.0 ± 1.1^{NS}
Serum prolactin (ng/mL)	17.4 ± 1.2^{a}	9.8 ± 0.3^{b}	9.7 ± 0.1^{b}	23.5 ± 0.2^{b}	19.2 ± 1.1^{b}	18.7 ± 0.9^{b}	10.1 ± 1.0^{b}	8.7 ± 0.3^{a}	8.7 ± 0.4^{NS}	24.9 ± 0.1^{b}	21.1 ± 0.3^{b}	20.6 ± 0.1^{b}
Serum progesterone (pg/mL)	13.9 ± 0.2^{NS}	13.6 ± 0.7^{NS}	13.4 ± 0.4^{NS}	15.1 ± 0.3^{a}	14.9 ± 0.1^{a}	13.0 ± 0.5^{b}	12.9 ± 0.2^{a}	11.8 ± 0.1^{a}	10.9 ± 0.3^{a}	14.8 ± 1.1^{b}	13.5 ± 1.3^{NS}	12.8 ± 0.1^{NS}
Serum testosterone (pg/mL)	19.8 ± 0.1^{b}	18.7 ± 0.2^{a}	16.5 ± 0.1^{a}	17.5 ± 0.2^{b}	16.9 ± 1.1^{a}	16.1 ± 0.3^{a}	13.1 ± 0.4^{b}	12.7 ± 0.2^{b}	12.3 ± 0.1^{b}	11.1 ± 1.1^{b}	11.4 ± 0.2^{b}	9.8 ± 0.3^{b}

Table 2
Plasma ACTH, serum cortisol, T3, T4, prolactin, progesterone, and testosterone of volunteers exposed to RFR from base stations.

Hormones (mean ± SE)	Groups								
	Controls (distance 500 m)						Volunteers exposed to RFR from base stations		
	1 Year		3 Years		6 Years		1 Year		
	Age_1	Age_2	Age_1	Age_2	Age_1	Age_2	Age_1		Age_2
							D_1	D_2	D_1
Plasma ACTH (pg/mL)	62.8 ± 1.2	58.3 ± 0.9	62.5 ± 0.3	58.4 ± 0.5	62.4 ± 0.7	58.9 ± 0.1	61.9 ± 0.2^{NS}	62.3 ± 0.1^{NS}	57.9 ± 1.3^{NS}
Serum cortisol (µg/mL)	33.3 ± 2.6	30.1 ± 1.4	32.9 ± 1.1	30.3 ± 1.4	32.7 ± 1.1	29.9 ± 1.9	32.4 ± 1.2^{NS}	32.9 ± 0.3^{NS}	28.8 ± 1.6^{NS}
Serum T3 (ng/ dl)	108.3 ± 1.6	100.0 ± 1.1	107.0 ± 1.9	100.0 ± 0.1	107.0 ± 0.1	99.9 ± 1.2	107.0 ± 1.1^{NS}	107.9 ± 0.4^{NS}	106.0 ± 1.1^{NS}
Serum T4 (µg/dL)	7.2 ± 1.3	6.3 ± 0.3	6.8 ± 1.2	6.3 ± 0.1	6.7 ± 1.2	6.2 ± 2.4	6.9 ± 0.3^{NS}	7.1 ± 1.1^{NS}	5.9 ± 1.1^{NS}
Serum prolactin (ng/mL)	18.3 ± 1.1	14.3 ± 1.6	18.0 ± 1.0	13.9 ± 1.2	18.0 ± 1.2	13.1 ± 0.2	17.6 ± 0.2^{NS}	17.6 ± 1.3^{NS}	19.1 ± 0.3^{b}
Serum progesterone (pg/mL)	12.4 ± 1.1	10.0 ± 0.8	12.3 ± 1.6	10.0 ± 0.5	12.2 ± 1.9	9.8 ± 2.4	12.3 ± 1.1^{NS}	12.3 ± 1.0^{NS}	10.1 ± 0.9^{NS}
Serum testosterone (pg/mL)	27.1 ± 0.3	24.2 ± 1.1	26.3 ± 1.1	23.2 ± 1.3	25.8 ± 1.4	22.9 ± 2.1	243 ± 1.1^{b}	24.9 ± 1.9^{NS}	20.1 ± 1.1^{b}

Age_1: represents age from 14 to 22 years. Age_2: represents age from 25 to 60 years.D_1: represents distance from 20 to 100 m. D_2: represents distance from 100 to 500 m.N Control = 10. N Strong = 13. N Moderate = 9. N Weak = 19.NS: non-significant change when comparing persons exposed to base stations with controls.

[a] Significant difference at $P > 0.05$ when comparing persons exposed to base stations with controls.

[b] Significant difference at $P > 0.01$ when comparing persons exposed to base stations with controls.

Table 2 (*continued*)

Hormones (mean ± SE)	Groups								
	Volunteers exposed to RFR from base stations								
	1 Year	3 Years				6 Years			
	Age_2	Age_1		Age_2		Age_1		Age_2	
	D_2	D_1	D_2	D_1	D_2	D_1	D_2	D_1	D_2
Plasma ACTH (pg/mL)	58.0 ± 0.9^{NS}	51.8 ± 1.7^{b}	54.6 ± 1.1^{b}	54.2 ± 0.6^{b}	45.2 ± 1.8^{NS}	47.3 ± 1.3^{b}	48.3 ± 1.4^{b}	40.7 ± 0.3^{b}	43.1 ± 1.1^{b}
Serum cortisol (µg/mL)	29.1 ± 1.3^{NS}	27.2 ± 1.2^{b}	27.4 ± 2.1^{NS}	25.6 ± 0.1^{b}	26.6 ± 1.1^{NS}	21.2 ± 0.4^{b}	22.4 ± 1.1^{b}	22.9 ± 1.1^{b}	24.2 ± 0.3^{b}
Serum T3 (ng/ dl)	100.1 ± 0.2^{NS}	97.3 ± 1.6^{b}	98.1 ± 0.9^{b}	97.4 ± 1.1^{NS}	98.2 ± 1.9^{NS}	78.0 ± 1.1^{b}	82.3 ± 1.9^{b}	91.3 ± 1.5^{b}	93.4 ± 1.9^{b}
Serum T4 (µg/dL)	6.1 ± 0.3^{NS}	4.4 ± 1.8^{NS}	4.9 ± 0.3^{NS}	5.1 ± 0.3^{b}	5.9 ± 0.8^{NS}	2.7 ± 0.1^{b}	2.8 ± 1.2^{b}	3.8 ± 1.2^{b}	3.9 ± 1.9^{b}
Serum prolactin (ng/mL)	19.6 ± 1.1^{b}	97.3 ± 1.6^{b}	98.1 ± 0.9^{b}	97.4 ± 1.1^{NS}	98.2 ± 1.9^{NS}	78.0 ± 1.1^{b}	82.3 ± 1.9^{b}	91.3 ± 1.5^{b}	93.4 ± 1.9^{b}
Serum progesterone (pg/mL)	10.5 ± 1.1^{NS}	4.4 ± 1.8^{NS}	4.9 ± 0.3^{NS}	5.1 ± 0.3^{b}	5.9 ± 0.8^{NS}	2.7 ± 0.1^{b}	2.8 ± 1.2^{b}	3.8 ± 1.2^{b}	3.9 ± 1.9^{b}
Serum testosterone (pg/mL)	20.3 ± 1.6^{NS}	20.2 ± 0.4^{b}	20.9 ± 0.9^{b}	18.1 ± 1.1^{b}	18.6 ± 1.3^{b}	11.8 ± 0.3^{b}	10.9 ± 1.6^{b}	15.3 ± 1.2^{b}	16.1 ± 1.5^{b}

obvious for persons living nearby base stations and exposed for a period of 6 years.

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American Academy of Environmental Medicine Recommendations Regarding Electromagnetic and Radiofrequency Exposure

Physicians of the American Academy of Environmental Medicine recognize that patients are being adversely impacted by electromagnetic frequency (EMF) and radiofrequency (RF) fields and are becoming more electromagnetically sensitive.

The AAEM recommends that physicians consider patients' total electromagnetic exposure in their diagnosis and treatment, as well as recognition that electromagnetic and radiofrequency field exposure may be an underlying cause of a patient's disease process.

Based on double-blinded, placebo controlled research in humans,[1] medical conditions and disabilities that would more than likely benefit from avoiding electromagnetic and radiofrequency exposure include, but are not limited to:

- Neurological conditions such as paresthesias, somnolence, cephalgia, dizziness, unconsciousness, depression
- Musculoskeletal effects including pain, muscle tightness, spasm, fibrillation
- Heart disease and vascular effects including arrhythmia, tachycardia, flushing, edema
- Pulmonary conditions including chest tightness, dyspnea, decreased pulmonary function
- Gastrointestinal conditions including nausea, belching
- Ocular (burning)
- Oral (pressure in ears, tooth pain)
- Dermal (itching, burning, pain)
- Autonomic nervous system dysfunction (dysautonomia).

Based on numerous studies showing harmful biological effects from EMF and RF exposure, medical conditions and disabilities that would more than likely benefit from avoiding exposure include, but are not limited to:

- Neurodegenerative diseases (Parkinson's Disease, Alzheimer's Disease, and Amyotrophic Lateral Sclerosis).[2-6]
- Neurological conditions (Headaches, depression, sleep disruption, fatigue, dizziness, tremors, autonomic nervous system dysfunction, decreased memory, attention deficit disorder, anxiety, visual disruption).[7-10]
- Fetal abnormalities and pregnancy.[11,12]
- Genetic defects and cancer.[2,3,13-19]
- *Liver disease and genitourinary disease.*[12,20]

Because Smart Meters produce Radiofrequency emissions, it is recommended that patients with the above conditions and disabilities be accommodated to protect their health. The AAEM recommends: that no Smart Meters be on these patients' homes, that Smart Meters be removed within a reasonable distance of patients' homes depending on the patients' perception and/or symptoms, and that no collection meters be placed near patients' homes depending on patients' perception and/or symptoms.

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Changes of Clinically Important Neurotransmitters under the Influence of Modulated RF Fields—A Long-term Study under Real-life Conditions

Klaus Buchner and Horst Eger

This follow-up of 60 participants over one and a half years shows a significant effect on the adrenergic system after the installation of a new cell phone base station in the village of Rimbach (Bavaria).
After the activation of the GSM base station, the levels of the stress hormones adrenaline and noradrenaline increased significantly during the first six months; the levels of the precursor dopamine decreased substantially. The initial levels were not restored even after one and a half years. As an indicator of the dysregulated chronic imbalance of the stress system, the phenylethylamine (PEA) levels dropped significantly until the end of the study period.
The effects showed a dose-response relationship and occurred well below current limits for technical RF radiation exposures. Chronic dysregulation of the catecholamine system has great relevance for health and is well known to damage human health in the long run.

Keywords: cell phone base station, long-term study, stress hormones, radiofrequency radiation, GSM-transmitted far-field radiation

Introduction

Despite the distribution of numerous wireless transmitters, especially those of cell phone networks, there are only very few real-life field studies about health effects available. In 2003, the Commission on Radiation Protection was still noticing that there are no reliable data available concerning the public's exposure to UMTS radiation near UMTS base stations (1).

Since the 1960s, occupational studies on workers with continuous microwave radiation exposures (radar, manufacturing, communications) in the Soviet Union have shown that RF radiation exposures below current limits represent a considerable risk potential. A comprehensive overview is given in the review of 878 scientific studies by Prof. Hecht, which he conducted on behalf of the German Federal Institute of Telecommunications (contract no. 4231/630402) (2, 3).
As early as the 1980s, US research projects also demonstrated in long-term studies that rats raised under sterile conditions and exposed to "low-level" RF radiation showed signs of stress by increased incidences of endocrine tumors (4, 5).

Concerned by this "scientific uncertainty" about how radiofrequency "cell tower radiation" affects public health, 60 volunteers from Rimbach village in the Bavarian Forest decided to participate in a long-term, controlled study extending about one and a half years, which was carried out by INUS Medical Center GmbH and Lab4more GmbH in

 Original study in German: BUCHNER K, EGER H (2011) Umwelt-Medizin-Gesellschaft 24(1): 44-57.

Zusammenfassung

Veränderung klinisch bedeutsamer Neurotransmitter unter dem Einfluss modulierter hochfrequenter Felder - Eine Langzeiterhebung unter lebensnahen Bedingungen

Die vorliegende Langzeitstudie über einen Zeitraum von eineinhalb Jahren zeigt bei den 60 Teilnehmern eine signifikante Aktivierung des adrenergenen Systems nach Installation einer örtlichen Mobilfunksendeanlage in Rimbach (Bayern).

Die Werte der Stresshormone Adrenalin und Noradrenalin steigen in den ersten sechs Monaten nach dem Einschalten des GSM-Senders signifikant; die Werte der Vorläufersubstanz Dopamin sinken nach Beginn der Bestrahlung erheblich ab. Der Ausgangszustand wird auch nach eineinhalb Jahren nicht wieder hergestellt. Als Hinweis auf die nicht regulierbare chronische Schieflage des Stresshaushalts sinken die Werte des Phenylethylamins (PEA) bis zum Ende des Untersuchungszeitraums signifikant ab. Die Effekte unterliegen einem Dosis-Wirkungs-Zusammenhang und zeigen sich weit unterhalb gültiger Grenzwerte für technische Hochfrequenzbelastung. Chronische Dysregulationen des Katecholaminsystems sind von erheblicher gesundheitlicher Relevanz und führen erfahrungsgemäß langfristig zu Gesundheitsschäden.

Schlüsselwörter: Mobilfunk-Basisstationen, Langzeituntersuchung, Stresshormone, Mobilfunkstrahlung, Fernfeld

in cooperation with Dr. Kellermann from Neuroscience Inc.[1].

Common risk factors such as external toxic agents, parameters of the catecholamine system (6) were determined prior to the activation of the GSM transmitter and followed up in three additional tests for a period of more than 18 months. The informed consent of all participants included the condition that the data were to be published anonymously.

-------------------------------- Materials and Methods

Study Setting and Selection of Study Subjects

In spring 2004, a combined GSMD1 and GSMD2 cell transmitter (900 MHz band) was installed on Buchberg mountain in D-93485 Rimbach (Lower Bavaria) with two sets of antenna groups each. The installation height of the antennas for both systems is 7.9 m; the horizontal safety distance along the main beam direction is 6.3 or 4.3 m, respectively. At the same tower, there is also a directional antenna at 7.2 m (7).

Shortly after it had become known that the wireless transmitters were to be installed, all inhabitants of Rimbach had been asked to participate in a mass screening. The municipality has approximately 2,000 inhabitants. In 60 volunteers (27 male, 33 female) aged between 2 and 68, the levels of adrenaline, noradrenaline, dopamine, and PEA (phenylethylamine)—which cannot be consciously regulated—were determined in their urine at the end of January/beginning of February 2004 (shortly before the activation of the antennas and the RF emissions beginning) as well as in July 2004, in January 2005, and in July 2005.

Most of these study participants signed up immediately after an informational gathering in late January 2004, at which the course of action by the cell phone service providers was criticized. Others signed up following a call for participation in the local paper. Since Rimbach is a small municipality, mouth-to-mouth propaganda also played a role. Participation was made attractive to the volunteers because a lab test that usually would be very expensive was offered for a small fee. Since the study required to show the status of the biological parameters over a given time period, only those study subjects participating in all four tests are included.

The data presented below come primarily from volunteers who have a certain interest in the life of their community and their health. Other persons joined the stress hormone investigation because of the recommendation of, or request by, their fellow citizens. This does not meet the requirements for a random sample. The result of this study, however, is hardly affected because Rimbach is a very small municipality. Therefore, the social contacts that lead to participation are very important. Most probably they do not affect the blood parameters. Furthermore, numerous large families participated as a whole whereby the health status of the individual family members did not play any role. For this reason, but especially because of the population structure, the study includes many children but only a few adolescents and young adults: there are hardly any opportunities for occupational training in Rimbach. In contrast, the municipality is attractive to young families with many children.

Sample Collection

The second morning urine was collected at INUS Medical Center on Mondays between 9:00 and 11:00 a.m. We made sure that each participant's appointment was always scheduled for the same time and that the time of breakfast or the state of fasting was the same for each participant at all tests. On the same day, the samples were sent by express to *Labor Dr. Bieger* in Munich where they were processed. In addition, samples were also sent to a laboratory in Seattle for control analyses (8-11).

Medical History

Medical doctors of the INUS Medical Center took a thorough medical history of each participant. At the initial test, the following data were also gathered: exact address, average time spent at home, indoor toxins, stress due to heavy-traffic roads, and the number of amalgam fillings. The latter number also included fillings that had already been removed. A nine-year-old child was noted to be electro-

1) INUS Medical Center, Dr. Adam-Voll Str. 1, 93437 Furth im Wald, Tel.: 09973/500 5412, www.inus.de; Lab4more GmbH, Prof. Dr. W. Bieger, Paul-Heyse-Straße 6, 80336 München, Tel.: 089/54321 730, info@lab4more.de; NeuroScience Inc., Dr. Kellermann, 373 280th Street - Osceola, WI 54020 - USA, Tel.: +1/715/294-2144, www.neuroscienceinc.com.

sensitive to the effects of household wiring and connected appliances. All other study participants declared themselves to be not electrosensitive.

When taking their medical history, participants were also questioned about subjective symptoms and chronic diseases at the start of the study and during its course; if overweight, this was also noted. In this study, overweight in adults is defined as a weight greater than the "body height in cm minus 100 plus 5 kg tolerance."

Consistency checks for the parameter "overweight," however, indicate that—especially with regard to children—different criteria have been applied during the taking of the medical history. These data, therefore, can only serve as a reference point. They are listed here anyhow since they can provide suggestions for further studies.

All atopic disorders such as:

1. Hay fever, neurodermatitis, allergies, asthma, eczema are referred to as "chronic disorders;" as well as
2. All chronic inflammations such as interleukin- or COX-2-mediated problems;
3. All autoimmune diseases such as rheumatism, multiple sclerosis (MS);
4. All chronic metabolic disorders such as diabetes, liver diseases, intestinal diseases, kidney diseases.

Out of the 16 chronically affected participants 12 had allergies.

It was also asked whether there were DECT, Wi-Fi, or Bluetooth devices in the house or apartment during the study period from late January 2004 until July 2005. Also included were those devices present only for part of the study period, but not those turned off at night.

Exposure Level Measurements

For the most part, Rimbach municipality is located at one side of a narrow V-shaped valley. The cell phone base station is situated almost right across from the village center on the other side. RF radiation levels were measured at the outside of the residences of all study participants, wherever possible with direct line of sight of the transmitter. Because the municipality is located on a slope, great differences were noted inside homes—depending on whether or not a line of sight to the transmitter existed. In three cases, it was possible to measure the exposure levels at the head end of the bed. In these cases, the peak value of the power density was lower by a factor of 3.5 to 14 compared to measurements in front of the house with direct line of sight to the transmitter. The exact location of DECT, Wi-Fi, and Bluetooth base stations (if present) as well as possible occupational exposures, etc. were not determined by most participants.

At first, the measurements were taken with a broadband RF meter HF38B of Gigahertz Solutions, for which the manufacturer guarantees an error margin of max. ±6 dB (+ 7 decimal places; but this error can be mostly eliminated by selecting the appropriate measurement range). However, an inspection revealed that the error margin was less than ±3 dB. In addition, the broadband RF meter

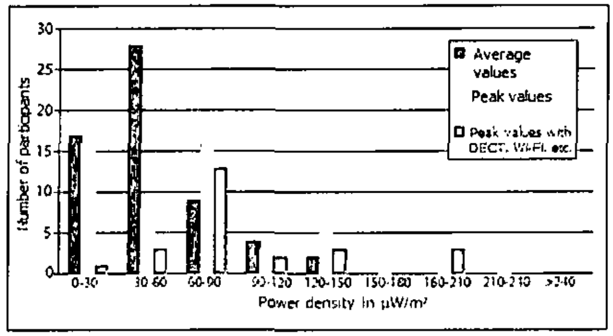

Fig. 1: Classification of participants based on average or peak value of the GSM power density level

HF59B (±3 dB, ±5 decimal places) was used at several points. With this RF meter, relevant frequencies can be analyzed with variable filters, the ELF modulation frequencies via fast Fourier analysis.

By using broadband RF meters, the testing effort and expense are reduced compared to spectrum analyzers. Thus, it was possible to take measurements at a greater number of points, and as a result, it was easier to determine the maxima and minima of the power density levels. Furthermore, the accuracy of high-quality broadband RF meters is similar to that of spectrum analyzers.

In this study, only cell phone signals are considered: not DECT, Wi-Fi, or Bluetooth devices inside homes or emissions from broadcast or TV stations at *Hohenbogen*, a mountain above Rimbach. For the most part, the emissions from the latter transmitters remained stable during the study period, whereas the focus of this study is on changes in exposure levels. For almost all sample measurements, the portion of the exposure due to the transmitter at *Hohenbogen* was at maximum 35 µW/m² (peak value). It was higher in the residences of only two study participants: 270 µW/m² (average) or 320 µW/m² (peak), respectively. At these residences, the GSM exposure was approximately 10 µW/m².

For the assessment, the peak values of the signals are used because, in the case of GSM radiation, they are less dependent on the usage level than average values. The peak value of the power density for all study participants from Rimbach was on average 76.9 µW/m² (Tab. 1).

In Figure 1 the exposure of the participants is given as power density levels in increments of 30 µW/m².

Classification of Participant Group and Exposure Levels

Sixty persons participated in the study; their age distribution is shown in Figure 2 according to year groups. In order to capture the effect of the cell phone base station, other environmental factors must be excluded as much as possible. It is vitally important to ensure that no major differences between high-exposure and low-exposure persons influenced the results.

Original study in German: BUCHNER K, EGER H (2011) Umwelt-Medizin-Gesellschaft 24(1): 44-57.

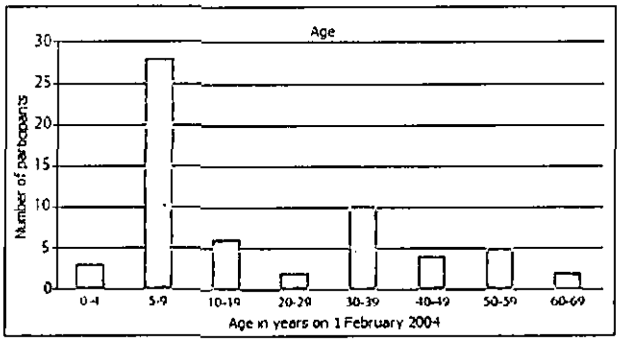

Fig. 2: Age distribution of study participants on 1 February 2004

	All	<=60 µW/m²	60-100 µW/m²	>100 µW/m²
Participants	60	24	20	16
Power density, avg (µW/m²)	76.9	21.7	68.1	170.7
Healthy adults	20	9	5	6
Sick adults	9	6	2	1
Healthy children	24	9	7	8
Sick children	7	0	6	1
Overweight	14	7	3	4
Amalgam number	12	5	3	4
Evaluation of amalgam/person	120	76.4	32.7	240
Street	8	0	8	0
Indoor toxins	17	7	6	4
DECT, Wi-Fi, Bluetooth	25	4	14	7

Tab. 1: Data on the 60 study participants who are classified into exposure groups 0 - 60 µW/m², 60 - 100 W/m², and above 100 µW/m², based on relevant peak values of GSM exposure in front of their residence.

Additional information:

Power density, avg (µW/m²) means: average peak value of GSM exposure level in the relevant category;
Healthy adults: adults without chronic diseases. Participants who were born after 1 February 1994 are referred to as children, all others as adults;
Sick adults: adults with chronic diseases;
Healthy children: children without chronic diseases;
Sick children: children with chronic diseases;
Overweight: see text;
Amalgam number: number of participants who had at least one amalgam filling (which may have been removed prior to the study period);
Evaluation of amalgam/person: For each tooth with an amalgam filling of a participant, the size of the filling (values from 1 to 3) is multiplied with the number of years this filling has been placed prior to the date of the initial test of this study (rounded up to the nearest whole number). The value in the table is the sum of these numbers for all amalgam fillings of a person in the respective category divided by the number of participants with amalgam fillings (= "amalgam number");
Street: number of participants who live at a busy street;
Indoor toxins: number of participants who have had contact with toxins, varnishes, preservatives, etc. at home or at work;
DECT, Wi-Fi: number of persons who had DECT, Wi-Fi, Bluetooth or the like at home at the end of January 2004 or later.

As shown in Table 1, the group with exposure levels greater than 100 µW/m² included fewer chronically ill persons and fewer residences at heavy-traffic roads, but considerably higher amalgam exposures by dental fillings compared to the average of the participants. These differences, however, cannot explain the observed development of the blood parameters as will be shown further below. It should also be noted that the number of children in the group of <= 60 µW/m² is considerably lower than in the other two groups.

Statistics

Because of the large individual differences in blood values, their asymmetrical distribution, and because of the many "outliers," the assessment presented here focuses on the following problem: "Did the level of a given substance predominantly increase (or decrease, respectively) in the test subjects?" For this problem, the so-called signed-rank paired Wilcoxon test (12) is applied. How to determine the confidence intervals of medians is described in an easy-to-understand form in (13).

Due to the rather large differences in individual values, we refrained from carrying out additional statistical analyses, especially those with parametric methods.

Results

1 Clinical Findings

Adrenaline, noradrenaline, and dopamine as well as phenylethylamine (PEA) levels were determined at the time when the medical history was taken at INUS Medical Center. Out of the 60 participants, eleven had sleep problems until the end of 2004. During the study period (until July 2005), eight additional cases with these problems were reported. At the end of January 2004, only two participants complained about headaches; eight additional cases were reported thereafter. For allergies, there were eleven cases in the beginning and 16 later; for dizziness five and eight; and for concentration problems ten and fourteen. Due to the limited number of participants, no meaningful statements can be made about changes during the study period regarding the conditions tinnitus, depression, high blood pressure, autoimmune diseases, rheumatism, hyperkinetic syndrome, attention deficit hyperactivity disorder (ADHD), tachycardia, and malignant tumors. (Tab. 2)

Symptoms	Before activation of transmitter	After activation of transmitter
Sleep problems	11	19
Headache	2	10
Allergy	11	16
Dizziness	5	8
Concentration problems	10	14

Tab. 2: Clinical symptoms before and after activation of transmitter

2 Adrenaline

The adrenaline level trends are shown in Figure 3. After the activation of the transmitter from January until July 2004, a clear increase is followed by a decrease. In participants in the exposure category above 100 µW/m², the decrease is delayed.

Since the distribution of the adrenaline levels is very asymmetrical as shown in Figure 4, the median values are better suited for evaluation than the average values. However, there is no significant difference between the trend of the median and the trend of the average values (Tab. 3). But it stands out that, in the lowest exposure group with a power density below 60 µW/m², median values do not decrease between July 2004 and January 2005.

The statement "The adrenaline values of study subjects increased after the activation of the transmitter, i.e. between January and July 2004" is statistically confirmed ($p<0.002$), as well as the statement "The adrenaline level of the study participants decreased from July 2004 to July 2005" ($p<0.005$). In the lowest exposure group, the increase is the smallest. Until the end of the study period, these values do not drop.

A certain dose-response relationship can be observed for the increase in adrenaline levels from January 2004 until July 2004. The increase in medians was 2.3 µg/g creatinine for all subjects. At an RF radiation level up to 60 µW/m², creatinine was 1.0 µg/g, and by contrast, for power density levels between 60-100 µW/m² it was 2.6 µg/g.

For subjects in the exposure group above 100 µW/m², creatinine levels were found *to be 2.7 µg/g, i.e. this value did not increase.* We refrain from any additional statistical analysis because, as shown further below, the increase in adrenaline levels was mainly observed in children and chronically ill participants whose numbers were not sufficient to be broken down into further subgroups.

		January 2004	July 2004	January 2005	July 2005
All	Average	8.56	10.79	8.84	9.14
	Median	7.44	9.75	8.40	7.45
	CI	5.9 - 8.4	6.6 - 11.7	6.1 - 10.0	6.5 - 9.6
0-60 µW/m²	Average	8.9	10.3	7.7	9.0
	Median	6.4	7.4	7.8	7.4
	CI	3.8 - 10.3	4.6 - 13.2	3.4 - 9.4	5.5 - 11.1
60-100 µW/m²	Average	7.9	10.4	8.4	9.0
	Median	7.4	10.2	8.1	7.2
	CI	5.3 - 10.0	6.6 - 12.8	5.0 - 11.2	6.4 - 9.7
>100 µW/m²	Average	8.9	12.0	11.1	9.6
	Median	8.2	10.9	10.6	8.6
	CI	5.3 - 10.9	5.7 - 19.6	5.8 - 15.2	4.9 - 13.4

Tab. 3: Results for adrenaline levels in µg/g creatinine
CI = 95% confidence interval of median

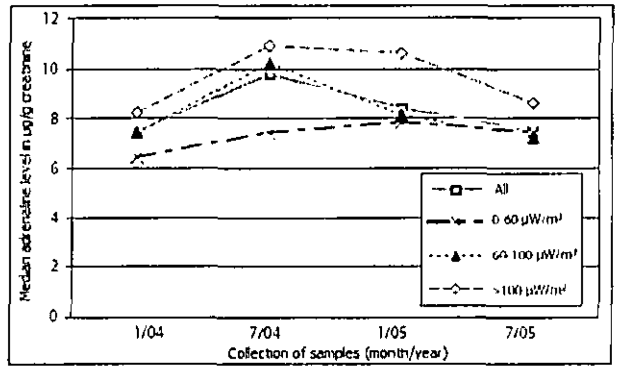

Fig. 3: Median adrenaline levels for all participating citizens of Rimbach whose cell phone base station exposure was above 100 µW/m², between 60 and 100 µW/m², or up to 60 µW/m². The power density levels refer to peak values of the GSM radiation exposure in front of a given residence.

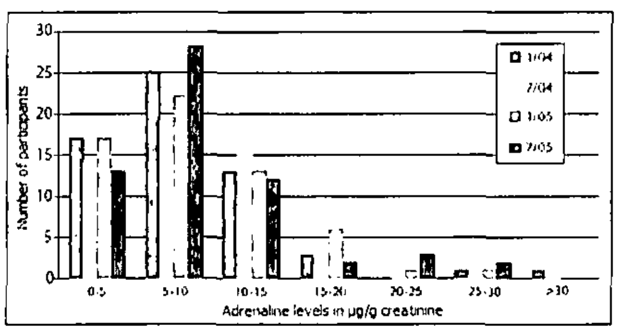

Fig. 4: Distribution of adrenaline levels in µg/g creatinine

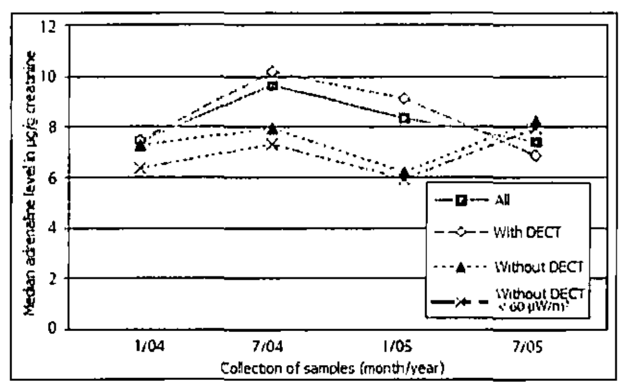

Fig. 5: Median adrenaline levels for all participating citizens of Rimbach who have a DECT phone, Wi-Fi, Bluetooth, or similar device, for those who do not have such wireless devices, and for the lowest exposure group without indoor wireless transmitters and with a GSM power density level up to 60 µW/m².

The impact of indoor wireless devices such as DECT, Wi-Fi, and Bluetooth (the latter are not specifically mentioned in the graphs) are shown in Fig. 5. Within the first year after the activation of the GSM transmitter, i.e. until and including January 2005, the group with indoor wireless devices shows the strongest responses.

It is possible that in the less exposed subjects seasonal fluctuations or other factors such as "overshooting" of the values could have played a role.
It should be noted here that both the average as well as the median adrenaline values increased after the activation of the transmitter and decreased again after one year. This, however, only applies to exposure levels >60 μW/m². Chronically ill subjects and children showed especially strong responses; except for some "outliers," no effect was observed in healthy adults.

The adrenaline level of overweight subjects and those with an *amalgam burden hardly changed during the study period (Fig. 6). In* contrast, chronically ill subjects showed especially strong responses above average. In fact, the increase in the median values between January and July 2004 for all study subjects was predominantly caused by children and chronically ill subjects; adults without any chronic disease show a flat curve. During this period, an increased adrenaline level between 5 and 10.3 was measured in three healthy adults. Because of these "outliers," the average values for healthy adults clearly increased in contrast to the median values.

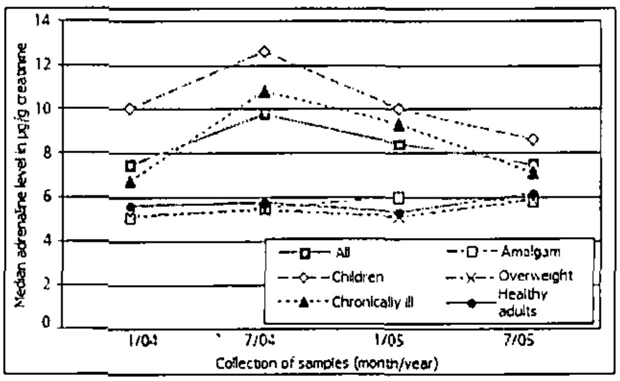

Fig. 6: Median adrenaline levels for participating children, for chronically ill subjects, for those with amalgam burden, and overweight subjects in Rimbach in comparison to the median levels of all study subjects and adults without chronic disease

The lower sensitivity of subjects with an amalgam burden can be explained by the fact that the effect occurs more often in children and that children according to our definition are younger than 10 years. They have hardly any fillings with amalgam.

3 Noradrenaline

The results for noradrenaline are similar to those for adrenaline *(Tab. 4, Fig. 7). The statement that individual noradrenaline levels* from January to July 2004 increased is statistically well supported with $p<0.001$. The fact that the levels dropped between July 2004 and July 2005 is also well supported with $p<0.0005$. Like in the case of adrenaline, the period under investigation is July 2004 to July 2005 to take the delayed decrease in the high exposure group into consideration. According to Table 4, the median of all noradrenaline levels increased from January to July 2004 for 11.2 μg/g creatinine; for exposures up to 60 μW/m², there were 2.2 μg/g creatinine, at 60-100 μW/m² 12.4 μg/g creatinine, and above 100 μW/m² 12.3 μg/g creatinine. As in the case of adrenaline, the increase for the last two groups is almost the same. Again, it is not possible to statistically verify a dose-response relationship. In Figure 7, a dose-response relationship

		January 2004	July 2004	January 2005	July 2005
All	Average	55.8	64.9	57.7	55.7
	Median	49.8	61.0	52.2	53.5
	CI	44.3-59.1	53.3-72.2	45.0-60.3	41.9 -60.5
0-60	Average	54.7	59.3	56.5	53.5
μW/m²	Median	45.2	47.4	48.7	48.1
	CI	35.1-67.8	36.3-75.6	40.1-60.0	36.3-65.6
60-100	Average	51.4	63.6	49.1	55.9
μW/m²	Median	47.5	59.9	45.8	54.8
	CI	38.0-59.1	53.1-74.8	40.5-58.4	34.9-66.5
>100	Average	62.9	74.9	70.1	58.8
μW/m²	Median	58.8	71.1	71.6	56.3
	CI	49.9-87.3	54.9-91.6	48.7-89.1	36.9-81.6

Tab. 4: Results for the noradrenaline levels in μg/g creatinine
CI = 95% confidence interval of the median

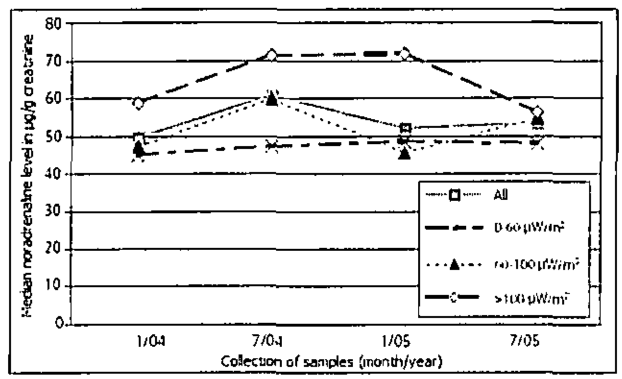

Fig. 7: Median noradrenaline levels in all participating citizens of Rimbach as a function of GSM power density levels (peak values)

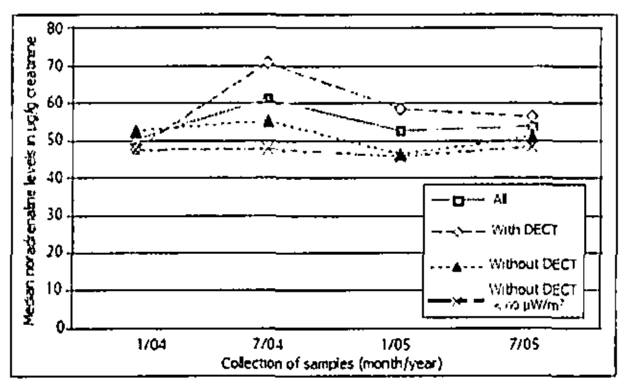

Fig. 8: Median noradrenaline values for subjects who had a DECT phone or other wireless devices at home, for those without indoor wireless devices, as well as for subjects without indoor wireless devices and with a GSM radiation exposure up to 60 μW/m² (peak value measured in front of residence)

is seen, whereby the dot-dashed line serves as reference for persons with very low exposures. It stands out that the "recovery period," i.e. the decrease in values in 2005, drags on for longer in subjects in the exposure group with GSM radiation levels above 100 μW/m². This also corresponds with the behavior of the adrenaline levels.

In comparison with adrenaline, noradrenaline plays a somewhat greater role in residences where wireless devices existed before the beginning of this study (Fig. 8).

The trend in Figure 9 shows that children and chronically ill subjects in contrast to overweight subjects express strong responses to cell tower radiation. The ratios, however, are not as clearly visible as with adrenaline. Especially in overweight subjects, they indicate a slow response to GSM radiation.

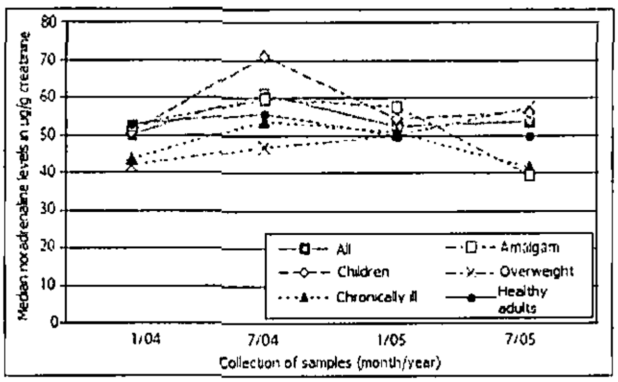

Fig. 9: Median noradrenaline levels of children, chronically ill subjects, those with amalgam burden and overweight subjects in Rimbach in comparison to the median values of all study subjects and healthy adults

Noradrenaline and adrenaline, however, responded very similarly.

4 Dopamine

For dopamine, inverse effects to those for adrenaline and noradrenaline were observed. The median dopamine levels decreased from 199 to 115 μg/g creatinine between January and July 2004 (Tab. 5). The fact that the dopamine levels of the study subjects decreased during this period is highly significant ($p<0.0002$). Thereafter, the median increased again: In January 2005, it was at 131 μg/g creatinine, in July of this year 156. This increase is also significant (for increase between July 2004 and July 2005 $p<0.05$).

This, too, is a dose-response relationship: from January to July 2004, the median for all subjects decreased for 84 μg/g creatinine, in the exposure group up to 60 μW/m² for 81, in the exposure group above 100 μW/m² even 153 μg/g (see Tab. 5 and Fig. 10). This dose-response relationship is statistically significant based on the signed-rank Wilcoxon test (12) with $p<0.025$. The following statement applies: "The decrease in dopamine levels for exposure levels up to 100 μW/m² is smaller than at exposure levels above 125 μW/m²."

In subsequent laboratory tests, the dopamine levels do not return to the same level as in January 2004. From Figure 11, it is obvious that the correlation with prior exposures to indoor wireless devices is small.

		January 2004	July 2004	January 2005	July 2005
All	Average	233	158	138	164
	Median	199	115	131	156
	CI	168-273	86-160	111-153	145-175
0-60 μW/m²	Average	217	183	130	148
	Median	189	108	116	147
	CI	142-273	80-254	90-157	129-167
60-100 μW/m²	Average	242	161	140	178
	Median	223	150	131	175
	CI	137-335	94-168	93-164	126-207
>100 μW/m²	Average	244	115	147	170
	Median	244	91	151	156
	CI	139-316	48-202	117-169	138-209

Tab. 5: Results for dopamine levels in μg/g creatinine
CI = 95% confidence interval of median

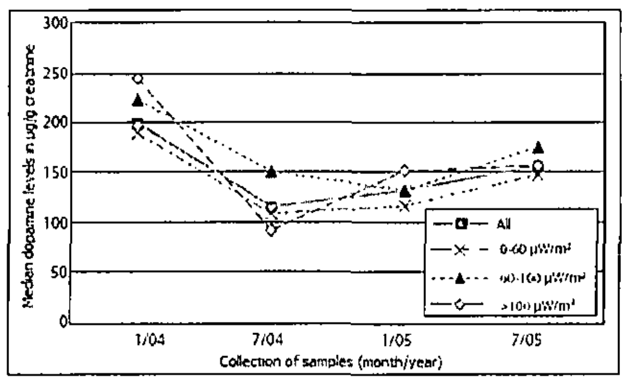

Fig. 10: Median dopamine levels for different GSM power density levels

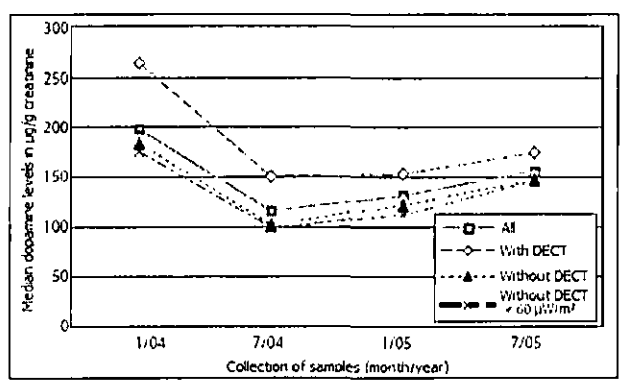

Fig. 11: Median dopamine levels for all participating citizens of Rimbach, for those with and without DECT phone, Wi-Fi, or Bluetooth, and for those without indoor wireless devices who had a GSM exposure level below 60 μW/m² (peak value).

Original study in German: BUCHNER K, EGER H (2011) Umwelt-Medizin-Gesellschaft 24(1): 44-57.

It is to be emphasized that the lowest exposure group without such indoor wireless devices and with a GSM power density level < 60 µW/m² responds almost as strongly as all other study subjects. This is consistent with the data in Figure 10: the data suggest that the effect of the radiation on the dopamine levels can already be observed at very low power density levels; however, it still can increase at levels above 100 µW/m².

Figure 12 shows that the radiation effect is somewhat more pronounced in children compared to the average, i.e. the gradient of the curves between the first two data points is somewhat greater. However, the difference is far too small to be statistically significant.

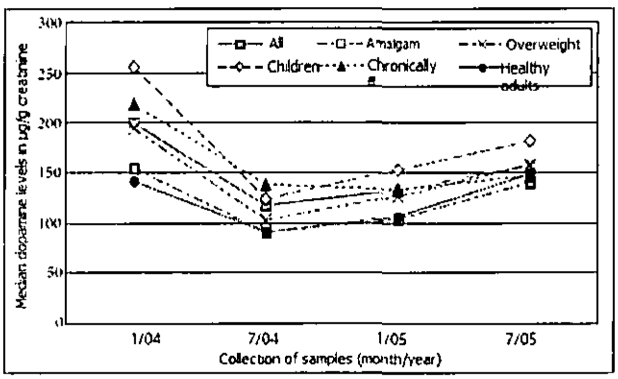

Fig. 12: Median dopamine levels of children, the chronically ill, with amalgam burden, overweight subjects, and healthy adults in Rimbach

In summary, dopamine levels decreased after the activation of the GSM transmitter and were not restored to the initial level over the following one and a half years. A significant dose-response relationship is observed. In children, the decrease is somewhat more pronounced than in adults.

5 Phenylethylamine (PEA)

Phenylethylamine (PEA) levels respond more slowly to the radiation compared to the substances investigated so far (Tab. 6, Fig. 13). Only in the exposure group above 100 µW/m² GSM radiation do the PEA levels decrease within the first six months. Thereafter, hardly any differences can be discerned between PEA values of the various power density levels investigated here.

The decrease of PEA levels between July 2004 and July 2005 is highly significant ($p < 0.0001$)

Similar to adrenaline and noradrenaline, a previous exposure to indoor wireless devices intensifies the effect of the GSM radiation (see Fig. 14). The subjects of the low-exposure groups without indoor wireless devices do respond in a time-delayed fashion, but after six months they respond just as clearly as the subjects of the highest exposure group. In this regard, the PEA levels behave like those of dopamine in contrast to adrenaline and noradrenaline, which only respond to stronger fields.

		January 2004	July 2004	January 2005	July 2005
All	Average	725	701	525	381
	Median	638	671	432	305
	CI	535 -749	569 - 745	348 - 603	244 - 349
0-60 µW/m²	Average	655	678	523	329
	Median	604	653	484	243
	CI	477 - 835	445 - 835	279 - 675	184 - 380
***60-100* µW/m²**	Average	714	699	535	451
	Median	641	678	426	330
	CI	492 - 746	569 - 790	310 - 804	293 - 438
>100 µW/m²	Average	843	739	514	371
	Median	780	671	413	305
	CI	451 - 1144	334 - 822	338 - 748	157 - 513

Tab. 6: Results for phenylethylamine (PEA) levels in ng/g creatinine
CI = 95% confidence interval of median

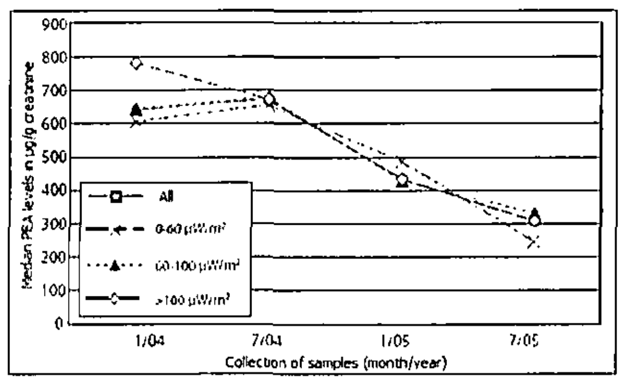

Fig. 13: Median phenylethylamine (PEA) levels for various GSM power density levels

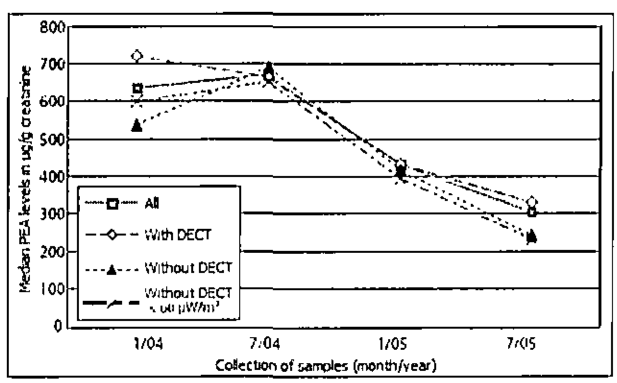

Fig. 14: Median phenylethylamine (PEA) concentrations in µg/g creatinine of subjects with and without indoor wireless devices at home and subjects without indoor wireless devices with a GSM power density level below 60 µW/m²

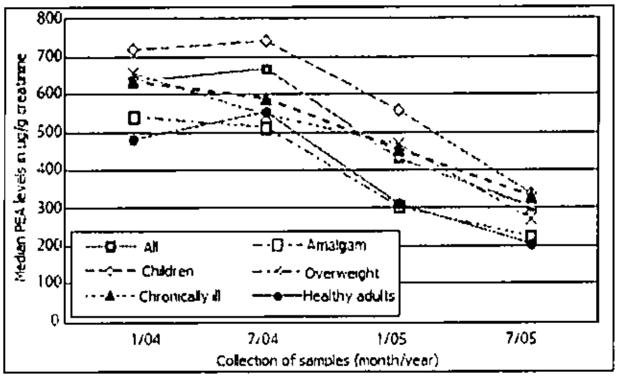

Fig. 15: Median phenylethylamine (PEA) concentrations in µg/g creatinine of children, the chronically ill, with amalgam burden, and overweight subjects, as well as health adults in Rimbach

In children, the effect of GSM radiation on their PEA levels is no greater than in the average of the study subjects; healthy adults also do not respond substantially differently. In contrast to the other substances looked at so far, the group of overweight subjects does respond particularly rapidly to PEA.

Summary of Results

Adrenaline and noradrenaline levels increase during the first six months after the GSM transmitter had been activated; thereafter, they decrease again. After an exposure period of one and a half years, the initial levels are almost restored. Only at power density levels above 100 µW/m² is this decrease delayed for several months. In contrast, dopamine levels decrease substantially after the exposure begins. Even after one and a half years, the initial levels are not restored. Six months after the activation of the transmitter, PEA levels decrease continuously over the entire exposure period. Only in the exposure group above 100 µW/m² is this effect observed immediately. All findings were observed well below current exposure limits (14).

Wireless devices used at home such as DECT, Wi-Fi, and Bluetooth amplify the effect of the GSM radiation. In the case of adrenaline and noradrenaline, almost exclusively children and chronically ill subjects (here mostly subjects with allergies) are affected. However, the response of chronically ill subjects to dopamine and the response of children to PEA are very similar to those found in the average of the study subjects. Except for PEA, overweight subjects show only very weak responses to GSM radiation.

Discussion

Catecholamine System and Phenylethylamine (PEA)

The survival of mammals depends on their ability to respond to external sources of stress. An established, well-researched axis of the human stress system represents the catecholamine system (6, 15, 16). It can be activated by psychic or physical stressors. Impulses mediated by nerves are responsible for an induction of the catecholamine biosynthesis at the level of tyrosine hydroxylase as well as dopamine beta-hydroxylase, whereby the effect is based on an induction of both enzymes. Many biochemical regulatory mechanisms tightly control catecholamine synthesis (8, 15, 17). Chronic dysregulation always leads to health problems in the long run. The development of high blood pressure under continuous stress serves as a clinical example; so-called "beta blockers" directly block the action of adrenaline and noradrenaline on the target receptors, and it is impossible to imagine medication-based therapy without them (15).

PEA can be synthesized from the essential amino acid phenylalanine either via tyrosine, dopamine, noradrenaline, and adrenaline or via a direct biochemical path (15) (Fig. 16). The sympathetic-mimetic effect of PEA was first described by Barger in 1910 (18).

PEA is also synthesized from phenylalanine and is considered a superordinate neuromodulator for the regulation of catecholamine synthesis (19-22).

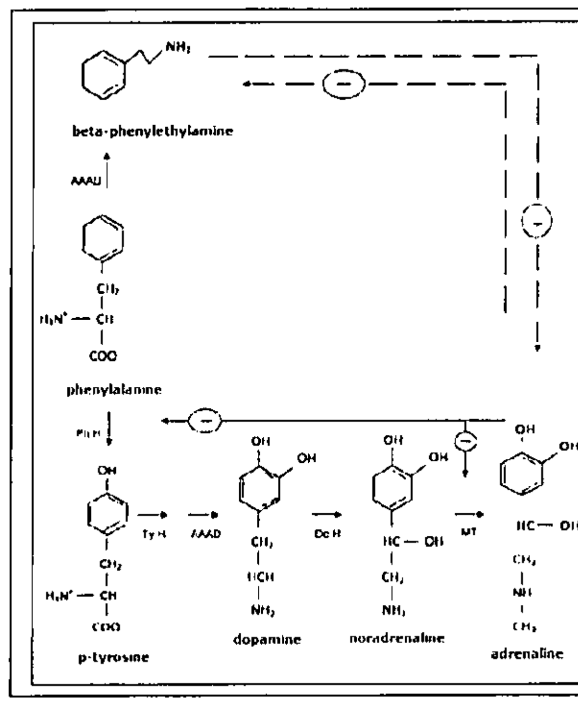

Fig. 16: Chemical structure of derivatives of the essential amino acid phenylalanine and the simplified synthesis pathways of catecholamines or phenylethylamine, respectively, simplified according to Löffler (15).

Abbreviations
AAAD: aromatic l-amino acid decarboxylase,
DoH: dopamine beta-hydroxylase,
PhH: phenylalanine hydroxylase,
MT: n-methyltransferase,
TyH: tyrosine hydroxylase
—(−)— ···· known feedback loop, · · (---) · · postulated feedback loop

In 1976, Zeller described the physiological relationships (23) and points out that PEA is released by the brain via electrical stimulation (24).

The effect mechanism of PEA in the catecholamine system is the center of current pharmaceutical research efforts. In molecular biological terms, intracellular TAAR (trace amine-associated receptor) G-protein-coupled receptors that mediate modulatory effects of PEA are verified (20).

For high nanomolar to low micromolar PEA concentrations, in vivo studies have shown amphetamine-like effects. During an increase of PEA, an increased amount of noradrenaline and dopamine is also released and the reuptake of these substances is impaired (25, 26).

According to Burchett, the following effects of PEA amplifying the catecholamine effect are assumed to be known: Direct agonist action via increased release of transmitters, reuptake inhibition, and stimulation of transmitter synthesis as well as inhibition of monoamine oxidase (MAO) (19). PEA's high lipophilia—a prerequisite for the permeability of membrane barriers such as the blood-brain barrier—is of note here; PEA levels in the brain, serum, and urine correlate quite well (10, 21, 25, 27).

The clinical relevance of changed PEA levels is well documented for mental illnesses. Endogenous depression is associated with lowered PEA levels, whereby the transition from depression to maniac episodes is accompanied by an increase in PEA levels (28-32).

The therapeutic increase in the PEA level has a positive impact on the course of the disease. Phenylalanine improves the effectiveness of antidepressants; PEA by itself is a good antidepressant—effective in 60% of the cases of depression.

In persons with ADD/ADHD (attention deficit hyperactivity disorder), PEA levels are substantially lower; the ADHD treatment with methylphenidate (Ritalin®) normalizes PEA excretion in the urine of responders (33, 34).

Contributing Factors

Laboratory tests of catecholamine have been established for years. Increased values are found in disorders such as pheochromocytoma, neuroblastoma, and arterial hypertension, whereby it is impossible for a subject to consciously regulate these values. Especially urine tests offer a sufficient level of sensitivity and specificity because urine contains 100 to 1000 times higher levels than blood plasma. The intraindividual variation coefficient ranges from 7% to 12% from one day to another; stored under appropriate conditions, the stability of the samples can be guaranteed without problems (8).

In Rimbach, urine samples were always collected at the same time of the day so that a circadian dependence could be ruled out. Other contributing factors such as increased physical activity as well as large meals were also ruled out by collecting the urine in the morning. Seasonal factors of the samples collected twice in winter and summer should have been reflected as undulating levels in the testing results. Only in the adrenaline levels of the lower exposure groups (Fig. 5) can such a corresponding correlation be found. All other data did not indicate any seasonal influences.

In the study presented here, the selection of the participating citizens of Rimbach was not based on random assignment, but on self-selection. We can assume that the subjects, especially the adults, had informed themselves about the issue of cell tower radiation. However, because it is impossible to consciously regulate these levels, this self-selection should not make any difference in this study.

Especially in children below age ten, it is not thought possible to maintain a chronic state of anxiety for one and a half years due to an abstract term such as cell tower radiation.

This study limits itself to the following type of questions: "Did the level of a given substance predominantly increase or decrease during the study period?" Independent of each model, this question can be clearly answered with the Wilcoxon test and the indication of the confidence interval. The corresponding results are statistically very well supported. Any statements beyond this—e.g. the dependence of levels on certain parameters—cannot be made because with 60 study subjects the number of cases is too small to establish the same type of statistical significance.

The great advantage of the "Rimbach data" is that prior to January 2004 the exposure levels were very low because there was no cell phone tower and because only a few citizens had installed DECT, Wi-Fi and similar devices. In addition, due to the testing equipment with a measurement accuracy of less than ± 3 dB combined with repeated control measurements, the classification of the exposure groups can be considered to be verified.

For the stress hormones adrenaline and noradrenaline, the increase occurred only after the installation and activation of the transmitter, and thereafter, levels continued to decrease but did not fully normalize.

For dopamine, significant differences in the dose-response relationship according to exposure group could be shown after the activation of the new cell tower antenna. Also, the consistently decreasing levels of the hypothetically superordinate regulatory PEA do not support the hypothesis that the stress factor for the observed changes in the adrenergic system would exclusively be found in the realm of psychological factors.

Mode of Action of Microwave Radiation

There is a wide range of evidence to interpret the newly emerging microwave exposures as an invisible stressor.

Microwaves are absorbed by living tissue. The frequencies used for cell phone technologies have a half-life penetration depth of several centimeters, whereby cell membranes constitute no obstacle (35).

Microwaves cause enzymes to malfunction directly by, for example, monomerization (36). Thus, it is conceivable that enzymes of the catecholamine system could be affected directly.

Intracellular processes are changed, and cellular mitosis is disturbed by forces acting on the cellular spindle apparatus (37, 38). The human body is required to provide a higher level of repair services that is comparable to a chronic state of stress. A decrease in adenosine triphosphate (ATP) due to microwave exposure could be demonstrated by Sanders in intracerebral tissue already in 1980 (39).

Within current exposure limits, Friedman could show the stress caused by microwaves in the cell membranes of a cell model (40). The oxygen radicals formed by NADH have an activating effect on subsequent intracellular cascades that amplify the membrane effect by a factor of 10^7, which in turn substantially change intracellular processes (17). Even reproductive impairments due to microwaves are mediated by the formation of free radicals (41).

In industry, more and more microwave devices are being used for chemical peptoid syntheses, which allow for a 100 times faster and more precise production even without any measurable heating (42). The toxic effects of free radicals formed by microwaves are used in such technical applications as water purification (43).

In several studies, the chronic symptoms of residents near cell tower antennas were described (44-48). Interestingly, the expansion of wireless networks corresponds with the increase in prescription expenses for methylphenidate, a drug whose chemical structure is related to PEA and which is indicated in cases of attention deficit disorder (ADD) (49).

Long-term studies over five years suggested an increased cancer incidence due to microwave exposure (50, 51). Since the catecholamine system is directly linked with the nervous system within the psychoneuroimmunological framework beside its organ-specific effects, the observed increase in cancer incidence can now also be understood from a pathophysiological perspective (6, 15, 52, 53).

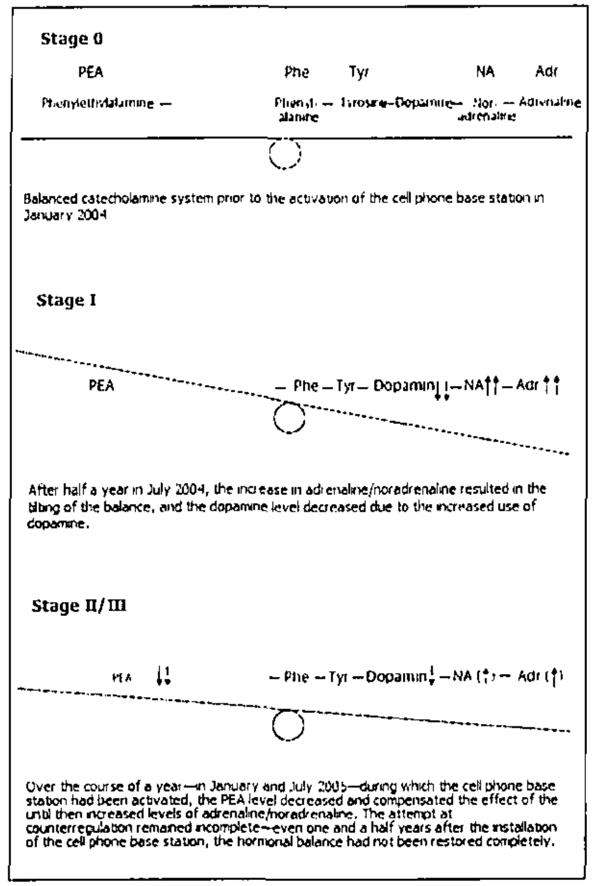

Fig. 17: Stage-like course of the stress response in Rimbach

Hypothesis of the Course of the Stress Response in Rimbach

Significant research on the stress-response axis was carried out in the 1950s. Selye established the nowadays generally accepted theory of the general adaptation syndrome of the human body to a stressor (16). He distinguished between three stages in the stress response, which can be found again in the description of the microwave syndrome according to Hecht (2, 3). Thus, after the stages of alarm and resistance, the last stage of exhaustion sets in (Fig. 17). The parameters investigated in the Rimbach study follow this pattern.

STAGE I—Activation Stage

The results of the long-term study presented here show an immediate activation of the adrenergic system. After the activation of the cell phone base station under investigation, the parameters adrenaline and noradrenaline increase significantly within a period of one and a half years. Because of the increased production of the final hormones noradrenaline/adrenaline, the use of dopamine increases, and as a result, the dopamine level decreases. The decrease in the dopamine level is the more pronounced, the higher the GSM radiation exposure level is at the residence of the individual participants.

STAGE II—Adaptation Stage

After this sympathicotonic activation stage, the body tries to compensate the increase in adrenaline and noradrenaline. In order to inhibit the overshooting catecholamine production and to ensure a stable regulation, the phenylethylamine level (PEA level) decreases. Here the decrease in PEA starts in the highest exposure group first.

STAGE III—Premorbid Stage

According to our hypothesis, the effects of adrenaline and noradrenaline are inhibited by feedback mechanisms at the expense of a chronically, over six continuous months, lowered PEA level. However, the attempt at counterregulation remains incomplete—even one and a half years after the installation of the cell phone base station; the hormonal balance had not been restored completely. The PEA level remains at a low level, which is to be interpreted as evidence for the beginning of exhaustion.

Conclusion

Thus, the following hypothesis is proposed: Although participants maintained their usual lifestyle, they developed chronic stress with a primary increase in adrenaline/noradrenaline and a subsequent decrease in dopamine in response to the microwave exposure from the newly installed cell phone base station. During the stage of counterregulation, the "trace amine" PEA decreases and remains decreased.

This is of considerable clinical relevance because psychiatric symptoms also exhibit altered PEA levels. In Rimbach, the increase in sleep problems, cephalgia, vertigo, concentration problems, and allergies could be clinically documented after the cell phone base station had been activated. The newly developed symptoms can be explained clinically with the help of disturbances in the humoral stress axis (53).

After having exhausted the biological feedback mechanisms, major health problems are to be expected. The possible long-term consequences of remaining caught in the exhaustion stage have already been described by Hecht and Selye (3, 16).

Thus, the significant results presented here not only provide clear evidence for health-relevant effects in the study subjects of Rimbach after a new GSM base station had been installed there, but they also offer the opportunity to carry out a causal analysis. This has already been successfully done in the "shut-down study" of Schwarzenburg, Switzerland (54). In Rimbach, the documented levels should return to normal once the relevant base station is shut down.

Epidemiological Evidence

There is current epidemiological evidence for the considerable clinical relevance of the dysfunction of the humoral stress axis with its endpoints of PEA decrease and adrenaline increase, as documented by us.

1. Decreased PEA levels can be found in a large portion of ADD/ADHD patients. As therapy methylphenidate is used, a substance that is structurally related to PEA. Between 1990 and 2004, the boom time of cell phones, prescription costs for this medication had increased by a factor of 86 (49, 55).

2. As part of the German Mobile Telecommunication Research Programme, approximately 3000 children and adolescents were studied in Bavaria for their individual cell phone radiation exposure levels in relation to health problems. Among the various data sets, the data set regarding behavioral problems showed a significant increased risk for both adolescents (OR: 3.7, 95%-CI: 1.6-8.4) and also children (OR: 2.9, 95%-CI: 1.4-5.9) in the highest exposure group (56). For the first time, the "Rimbach Study" provides a model of explanation in biochemical terms.

3. Pheochromocytomata are adrenaline- and noradrenaline-secreting tumors of the adrenal gland (57). This type of tumor due to microwave exposure has already been demonstrated in animal experiments in 1985 (5). The increase of this disease in the US population is highly significant. Concurrent with the increase in local microwave exposures due to an increased number of base stations and use of wireless communication technologies, the number of cases have increased from 1,927 to 3,344 between 1997 and 2006 (58, 59).

It is a physician's responsibility—not bound by directives—to work toward the preservation of the natural basis of life regarding human health (60). Now it is the duty of the responsible agencies (public health department, Bavarian State Ministry of the Environment and Public Health as well as other federal ministries) to investigate the current situation.

Note

For the data collection, financial and personnel support was provided by INUS Medical Center and the two laboratories Lab4more GmbH and Neuroscience Inc.

The above-listed institutions were so kind to provide clinical examinations as well as the laboratory tests for the evaluation without external funding.

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Editor's Note

The above paper is identified as an original scientific paper and it was subject to a special peer-review process in cooperation with the Scientific Advisory Board.

The Editorial Team

Translation

By Katharina Gustavs and authorized by the authors and publisher

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PICK OF THE WEEK #22: A VERY IMPORTANT SYMPOSIUM!

February 23, 2011. Janet Healer reviewed studies of people occupationally exposed to radio frequency radiation. Below are some excerpts from her document presented at the "Biological Effects and Health Implications of Microwave Radiation" symposium. These are direct quotes with the numbered citations removed and my comments provided in square [ ] brackets. I have tried to restrict quotes to studies that were conducted at or below our current guidelines of 1 mW/cm^2, although in many instances exact exposure conditions are not provided. Emphasis added. Link to proceedings is available at the end of this document.

1. page 90. "There is increasing evidence that radio-frequency radiations can affect biological organisms, even at relatively low intensities, particularly under conditions of chronic exposure [WiFi in schools, offices and homes for example]. A substantial number of observations have been made at intensity levels below those presently accepted as tolerable for continuous exposure in the United States and most of Western Europe. To date, the deleterious effect of radio-frequency fields, particularly of microwaves, at relatively high intensities, e.g., 50 mW/cm^2 or greater, has been recognized and attributed to heating. However, biological hazards may exist at lower levels, extending well below 10 mW/cm^2, and effects at both high and low intensities may be attributable to more complex modes of interaction. **At low intensities effects may be subtle, impairing performance; chronic, affecting general mental and physical health and longevity; and may also be mutagenic, affecting succeeding generations.**"

2. page 91: ". . . the Moscow Institute conducted a 10-year study of over 1000 individuals exposed in various occupations over periods from months to as long as 20 years. The study included investigation of symptoms associated with chronic, long-term low-level exposures that "do not produce a thermal effect." Effects of various frequency bands were compared from below the high-frequency (HF) [3 to 30 MHz] band up through the superhigh frequency (SHF) [3 to 30 GHz, wavelength 1 to 10 cm] band. A large portion of the work was done in the centimeter range with reported exposure intensities of 1 mW/cm^2 and below [note 1 mW/cm^2 is the current guideline in the U.S., Canada, and is recommended by both ICNIRP and the World Health Organization]. Even at these low intensities, systematic, long-term exposures were reported to

produce symptoms. Similar observations have been made at these and lower frequencies extending into the ELF [extremely low frequency] region.

3. page 92: "The symptomatology associated, in the Soviet literature, with prolonged exposure most commonly includes **headache, increased fatigability, diminished intellectual capabilities, dullness, partial loss of memory, decreased sexual ability, irritability, sleepiness and insomnia, emotional instability, sweating, and hypotension**. **Shortness of breath** (dyspnea) and **pains in the chest region** are also reported. [Note: these are similar to symptoms of electrohypersensitivity]. Symptoms of disturbance of the vegetative nervous system including sinus arrhythmias, a tendency toward bradycardia [slowed heart beat], and other vagotonic changes are common observations." [Note: vagotonic changes refer to over excitation of the vagus nerve--a nerve that supplies the throat, voice box, lung, heart, and stomach--adversely affecting function of the blood vessels, stomach, and muscles resulting in dizziness, sweating, constipation, and pain].

4. page 92: "The most commonly reported **objective physiological changes** [indicating that these symptoms are NOT *psychological*] are **neural, cardiovascular, blood compositions, and endocrine functions**."

5. page 92: "At low intensities, neural changes, like other reported biological shifts, are typically functional, are not accompanied by distinct pathological change, and disappear after the subject is removed from the radiation environment. Nervous system response is expressed in the electroencephalogram (EEG) and by altered response times. Commonly, responses are characterized by initial excitation followed by subsequent inhibition."

6. page 93: "Various biochemical, neurohumoral and metabolic disruptions have been observed which can affect neural and other body functions. Changes in **histamine** [leading to inflammation] in the blood (generally increases) have been reported. Decreased **cholinesterase** [enzyme affecting nervous system and immune system] levels are frequently reported in exposed people and also in animals where they have been observed in connection with altered neural response. **EEG** [brain wave activity] changes have been observed in some occupationally exposed people at microwave and lower frequencies. These changes are reported to be early occurring and often appear before other changes are detectable in the organisms. They are frequently reported to persist after the cessation of irradiation.

7. page 93: They [Czechoslovakian scientists] regard EEG shifts as a kind of early-warning system for detection of organism response to radio frequency radiation on a very subtle level.

8. page 94: "Numerous Soviet studies cite **cardiovascular disturbances** which they widely regard as the predominant vegetative response to radio-frequency irradiation. In general, cardiovascular responses are characterized by hypotension, dystonia [neurological movement disorder causing sustained muscles contractions leading to twisting or repetitive movements of the body], and vagotonic reactions. Electrocardiographic (EKG) studies of exposed people and of animals, report a predominance of bradycardia, arrhythmia, and particularly sinus arrhythmias. Depressed intracardial conduction, commonly intraventricular, and lowered EKG waves, particularly T-waves, are also reported. Shifts are reported more often in persons with long histories of occupational exposure. Some examinations suggest a heightened susceptibility of persons with predisposition to, or a history of, cardiovascular disease. In the interest of

occupational hygiene, many Soviet investigators (and at least one U.S. researcher) have recommended that **cardiovascular abnormalities be used as screening criteria to exclude people from occupations involving radio-frequency exposures**. [Note that we have anecdotal evidence that children in schools with WiFi or with WiFi in their home experience a racing or irregular heart beat that normalizes when they are not exposed.]

9. *page 94: "An extensive examination program was conducted* by the Institute of Labor Hygiene and Occupational Diseases, Moscow, involving over 500 individuals, periodically exposed for periods up to approximately10 years to cm and longer wave radiations at low intensities (e.g., below 1 mW/cm², and up to several mW/cm²). This program revealed a variety of cardiovascular shifts predominant among which were bradycardia and vascular hypotension [low blood pressure]. Differences in responses to acute exposures of higher intensities and longer term chronic exposures at lower intensities were noted. Although these effects are generally reported to be reversible, a few exceptions are noted for certain individuals chronically exposed over many years, who showed pronounced pathological conditions."

10. page 94: "In the **blood**, alterations have been reported in the protein fractions, ions, histamine content, hormone and enzyme levels, and immunity factors, but most frequently reported are changes in cellular composition."

11 page 94: "Increased **thyroid** gland activity and sometimes enlargement is the most commonly reported endocrine response of exposed people. **Adrenal** changes are also reported."

12. page 94: "A few occupational studies have suggested possible disturbances in some **reproductive system** functions. Several foreign low-intensity animal studies report reproductive system disturbances and cases of adverse effects on progeny, although contradictory evidence has also been reported. Of particular significance are possible **genetic changes** which might occur in large populations over long periods of time. Very little genetic data exists, although one U.S. study suggested a possible relationship between paternal radar exposure and mongoloidism.

13. page 94: "A 1967 Polish paper discussing **ophthalmological aspects** of safety standards for workers during operation of electromagnetic-field generators in military installations, indicates concern for workers with some eye ailments when working in microwave 'fields as low as 0.01 mW/cm²." [Note: This value is 1% of the current WHO guideline!]

14. page 94. "There is general agreement among Soviet and Eastern European investigators that systematic chronic exposure to low-intensity radiations (around 10 mW/cm² and lower) can have an adverse effect on health. Their standards are more restrictive than those of the United States by several orders of magnitude (e.g., 0.01 mW/cm² for continuous daily microwave exposure). Furthermore, separate standards exist for various frequency ranges below the microwave region (e.g., 60 kHz-30 MHz, and 30-300 MHz). In Czechoslovakia maximum permissible exposures distinguish between **pulsed** and **continuous-wave radiations** and are **more restrictive for the pulsed case** (0.025 mW/cm² vs 0.01 mW/cm²)." [Note: WiFi and mobile phones use the more harmful pulsed radiation.]

15. *page 95: "In summary, considerable investment of time, money and talent have been made* in foreign programs to study the effects of low-intensity occupational radio-frequency exposures

in man. These studies have resulted in the accumulation of a large body of research data, which in aggregate cannot be ignored even though in many details it must be substantiated." [Note: So why has it been ignored and why are federal and international health authorities denying that a problem exists below the thermal guidelines currently at 1 mW/cm^2 in many countries?]

A total of 119 references were cited.

Can anyone guess when this was published? Would you believe 41 years ago in 1970!!!

Cleary, S.F. (Editor). 1970. Biological Effects and Health Implications of Microwave Radiation, Symposium Proceedings, Richmond Virginia, September 17-19, 1969. Sponsored by Medical College of Virginia, *Virginia Commonwealth University with the support of* Bureau of Radiological Health, U.S. Department of Health, Education, and Welfare, Public Health Service, Environmental Health Service. 275 pp.

Click here to download this document as a searchable pdf (7.1 MB).

This was a very important symposium with more than 30 additional papers presented. The panel discussions alone are illuminating.

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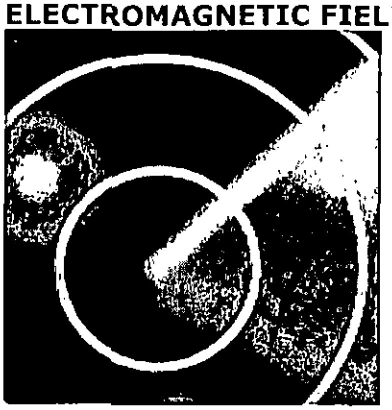
37. Panel Discussion II: Future Needs in Research on the Biological Effects of Microwave and R. F. Radiation, *A. M. Burner* (Moderator), *N. Telles, S. Michaelson, A. Frey, E. Alpen, R. L. Carpenter, C. Susskind, and J. H. Heller*

38. Index

PICK OF THE WEEK #6: CLINICAL & HYGIENIC ASPECTS OF EXPOSURE TO ELECTROMAGNETIC FIELDS



August 16, 2010. Pick of the Week #6: Clinical & Hygienic Aspects of Exposure to Electromagnetic Fields.

Dodge, CH. 1969. Clinical and Hygienic Aspects of Exposure to Electromagnetic Fields: A Review of the Soviet and Eastern European Literature. Biological Effects and Health Implications of Microwave Radiation, Symposium Proceedings, Richmond, Virginia, September 17-19, 1969 (BRH/DBE 70-2) (PB 193 898).

Christopher Dodge, affiliated with the Library of Congress, wrote the first comprehensive review of the world (especially the Soviet and Eastern European) literature on the biological effects of microwaves in 1964. The current document was written 5 years later during which time the author was with the Biosciences Division, U.S. Naval Observatory, in Washington, D.C. This document concentrates on human clinical studies and occupational hygiene surveys of microwave exposure and is well worth reading.

What is clear is that by the late 1960 the Soviet and Eastern European scientists had conducted numerous studies on the effects of microwave radiation on humans, that biological and health effects were documented for a range of frequencies at non-thermal levels, and that this information was available to the U.S. military. Why this science was not taken more seriously, why guidelines were not influenced by this research, and why we are still debating thermal vs non-thermal effects is a mystery that I leave for historians and philosophers to debate.

Here are a few gems from this document:

1. By 1933 Soviet scientists recognized that electromagnetic fields affected the human nervous system. Indeed changes to the **central (CNS) and autonomic (ANS) nervous system** attributed to radio frequency radiation were frequently documented, as were additional effects as shown in Table 1. Frequencies from 30 MHz to 300 GH at both thermal (greater than 10 mW/cm^2) and non-thermal (microW/cm^2 to milliW/cm^2) intensities were known to affect the CNS.
2. The most disappointing aspect of the literature cited was the **absence of information** on the specific circumstances of the irradiation, characteristics of the environment and the conditions of the body exposed, which makes repetition of the studies difficult.
3. Panov et al. (1966) proposed **three chronological stages** of human response to microwaves (Table 2).
   - The **first stage** is not marked by severe episodes such as fainting or dramatic changes in pulse or blood pressure and the subject responds to outpatient treatment.
   - The **second stage** is called the "syndrome of autonomic and vascular dystonia" and the key features include altered pulse including bradycardia (slow) and tachycardia (rapid), either high or low blood pressure, altered ECG and general neuro-circulatory asthenia. Severe episodes (fainting) may occur and the subject requires hospitalization of unspecified nature or duration.
   - *The* ***third stage*** *is called diencephalic syndrome in which visceral dysfunctions and crisis* are observed. Typical episodes include apathic embolic disorders, hypersomnia, hypokinesis, hypothalamo-pituitary-suprarenal weakness, and inhibition of sexual and digestive reflexes. Panov claims these changes are not always reversible and that subjects require hospitalization.
4. The general **subjective complaints** resulting from EMR exposure shown in Table 3 resemble symptoms associated with electrohypersensitivity (EHS).
5. Edelwejn (1966) found that the **symptoms** (Table 3) experienced by Polish personnel exposed to microwave radiation for up to six hours/day **depended on the length of employment and degree of exposure**. During the first three years, a dramatic response to microwave exposure accompanied by neurotic symptoms was reported. This was followed by a gradual adaption phase and then, many years later, by the reappearance of neurologic symptoms. Soviet workers exposed to electric and magnetic fields near hydroelectric stations also complained of symptoms in Table 3. Ospiov (1965) concluded that most subjective symptoms were reversible and that pathological damage to neural structures was insignificant.
6. In one study, a larger percentage of subjects exposed to **weak** (1 to 100s microW/cm^2) and **moderate** (100s microW/cm^2) levels of EMR experienced symptoms than those who were sporadically exposed to **intense** levels (3000 to 4000 microW/cm^2) (see Figure 1 below, note this figure is based on Table 4 of the original document).
7. Pulsed ultra high frequency (UHF) fields [0.3 to 3 GHz] could be used as a form of contactless **electrosleep**, which was called **radio-sleep**.

8. Numerous changes were documented in the **blood** including altered blood sugar, cholesterol and lipids; altered levels of pyruvic acid, lactic acid, and creatinine; as well as hematopoietic [blood forming processes] and biochemical responses to electromagnetic radiation (see Tables 8,9, 10).
9. Effects on the functioning of and damage to the **eyes** were mostly documented at either acute or chronic thermal levels of exposure (see Table 11).
10. Major **endocrine responses** included altered functioning of the pituitary, thyroid and adrenal glands. Damage to sex glands and functions have been frequently documented after chronic exposure to primarily thermal intensities (Table 12). Decreased spermatogenesis, altered sex ratio at birth (excess females), changes in menstruation, retarded fetal development, congenital effects in newborns, decreased lactation in nursing mothers have been documented as result of thermal exposure (greater than 10,000 microW/cm^2).

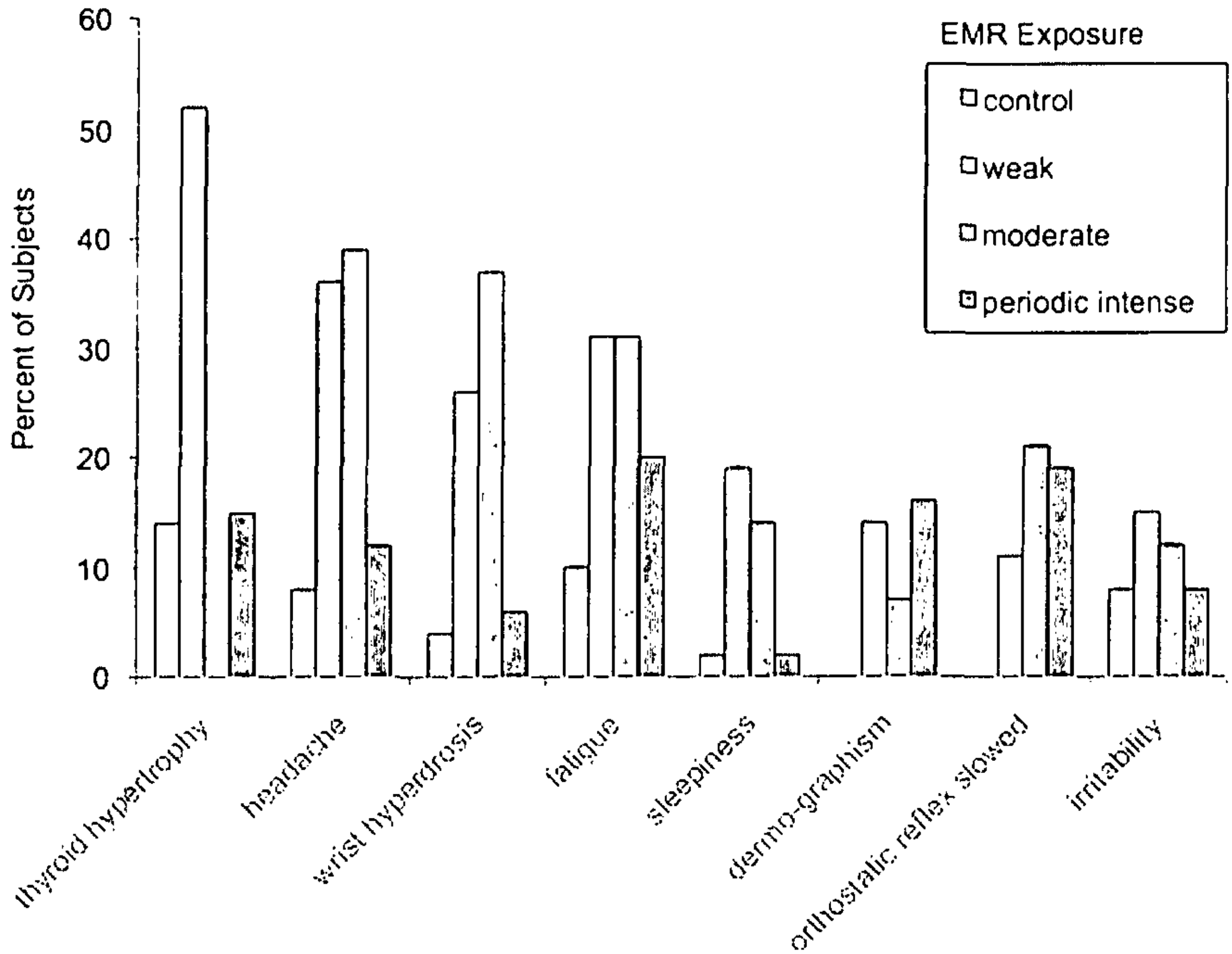


Figure 1. Percentage of subjects who responded to weak (1 to 100's microW/cm2), moderate (100's microW/cm2), and periodic intense (3,000 to 4,000 microW/cm2) levels of microwave radiation. Based on data in Table 4, Dodge, 1969. [*Note*: U.S. and Canadian guidelines are 1,000 microW/cm2 so the weak and moderate exposures are well below these guidelines.]

PICK OF THE WEEK #5: WHY THE DOUBLE STANDARD?

August 2, 2010. **Pick of the Week #5: Why the double standard?**

Inglis, L.P. 1970. Why the double standard? – A critical review of Russian work on hazards of microwave radiation. IEEE International Symposium on Electromagnetic Compatibility, July 14-16. 1970.

Summary

Continued interest in the determination of appropriate national levels of exposure to microwave fields has directed attention to Soviet work in this field. The vastly different standards adopted in the two countries have aroused much speculation as to the reasons. In this paper the Russian work is reviewed, and the major individuals identified. An explanation for the different exposure limits is offered, based partly on the difference in national organization.

COMMENTS

This document is written by Leo P. Inglis, who worked for Atomics International Division, North American Rockwell Corp.– a company involved with the early development of nuclear technology for commercial and government applications.

In "*Why the double standard?*" Inglis tries to tease apart the reasons for the much lower radio frequency standards used in the USSR compared with those used in the USA.

A much quoted paragraph, and the focus of this document, is the following:

"*In the U.S., the thermal effects are generally believed to be the only ones of significance; other contentions are usually dismissed as lacking a provable basis. In the USSR, non-thermal effects are considered the most significant and are overwhelmingly the ones most studied.*"

Several interesting concepts are presented based on Russian research.

1. Biological effects of radio waves are reduced with an increase in wavelength (i.e. at lower frequencies) and that this might be true when comparing different regions of the spectrum, but within the microwave band this general regularity may not exist.
2. There is a possibility of resonant absorption of microwaves by complex protein molecules, particularly enzymes. The result of such absorption could change molecular structure and when protein structure changes so does its function.
3. Pulsed and modulated radiation are more harmful than continuous waves and may stimulate the nervous system as shown by studies with rabbits that document changes in brain wave activity as measured by EEG, occurring within 10 seconds of microwave exposure (in the absence of heating) and lasting 10 to 15 minutes after irradiation ended.

The results that I found most intriguing were those by Drogochina and Sadchikova (1965), who studied, for several years, individuals exposed to microwave radiation in the course of their work. They investigated the development of various symptoms (which we would today call electrohypersensitivity or EHS) resulting from exposure to radio frequencies in the centimeter *wavelengths (high MHz and low GHz frequencies similar to mobile phones and WiFi).* These symptoms fell into three stages.

The **initial stage** symptoms usually appeared within 3 to 5 years of exposure. Most characteristic is the asthenic syndrome [note: Asthenic syndrome describes a person characterized by low energy, susceptibility to physical and emotional stress, and a diminished capacity for pleasure], which develops because of the exhausting action of the radio frequencies on the central nervous system, and results in increased fatigue, headaches, and sleepiness during work hours. Among the biological effects that occur are bradycardia [heart rate less than 60 bpm], changes in heart conduction on the electrocardiograph, weak development of dermographia [development of welts where someone scratches the skin], and hyperhydrosis [excessive perspiration] of the wrists. Often there is a slight enlargement of the thyroid gland and a tendency towards increase in the leukocyte [white blood cell] count and histamine content of the blood. All these changes are unstable and can be eliminated by a brief interruption of the work involving exposure.

The **second stage** develops if exposure continues. Patients suffer prolonged headaches, pain in the region of the heart, bradycardia, increased blood pressure, pronounced changes in the appearance of the electrocardiogram, a lowered olfactory response, and often such trophic disturbances as loss of hair and brittleness of the nails, and a decrease in sexual potency [Does the surge in the use of Viagra and other drugs to enhance male performance relate to microwave exposure?]. Some medical treatment is required and temporary transfer to other work is mandatory.

The **third stage** is poorly described in the article. Symptoms include strong recurring headaches, vertigo and fainting, heart pains, shivering and trembling, gastrointestinal disturbances, pronounced dermographia and hyperhydrosis. Symptoms can remain even a year after the individual had changed jobs, although at a reduced level.

In the *discussion*, Inglis quotes from testimony presented by Dr. Charles Susskind (UC Berkeley) before the Senate Committee hearings on "Radiation Control for Health and Safety Act of 1967."

Dr. Susskind recommends that much basic research at lower power densities should be performed before "*. . . we can decide whether we should adopt the much stricter safety level of the Soviet Union.*" He also suggests that "*non-ionizing radiation might ultimately prove to be a greater problem than ionizing radiation.*"

According to Inglis, "*If that prophecy should prove correct, I am sure the Russian literature will one day be weighed more carefully than it is at present* [i.e. 1970]." We are fortunate that Dr. Glaser kept these documents.

Others have also expressed concern about the proliferation of microwave radiation.

In a 1973 report submitted by JA Tanner from the Division of Mechanical Engineering and co-authored by faculty in the Department of Anatomy at Queen's University in Kingston, Ontario, the authors conclude:

"*In view of the expected proliferation of MW [microwave] devices in many different applications, a substantial increase in MW background activity is feared that may endanger human health. On this basis strict control of the use of these devices must be introduced while present safety standards are revised and extensive research is conducted into long term effects of exposure to low intensity MW radiation. In particular, a study of the possible accumulative effects of MW radiation (directly or indirectly) through sensitization must be conducted.*"

A few years later, Robert O. Becker (MD) stated the following:

"*I have no doubt in my mind that at the present time, the greatest polluting element in the earth's environment is the proliferation of electromagnetic fields. I consider that to be far greater on a global scale, than warming, and the increase in chemical elements in the environment.*"

Inglis (Rockwell Corp.), Susskind (UC Berkeley), Tanner (Mechanical Engineering, Queen's University) and Becker (Orthopedic Surgeon and Professor SUNY, Syracuse) can't all be wrong. So why weren't they listened to?

It is now 2010. Forty years have passed yet the thermal debate is alive and well in many developed countries. The symptoms of asthenia or electrohypersensitivity are becoming more prevalent in society as is our exposure to microwave radiation. When once this was an occupational illness it has become a societal illness and one that is likely to get worse as we continue to install smart meters on homes, Wi-Max in communities and WiFi in schools.

As I write this biblical images come to mind.

I image the sea level rising as Noah gathers his family and the animals on his boat. It rained for 40 days and 40 nights and we have had at least 40 years of knowing this technology is harmful.

Today, instead of water, levels of microwave radiation are rising and many have already suffered from exposure. Complaints of insomnia, chronic fatigue, chronic pain, allergies, depression, anxiety, heart problems, cancers, reproductive problems, neurological disorders, diabetes are on the rise and studies show these are the symptoms associated with electrosmog. Countless people will die as the technology invades our homes, schools, and communities. The Noah equivalents call themselves *electromagnetic refugees*. They find safe havens and ensure their homes and communities are electromagnetically clean.

I also image Moses descending from Mount Sinai seeing his people dancing around a calf made of gold, a false god. Is the thermal standard not a false god that governments have fabricated and are worshipping? What will it take for the blind to see and the deaf to hear what governments and industry have been hiding and negating for the last 40 years? Moses didn't live to see the promised land and many of my colleagues wonder if they will see what happened to cigarettes also happen to wireless technology during their lifetime.

What we need is labelling and awareness raising of the hazards of this type of radiation. We need more protective guidelines in those countries still falsely worshiping the golden calf and stating that heating is the only effect of microwave exposure. We need a shift to wired technology, especially fibre optics that is much faster, more secure, and safer than wireless. We need to change behaviour and limit places where wireless is allowed. We can all built a boat to carry us to safety or we can have the levels of microwave radiation recede to levels that are tolerable to the most sensitive in our society.

The choice is ours but it will take a monumental effort to achieve.

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