From: Donag1@aol.com [mailto:Donag1@aol.com]
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ONLINE FIRST

Maternal Exposure to Magnetic Fields During Pregnancy in Relation to the Risk of Asthma in Offspring

De-Kun Li, MD, PhD; Hong Chen, MPH; Roxana Odouli, MSPH

Objective: To determine whether maternal exposure to high levels of magnetic fields (MFs) during pregnancy is associated with the risk of asthma in offspring.

Design: A prospective cohort study.

Setting: Kaiser Permanente Northern California.

Participants: Pregnant Kaiser Permanente Northern California members in the San Francisco area.

Main Outcome Measures: Asthma was clinically diagnosed among 626 children who were followed up for as long as 13 years. All participants carried a meter to measure their MF levels during pregnancy.

Results: After adjustment for potential confounders, a statistically significant linear dose-response relationship was observed between increasing maternal median daily MF exposure level in pregnancy and an increased risk of asthma in offspring: every 1-mG increase of maternal MF level during pregnancy was associated with a 15% increased rate of asthma in offspring (adjusted hazard ratio [aHR], 1.15; 95% confidence interval [CI], 1.04-1.27). Using the categorical MF level, the results showed a similar dose-response relationship: compared with the children whose mothers had a low MF level (median 24-hour MF level, ≤0.3 mG) during pregnancy, children whose mothers had a high MF level (>2.0 mG) had more than a 3.5-fold increased rate of asthma (aHR, 3.52; 95% CI, 1.68-7.35), while children whose mothers had a medium MF level (>0.3-2.0 mG) had a 74% increased rate of asthma (aHR, 1.74; 95% CI, 0.93-3.25). A statistically significant synergistic interaction was observed between the MF effect and a maternal history of asthma and birth order (firstborn).

Conclusion: Our findings provide new epidemiological evidence that high maternal MF levels in pregnancy may increase the risk of asthma in offspring.

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ASTHMA IS THE MOST COMMON chronic condition among children. Approximately 13% of children younger than 18 years (9.4 million children in the United States) have asthma.[1] Based on reports from the Centers for Disease Control and Prevention, asthma is a leading cause of hospitalization and emergency department visits for children younger than 18 years in the United States, with staggering annual costs of more than $30 billion (http://www.cdc.gov/HealthyYouth/asthma).[1] The prevalence of asthma has been steadily rising during the last several decades, with an increase of about 74% from 1980 to 1996. While not ruling out genetic susceptibility, such a secular increase indicates the presence of important environmental risk factors that remain elusive.

Environmental exposures during pregnancy could affect fetal development of the immune system and lungs and thus have an impact on the risk of asthma in offspring.[2-5] Among the limited research, chemical exposures have represented much of the focus, while the potential of environmental physical exposures has rarely been examined. One such physical exposure is increasing man-made electromagnetic fields (EMFs). In addition to traditional low-frequency EMFs from power lines and appliances, the buildup of increasingly stronger wireless networks both inside and outside living and work spaces and the proliferation of cell phones and other wireless devices have led to human populations being surrounded by EMFs of increasing intensity. This parallel increase in both EMF exposure and asthma prevalence in the past several decades warrants examination.

Studies have shown that EMFs could adversely affect reproductive outcomes and the immune system.[6-15] A recent study also

Author Affiliations: Division of Research, Kaiser Foundation Research Institute, Kaiser Permanente, Oakland, California.

showed an EMF effect on brain cell activities.[16,17] Therefore, it is conceivable that exposure to high EMFs, especially during pregnancy (the period of fetal development), may have an impact on the risk of asthma in offspring. To examine this hypothesis, we conducted a prospective study based on a cohort of pregnant women whose daily exposure to magnetic fields (MFs) was captured objectively by a meter during their pregnancy and whose offspring from the index pregnancy were followed up for as long as 13 years for their asthma diagnosis.

METHODS

A prospective cohort study was conducted to examine the effect of EMF exposure on the risk of miscarriage among pregnant members of Kaiser Permanente Northern California (KPNC) in the San Francisco area who were recruited from 1996 to 1998.[6] The members of KPNC are representative of the racially/ethnically diverse underlying population. All pregnant women who submitted a pregnancy test in the KPNC facilities of the San Francisco area were informed of the study, and those with a positive pregnancy test result were recruited for their possible participation. The study was approved by the KPNC institutional review board, and all participants signed an informed consent form.

RECRUITMENT

Women who spoke English and intended to carry the pregnancy to term at the time of recruitment were eligible for participation in the study. We recruited pregnant women early in gestation (5-13 weeks) because miscarriage usually occurs during the first trimester.[6] All participants were interviewed in person during pregnancy to ascertain risk factors for adverse pregnancy outcomes and potential confounders. Of the original 1063 recruited women, 829 delivered a live birth. Of these offspring, 28 did not have medical records in our KPNC system, which means that they likely received their pediatric care outside the KPNC system and therefore were not included in the study.

EXPOSURE MEASUREMENT: MFs

Electromagnetic field refers to both electric fields and MFs. In this study, because the instrument we used (EMDEX-II meter; Enertech Consultants, Campbell, California) measures only MFs, hereafter we will refer to our exposure as *MFs*. All participants were asked to wear an EMDEX-II meter for 24 hours during the first or second trimester so that their actual MF exposure level throughout the day from all sources could be measured objectively. The EMDEX-II meter collected MF measurements in the frequency range of 40 to 800 Hz every 10 seconds. The MF level was measured in milligauss. The meter was programmed to show only the time of day, without displaying any MF exposure level, so that participants were not aware of their MF exposure during the measurement period. This design was implemented to avoid changes of any routine daily activities due to the MF level displayed. At the end of the measurement period, the women were asked to rate their activity patterns during the measurement period as either similar to or quite different from those during a typical day of their pregnancy. Of 801 participants whose children had pediatric care at KPNC, 67 did not have complete 24-hour MF measurements. These mother-child pairs were excluded from the study.

OUTCOME MEASUREMENT: ASTHMA IN OFFSPRING

The children of the remaining 734 pairs with complete maternal 24-hour MF measurements during pregnancy were followed up until (1) they received a diagnosis of asthma, (2) they left the KPNC system (no longer a KPNC member), or (3) the end of the study period (August 31, 2010). To be considered as having a case of asthma, a child had to have received a clinical diagnosis of asthma (*International Classification of Diseases, Ninth Revision,* codes 493.00-493.99) on at least 2 occasions within a 1-year period during follow-up. We excluded those who had either only 1 diagnosis (n=67) or 2 diagnoses that were more than 1 year apart (n=17) or those who used antiasthmatic medications without a clinical diagnosis of asthma (n=24). These children were considered to have suspected asthma and formed a separate outcome group. They were not included in the main analyses but were analyzed separately for comparison. The final analyses included 626 mother-child pairs with both maternal MF measurements and a known asthma status.

POTENTIAL CONFOUNDERS

Although the number of known potential confounders are likely limited because of (1) a lack of association between MF exposure and many commonly known social, demographic, and behavioral factors and (2) the small number of known risk factors for asthma,[2,4] we evaluated many common sociodemographic characteristics and known prenatal and postnatal risk factors for asthma to ensure that they truly did not confound the association between maternal MF exposure during pregnancy and the risk of asthma in offspring. Because most variables evaluated were not confounders, we included the common sociodemographic variables such as maternal age, education, and race/ethnicity as well as the main risk factors for asthma such as a maternal history of asthma and smoking during pregnancy in the final model.

DATA ANALYSIS

We used the Cox proportional hazard regression model to examine the relationship between in utero MF exposure and the risk of asthma in offspring after controlling for potential confounders. Survival analysis has the advantage of taking into account different follow-up times for the offspring with regard to asthma diagnosis. All children were followed up starting from birth until (1) they received diagnoses of asthma (failed), (2) they left the KPNC system (censored), or (3) the end of the study (censored).

To quantify a woman's overall daily MF exposure burden, we used median 24-hour MF exposure to reflect her overall MF exposure during pregnancy to reduce the impact of outliers. Because everyone is exposed to MF at some level, we examined whether an increasing MF exposure during pregnancy is associated with an increased risk of asthma in offspring, a dose-response relationship rather than a dichotomized variable of yes/no. We first examined the dose-response relationship using the median MF level as a continuous variable. To present the association as categorical MF exposure for an easier interpretation, we divided the median MF level into 3 categories: low (≤10th percentile [≤0.3 mG]), medium (>10th-90th percentile [>0.3-2.0 mG]), and high (>90th percentile [>2.0 mG]).

RESULTS

Table 1 presents the characteristics of the study population according to their MF exposure level during pregnancy. We examined maternal, prenatal, genetic, and

Table 1. Characteristics of the Study Population

Characteristic	Median Magnetic Field (MF) Level, %: Low,[a] (n=81)[d]	Medium,[b] (n=482)[d]	High,[c] (n=63)[d]	χ^2 Test (*P* Value)
Sociodemographic factors				
Maternal age, y				.91
≤25	19.7	18.3	19.1	
26-30	32.1	31.5	31.7	
31-35	30.9	32.8	38.1	
>35	17.3	17.4	11.1	
Maternal education				.93
<College	51.8	55.8	57.1	
College	32.1	27.8	28.6	
Postgraduate	16.1	16.4	14.3	
Maternal race/ethnicity				.66
White	40.7	38.4	47.5	
Black	4.9	8.3	4.8	
Hispanic	21.0	19.5	17.5	
Asian/Pacific Islander	24.7	29.1	25.4	
Other	8.6	4.7	4.8	
Maternal prepregnancy BMI				.97
≤25	71.6	71.6	73.0	
>25	28.4	28.4	27.0	
Family income, $				.004
<30 000	24.4	18.4	13.3	
≥30 000	26.9	44.7	60.0	
≥60 000	48.7	36.8	26.7	
Prenatal factors				
Smoke during pregnancy				.90
Yes	8.6	9.5	7.9	
No	91.4	90.5	92.1	
Infection in pregnancy				.66
Yes	34.6	32.6	38.1	
No	65.4	67.4	61.9	
Antibiotic use in pregnancy				.48
Yes	34.6	41.3	42.9	
No	65.4	58.7	57.1	
Mode of delivery				.66
Vaginal birth	77.3	79.7	83.6	
Cesarean section	22.7	20.3	16.4	
Genetic factor				
Maternal history of asthma				.85
Yes	8.6	7.1	6.3	
No	91.4	92.9	93.7	
Infant factors				
Breastfed				.89
Yes	88.9	91.7	90.5	
No	11.1	8.3	9.5	
Sex				.66
Female	44.4	49.4	46.1	
Male	55.6	50.6	53.9	
Parity				.48
First child	51.9	45.6	50.8	
Not first child	48.1	54.4	49.2	
Low birthweight, <2500 g				.07
Yes	9.9	4.1	3.2	
No	90.1	95.9	96.8	
Preterm, <37 wk				.95
Yes	7.4	7.5	6.3	
No	92.6	92.5	93.7	
KPNC member at the end of follow-up				.92
Yes	58.0	60.4	60.3	
No	42.0	39.6	39.7	
NICU admission				.34
Yes	11.8	7.9	5.1	
No	88.2	92.1	94.9	
Use of antibiotics before the first diagnosis of asthma				.10
Yes	84.8	87.3	77.4	
No	15.2	12.7	22.6	
Other factors				
MF level measured on a typical day				.99
Yes	64.2	63.9	63.5	
No	35.8	36.1	36.5	

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); NICU, neonatal intensive care unit; KPNC, Kaiser Permanente Northern California.

[a] Less than or equal to the 10th percentile (≤0.3 mG).

[b] Greater than the 10th percentile to the 90th percentile (>0.3-2.0 mG).

[c] Greater than the 90th percentile (>2.0 mG).

[d] The following 3 variables had missing data: family income (n=32), maternal mode of delivery (n=22), and NICU admission (n=24).

Table 2. Maternal Exposure to Magnetic Fields (MFs) During Pregnancy and the Risk of Asthma in Offspring

Maternal Daily Median MF Level	Asthma in Children Yes	Asthma in Children No	cHR (95% CI)	aHR[a] (95% CI)
Continuous MF level, mean[b] (SD), mG	1.22 (1.22)	0.98 (1.09)	1.12 (1.02-1.23)	1.15 (1.04-1.27)
MF level in category, No. (%)				
Low, ≤10th percentile	11 (13.6)	70 (86.4)	1 [Reference]	1 [Reference]
Medium, >10th-90th percentile	98 (20.3)	384 (79.7)	1.65 (0.88-3.08)	1.74 (0.93-3.25)
High, >90th percentile	21 (33.3)	42 (66.7)	3.16 (1.52-6.57)	3.52 (1.68-7.35)

Abbreviations: aHR, adjusted hazard ratio (adjusted for maternal age, race, education, smoking during pregnancy, and a history of asthma; further adjustment for the remaining variables in Table 1 did not materially change the results); cHR, crude hazard ratio; CI, confidence interval.
[a]Trend test, $P<.001$.
[b]Mean of median.

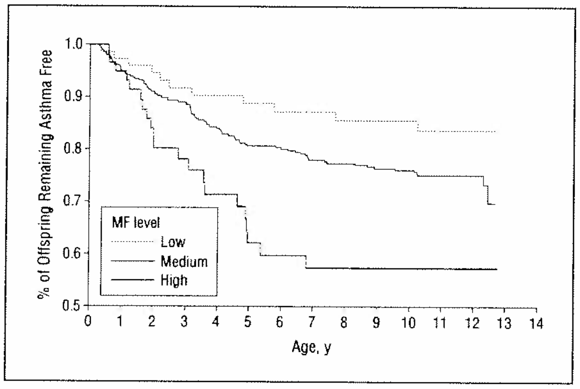

Figure. Kaplan-Meier estimates of asthma risk by maternal magnetic field (MF) exposure level during pregnancy.

infant factors that may be related to MF exposure, the risk of asthma, or both (ie, potential confounders). Of the 19 factors examined, none was related to MF exposure level except family income, which did not show a clear pattern of a relationship (Table 1). The percentages of children who were unavailable for follow-up at the end of the study because of their exiting KPNC membership and those whose MF exposure was measured on a typical day during pregnancy were quite similar among all MF exposure levels (Table 1).

Overall, 130 children (20.8%) of the study participants developed asthma during 13 years of follow-up, with most cases (>80%) diagnosed by 5 years of age. **Table 2** presents the results examining the dose-response relationship between increasing maternal MF exposure level in pregnancy and the risk of asthma in offspring using MF exposure level as both a continuous and a categorical variable. After adjustment for maternal age, race, education, smoking during pregnancy, and a history of asthma, a statistically significant linear dose-response relationship was observed between increasing maternal median daily MF exposure level in pregnancy and an increased risk of asthma in offspring (adjusted hazard ratio [aHR], 1.15; 95% confidence interval [CI], 1.04-1.27). In other words, 1 unit (1 mG) of increase in the maternal median MF exposure level during pregnancy was associated with a 15% increased rate of asthma in offspring (Table 2). Using the categorical MF level (low, medium, and high) as dummy variables, the results confirmed the linear dose-response relationship: compared with children whose mothers had a low MF level (<0.3 mG) during pregnancy, children whose mothers had a medium MF level (>0.3-2.0 mG) had a 74% increased rate of developing asthma (aHR, 1.74; 95% CI, 0.93-3.25). Furthermore, children whose mothers had a high MF level (>2.0 mG) during pregnancy had more than a 3.5-fold increased rate of developing asthma (aHR, 3.52; 95% CI, 1.68-7.35). Further adjustment for the remaining 14 factors, including family income, listed in Table 1 did not materially change the results. Finally, a similar association was also observed using suspected asthma cases, although the association was weaker, perhaps because of the misclassification of asthma cases. The aHRs were 1.24 and 1.41 for medium and high maternal MF exposure levels, respectively.

The **Figure** shows the Kaplan-Meier survival curves for the percentages of offspring who remained free of asthma during the 13-year follow-up period for 3 different maternal MF exposure levels in pregnancy. The cumulative asthma risks (1 − cumulative survival rate) in offspring were 0.16, 0.30, and 0.43 for low, medium, and high maternal MF exposure levels, respectively.

To determine whether other factors would modify the observed association, we examined the association stratified by 2 known risk factors for asthma: maternal history of asthma (a possible genetic risk factor) and firstborn child (a possible environmental risk factor, the hygiene hypothesis).[2-5] **Table 3** shows that the observed association was noticeably stronger among the children whose mothers had a history of asthma (aHR, 6.06; a more than 6-fold increased rate of asthma for 1 unit [1 mG] of increase in MF level in the maternal median MF exposure level during pregnancy) than among those whose mothers did not have a history of asthma (aHR, 1.12). Similarly, the association between increasing maternal MF exposure levels in pregnancy and the risk of asthma in offspring was stronger among firstborn children (aHR, 1.40; a 40% increased rate of asthma for every 1 unit [1 mG] of increase in MF level) than among later-born children (aHR, 1.07) (Table 3). The presence of these 2 risk factors (ie, history of maternal asthma [$P<.005$] and being a firstborn child [$P<.05$]) significantly exacerbated the adverse effect of maternal MF exposure in pregnancy on the risk of asthma in offspring.

Table 3. Maternal Exposure to Magnetic Fields During Pregnancy and the Risk of Asthma in Offspring in Relation to Other Risk Factors for Asthma

Other Risk Factor for Asthma	Total No.	Asthma in Children, Mean (SD)		aHR (95% CI)	*P* Value
		Yes	No		
Maternal history of asthma					*P*<.005
Yes	45	1.17 (0.87)	0.65 (0.49)	6.06 (2.20-16.72)	
No	581	1.22 (1.25)	1.01 (1.11)	1.12 (1.01-1.25)	
Birth order					*P*<.05
First child	294	1.33 (1.31)	0.96 (0.88)	1.40 (1.16-1.70)	
Not first child	332	1.13 (1.14)	1.01 (1.25)	1.07 (0.92-1.25)	

Abbreviations: CI, confidence interval; aHR, adjusted hazard ratio (adjusted for maternal age, race, education, smoking during pregnancy, and a history of asthma; further adjustment for the remaining variables in Table 1 did not materially change the results).

Table 4. The Strengths of the Association in Relation to the Measurement Accuracy of Magnetic Fields (MFs)

Maternal Daily Median MF Level	Asthma in Children, No. (%)		aHR (95% CI)
	Yes	No	
Measured on a typical day			
Low, ≤10th percentile	5 (9.6)	47 (90.4)	1 [Reference]
Medium/high, >10th percentile	73 (21.0)	275 (79.0)	2.52 (1.01-6.30)
Measured on a nontypical day			
Low, ≤10th percentile	6 (20.7)	23 (79.3)	1 [Reference]
Medium/high, >10th percentile	46 (23.3)	151 (76.7)	1.31 (0.55-3.13)

Abbreviations: CI, confidence interval; aHR, hazard ratio (adjusted for maternal age, race, education, smoking during pregnancy, and a history of asthma).

COMMENT

In this prospective cohort study, we found that a high maternal MF exposure level in pregnancy is associated with a significantly increased risk of asthma in offspring. The observed association showed a dose-response relationship. Given the lack of understanding of the causes of asthma, our findings could open up a new research area to elucidate risk factors of asthma that are unknown and have not been examined before. Also, our study provides new findings for the potential adverse health effect of MF exposure on an end point (asthma) that, to our knowledge, has not been previously studied. While the public has been increasingly aware of EMF exposure owing to the increasing presence of infrastructure of wireless networks and the pervasive use of wireless devices, studies on EMF health effects remain limited. Because EMF exposure is ubiquitous and exposure to it is involuntary, these new findings have important public health implications. Nevertheless, they need to be replicated by other studies.

While prenatal risk factors for asthma are not well understood, pregnancy is one of the most influential periods when allergic sensitization (atopy) is developed in the fetus.[2,18,19] The underlying pathogenesis of asthma is likely structural and due to functional defects in epithelium and an impaired innate immune system.[3] Prenatal exposure to high MF levels could interfere with the development of both epithelial cells and normal immune systems. Research by multidisciplinary collaborative studies is needed to understand these mechanisms.

The current study has several methodological strengths that enhanced the validity of the new findings. First, it was a prospective cohort study in which MF exposure was measured in pregnancy, long before the diagnosis of asthma in offspring. This study design substantially reduces the likelihood of potential biases associated with participation influenced by the presence of outcomes. Second, both the exposure (MF levels) and the outcome (diagnosis of asthma) in this study were measured objectively without the knowledge of each other, thus reducing the concern of recall bias associated with the ascertainment of exposure and outcome variables that has existed in many epidemiological studies. Unlike many case-control studies of the MF health effect, in which MF exposure in the etiologically relevant period of the past was either reconstructed or surrogated by the current exposure measurement (eg, studies of childhood leukemia), MF exposure levels in this study were prospectively measured during the etiologically relevant period (eg, pregnancy). Also, while EMF exposure measurement in past studies was frequently based only on recalls, surrogate measures, and home spot measurements, the current study asked participants to carry an EMDEX-II meter that objectively captured their MF exposure from all sources during pregnancy. Furthermore, all diagnoses of asthma were based on clinical records, not on self-report by the participants, thereby reducing measurement errors of the outcome of interest. Finally, MF exposure is not related to most sociodemographic, behavioral, and commonly known risk factors (Table 1).[6,9] Given that confounders have to be associated with the exposure of interest, a lack of association between MF exposure and those factors limits the number of potential confounders, making the observed association robust against potential biases.

While, compared with previous studies, we improved the accuracy of measuring MF exposure by asking participants to wear an EMDEX II meter for 24 hours, it was not feasible to measure MF exposure throughout pregnancy. Therefore, the accuracy of the MF measurement in reflecting the MF exposure in pregnancy may still be questioned, although one study has reported that MF exposure levels were relatively stable within 12 to 36 months.[20] Assuming that there was some misclassification of MF exposure because of measurement errors, given that this was a cohort study and MF was measured long before the diagnosis of asthma, such misclassification would be nondifferential (ie, the same degree of misclassification to both mothers of children with and without asthma). Nondifferential misclassification generally leads to attenuation of observed associations. Without such misclassification, the observed association could have been stronger. In fact, our reanalysis of the association, stratified by whether the MF measurement was conducted on a typical day of pregnancy (more representative of MF exposure in pregnancy) or a nontypical day (less representative of MF exposure in pregnancy, thus more measurement errors) provided evidence supporting this argument. As shown in **Table 4**, we indeed observed that less measurement error (ie, measured on a typical day) led to a stronger observed association (>2.5 times risk of asthma associated with a higher maternal MF exposure level during pregnancy) compared with more measurement error (ie, measured on a nontypical day), a nonstatistically significant 31% increased risk of asthma. Therefore, had we been able to measure participants throughout pregnancy, the observed association between maternal MF exposure in pregnancy and the risk of asthma might have been stronger than that presented in Table 2.

In addition to observing an association between high maternal MF exposure during pregnancy and the risk of asthma in offspring with a dose-response relationship, we also observed a statistically significant interaction between the MF effect on asthma and the other 2 risk factors for asthma: maternal history of asthma and birth order (firstborn). A maternal history of asthma is a well-established risk factor for genetic susceptibility that has been supported by the results of both genome-wide association studies and candidate gene studies.[2,5] Such an interaction with known risk factors for asthma not only revealed possible synergistic adverse effects between prenatal MF exposure and these 2 risk factors on the risk of asthma but also provided further support for the underlying association between maternal MF exposure in pregnancy and the risk of asthma in offspring. Synergistic factors themselves are often independent risk factors.

In conclusion, the findings of the present study open up a new area in understanding the risk factors for asthma and the health effects of ubiquitous MF exposure, especially during pregnancy. As with any epidemiological study, these findings need to be replicated. If confirmed, they have the potential to inform new intervention strategies to reduce asthma, the most prevalent chronic disease among children.

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Correspondence: De-Kun Li, MD, PhD, Division of Research, Kaiser Permanente, 2000 Broadway, Oakland, CA 94612 (dkl@dor.kaiser.org).
Author Contributions: *Study concept and design:* Li. *Acquisition of data:* Li and Odouli. *Analysis and interpretation of data:* Li and Chen. *Drafting of the manuscript:* Li. *Critical revision of the manuscript for important intellectual content:* Chen and Odouli. *Statistical analysis:* Li and Chen. *Obtained funding:* Li. *Administrative, technical, and material support:* Li and Odouli. *Study supervision:* Li.
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Report of Electrical Investigation at the Jerry Martin Dairy Farm

Donald Hillman,[1] Dave Stetzer,[2] Louis R. Hillman,3 and P. Smith[4]

[1]**Donald Hillman, Ph.D., Professor Emeritus, Dept. of Animal Science (Dairy), Michigan State University, 750 Berkshire Lane, East Lansing, MI 48823**
[2]**Dave Stetzer, *Stetzer Consulting LLC*, Power Quality Specialist, Industrial Electrician, Blair, WI 54616**
[3]**Louis R. Hillman, M.S., Associate Investigator, 750 Berkshire Lane, East Lansing, MI 48823**
[4]**Phillip Smith, Electrician-Journeyman, Observer, Lansing, MI 48917**

INTRODUCTION

Extraneous electrical current (uncontrolled current in places where it should not be) was measured at various locations on a dairy farm served by a single-phase wye (Y) grounded-neutral distribution system. The Martin family had 147 cows on DHIA (Dairy Herd Improvement Association) records. Dairy farmers at this and other locations using the same utility had experienced inferior health, excessive and ineffective veterinary treatment, and low milk production of cows relative to the breeding potential of the herd. Electrical utility experts had tested 10 days earlier and said no unusual voltage was found on the farm. No testing reports were provided by Thumb Electric, Inc. Utilities in Michigan and other Midwest states test for peak voltage only and fail to measure 25-50% of current that occurs from nonsinusoidal waveforms that are on the power lines. Our purpose was to determine the magnitude of voltage, frequency, and current at cow contact and other locations on the farm and determine the quality of electricity serving the farm. Herd performance had improved at other locations when power quality was improved by installing devices to remove power-line harmonics and radio-frequency nonsinusoidal waveforms from the electrical supply or by moving the cattle to another location.

INVESTIGATIVE PROCEDURES

A Fluke® 199c Scopemeter, 200 MHz Oscilloscope, sampling rate 2.5 GS/s (Giga Samples per second), and sure-grip banana nose Test leads with PNC Ethernet extension cables were used, as necessary, to measure voltage and frequencies. A Fluke® Model 80i110s current clamp attached to the oscilloscope measured current (amperes) and frequencies. Data were recorded on site, to a Dell® Studio laptop computer, plotted and printed using Flukeview® 4.2 software. An AEMC Model 3730 ammeter clamp measured current on the Primary Neutral-to-Earth (PN-E) and Secondary Neutral-to-Earth (farm side). Aluminum 4"x 4"x 3/8" plates bolted to a test wire were electrodes in water tanks and on the floor with a 200-pound rubber-booted man stepping on the plate at the wet-manure, lightly covered floor sites to insure contact with the ground. The step-potential method was recommended by Advisors to the Minnesota Public Utilities Commission (1996). A 4-foot length, 3/8" diameter copper rod was driven into the ground at a remote site connected to a 50-foot shielded wire that served as a common ground for the oscilloscope in other measurements.

RESULTS

Current entering the earth at the transformer pole, Primary Neutral-to-Earth downground was 10 milliamperes (mA) measured with the AEMC Model 3730 Current clamp. The scopemeter measured 250 milliVolts PNV-Earth to a remote ground stake. Resistance at the utility down ground was 19 Ohms.

Figure 1 displays the distorted voltage waveform from the utility Primary Neutral-to-Earth at the transformer pole. Note that the duration of the voltage spike at the cursors was 0.05 ms (milliseconds) in the Datablock. This represents a 20 kiloHertz (20,000 cycles per second) riding on a 60-Hz waveform.

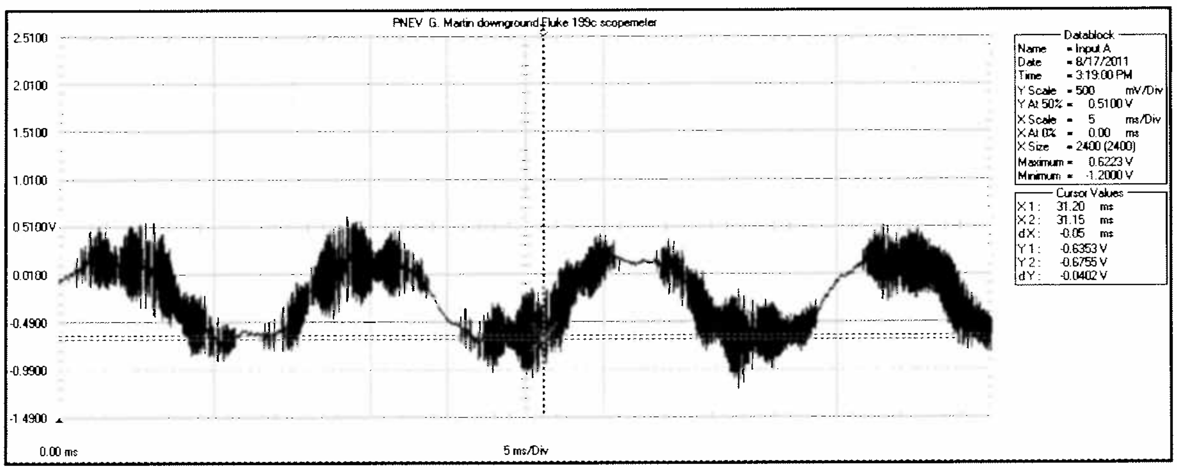

Figure 1. The distorted waveform was measured at the Jerry Martin farm, 200 North Frieberger Road near Sandusky, MI, with a Fluke 199 Scopemeter, 8/17/2011, at 3:19 PM. The meter was connected from the primary downground at the transformer pole to a remote ground rod. A 20-kHz (kiloHertz) wave (0.05 milliseconds duration) was riding on the distorted 60-cycle sine wave. Voltage of the waveform was 1.5103 V peak-to-peak. Dairy cows are sensitive to peak-to-peak voltage, not RMS nor peak voltage (Aneshansley & Gorewit, ASAE Paper 99-3152, at Toronto, Ontario, Canada, 1999).

Figure 2 displays the voltage waveform recorded with the Fluke 199c oscilloscope from the water in the cow-drinking water tank, near the milking parlor. The distorted waveform measured 155.48 mV peak-to-peak in the electrode in the water. Cows refuse to drink sufficient water for high-level milk production when electrical spikes are in the water, first observed by Craine et al in ASAE report 69-814, Effects of distribution system ground voltages on domestic water lines. Similar observations were reported in herds on Michigan farms by Hillman et al (2011) in MPSC Case No. U-16129 currently before the Michigan Public Service Commission.

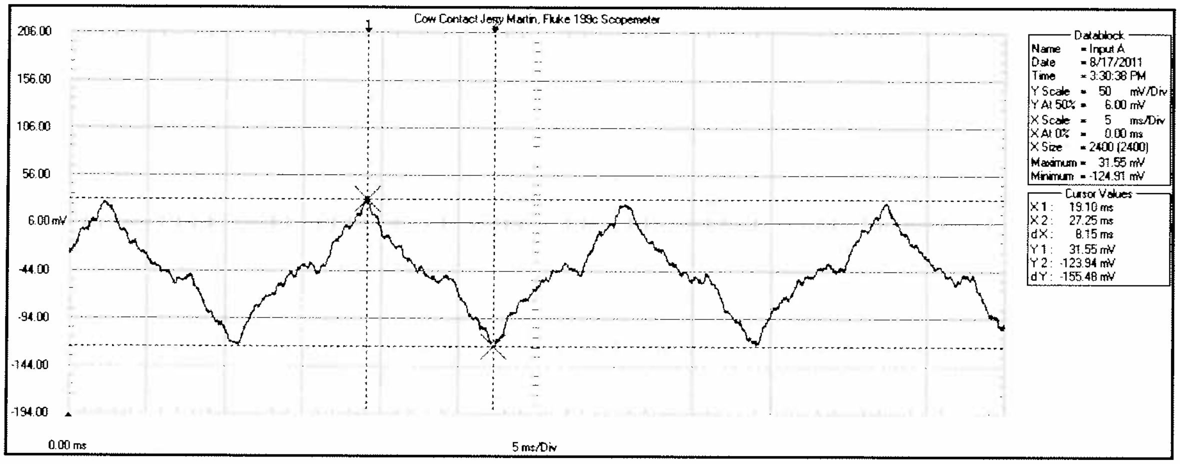

Figure 2. The distorted waveform was measured at cow contact (Water in tank to rear hoof) on the Jerry Martin farm near Sandusky, MI, with a Fluke 199c Scopemeter. The distorted waveform measures 155.48 mV peak-to-peak in the water. Cows refuse to drink sufficient water for high-level milk production with electrical spikes in the water. Craine et al (ASAE), Effects of distribution system ground voltages on domestic water lines, 1969, ASAE Paper No. 69-814, St. Joseph, MI 49085.

Figure 3 displays the frequency spectrum of voltage in the cows' water tank from Figure 2. In addition to the 60 Hz (59.9 Hz) fundamental frequency, a 3rd Harmonic (179.7 Hz), a 5th Harmonic (299.5 Hz), and a 7th Harmonic (419.4 Hz) plus many other frequencies were recorded from the water in the tank, that were contributing to the distorted voltage waveform.

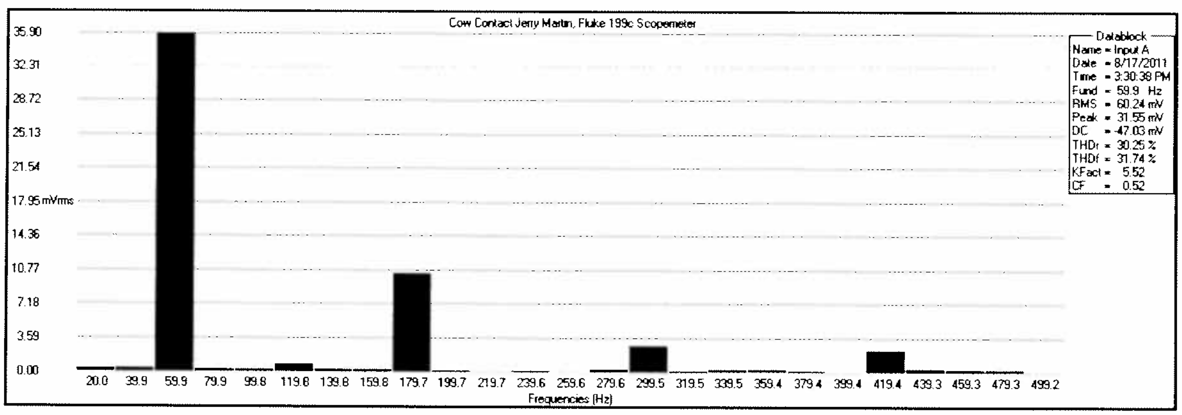

Figure 3. The frequency spectrum of voltage (from the waveform in Figure 2) in the drinking water tank for cows. In addition to the 60-Hz (59.9 Hz fundamental frequency), a 3rd harmonic (179.7 Hz rms), a 5th harmonic (299.5 Hz), a 7th harmonic (419.4 Hz), and many other frequencies were contributing to the distorted voltage waveform. Harmonics are whole number multiples of fundamental 60 Hz. The 3rd, 5th, and 7th harmonic currents were associated with childhood leukemia (cancer and brain tumors) in Denver, Colorado (Kaune et al, Bioelectromagnetics 23:177-188, 2002), and with decreased milk production and impaired health of dairy cattle in Midwest herds (Hillman, Stetzer, et al, ASAE Paper No 13-3116, Las Vegas, NV, 2003).

Harmonics are whole number multiples of the 60 Hertz (fundamental frequency) voltage power supply. The 3rd, 5th, and 7th Harmonic currents were associated with childhood leukemia in Denver, Colorado, during a study conducted by Kaune et al, published in Bioelectromagnetics 23:177-188, 2002. The 3rd, 5th, and 7th Harmonics measured from step-potential in cow stalls were associated with statistically significant decreased milk production, and impaired health of dairy cows in Midwest herds (Hillman et al, ASAE presentation paper No. 13-3116, Las Vegas, NV, 2003.

Figure 4 displays the waveforms measured fom the 120-volt receptacle in the barn of Jerry Martin family farm, 200 Frieberger Road, Sandusky, MI. The waveforms were captured with a Fluke® 199c Scopemeter oscilloscope. Channel A was connected to the 120-Volt potential. Channel B was connected to the same potential, except through the Graham Ubitquitous filter. The filter removes the 60-cycle per second (Hz). The area between cursors, 0.02 milliseconds represents a frequency of 50 kiloHertz (50,000 cycles AC per second). Energy above 1.7 kiloHertz dissipates internally to the human body according to Robert Kavet (2000, 2005) in reports to NIEH (National Institute of Environmental Health) published in Bioelectromagnetics Vol. 21, and 26-S on *"**The possible role of contact current in cancer risk associated with residential magnetic fields**,"* as do many other frequencies.

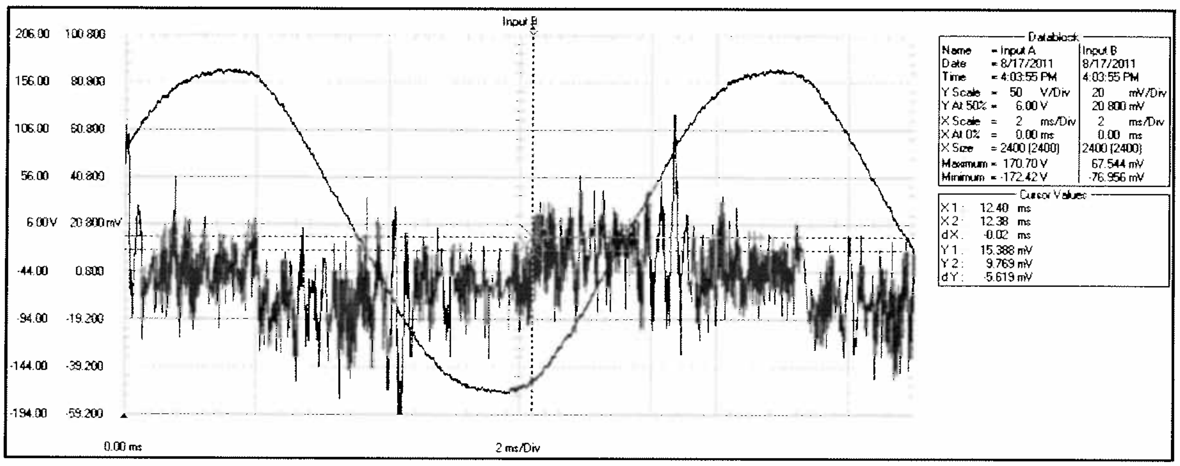

Figure 4. These waveforms were measured at the 120-volt outlet in the barn of Jerry Martin, 299 Frieberger Road, near Sandusky, MI, with a Fluke 199c Scopemeter. Channel A was connected to the 120-volt potential. Channel B was connected to the same potential, except through the Graham Ubiquitous filter (removes the 60 cycle). The area between the cursors represents a frequency of 50 kiloHertz. Energy above 1.7 kiloHertz dissipates internal to the human body (Kavet, 2000, 2005). The number on the microsurge meter was 852 plugged into the same outlet; microsurge numbers should be <50.

The number on the Graham/Stetzer Microsurge meter was 852 microsurges, and was fluctuating rapidly when plugged in to the same outlet. Microsurge numbers should be less than 50 and often read 10-20 when frequency filters are used in the outlets.

DISCUSSION

The single-phase lines serving the J. Martin farm at 200 Frieberger Road, Sandusky, MI are heavily polluted with power line harmonic and radiofrequency voltage and current. The frequencies recorded from the Primary Neutral downground at the transformer pole are similar but somewhat lower magnitude than we measured from the neutral of the 3-phase line at a neighboring farm about 0.4 miles North, earlier the same day. The 3-phases deposit more frequency distorted PN-G current than the single phase, perhaps because three contaminated phases are fed into a single neutral. Secondly, the very small neutral wire from 1-phase of the 3-phases serving the transformer pole at the Martin farm and home may be limiting the electrical noise (dirty electricity) that it can transfer to the Martin service. On the other hand, the neutral wire may be too small to carry all of the neutral current residual back to the substation as it should.

Investigators observed a large radio transmission communication antenna just south of M-46 on Frieberger road, 0.2 miles from the Martin farm. The communication tower is approximately 200 feet from the Thumb Electric 3-phase transmission line that serves Ken Zimmerman, Jerry Martin, and single-phase lines on Argyle Road where a dairy farmer, a beef cattle producer, and neighbors have filed complaints of excessive electricity in the animal and human environment causing unwanted harmful effects on animals and families, as provided in Michigan Public Health Code Act 368 of 1978.

Wind powered generators produce alternating current (AC) that is converted to direct current (DC) for storage as in a battery to provide a uniform supply whether the wind blows fast or slow, and then the DC is reconverted to AC using switch mode technology. Wind power electricity has been recorded as distorted current (noise or dirty electricity) on the primary neutral and phase wires of customers connected to the utility (Stetzer, unpublished). A large number of wind power generators have been and are currently being installed in Huron and Sanilac Counties. TEC and other utilities may need to monitor the quality of electricity from those sources and install power conditioning practices as necessary.

Mitigation of Power Quality Interference from Power Supplies

Barry Kennedy listed nine categories of power conditioning equipment that utilities can use to mitigate inferior quality power after first determining the source(s) of the problem as follows: Surge suppressors, Noise filters, Isolation transformers, Low-voltage line reactors, Various line voltage regulators, Motor-generator sets, Dual feeders with static transfer, Uninterruptible supplies (UPSs), and Harmonic filters. Because at least two problems have been identified: (1) primary-neutral wires are not adequate to return the residual current to the substation since the utility is depositing large amounts of current on customer premises and (2) the large amounts of dirty electricity, i.e., power-line harmonics, and radio-frequency (RF) current apparently induced on the power lines from communication antennas, 0.2 miles from the farm can be mitigated by installation of appropriate "*Noise filters*" and/or a *shielded-neutral isolation transformer (SNIT).* The IEEE (Institute of Electrical and Electronic Engineers), often considered the ultimate authority on electrical matters ,issued Rule 519, 1992, setting the voltage distortion limits (THD--Total Harmonic Distortion), maximum at 5% and not more than 3% of neutral voltage or current supplied by the same harmonic frequency. Utility engineers can determine the best course of action to mitigate these problems promptly.

Perhaps Thumb Electric executives will adopt a policy of "Prudent Avoidance," meaning that they will consider animal and human health above "profit only" in designing and evaluation of their electrical system. Since public research from universities provide little or no information about the health effects of EMF and the public information system, e.g. schools, County Extension Services of State Universities, and government agencies, e.g., the MPSC, offers no scientific information about Safe Hygiene for students and families, the utilities themselves led by customer demand may be the best solution for Prudent Avoidance of unnecessary electric and electromagnetic exposure.

Our data from previous studies (D. Hillman, D. Stetzer, M. Graham, C. Goeke, H. VanHorn, and C. Wilcox) reported in MPSC Case U-13934, Attorney General v Consumers Energy Company, revealed that transients, 3rd, 5th, and 7th harmonic currents resulting from Primary Neutral-to-earth voltage, measured at the feet of the cows in cow stalls, accounted for significant changes in milk production, animal health, reproduction, and death of cattle. In that research, milk production decreased as the number of transient and harmonic frequency voltage events increased daily. The information was based on step potential (voltage difference between front and rear feet) electrical data from 1705 cows in five herds for 515 days. Milk decreased at a rate of -0.063 lb (-0.028 kg) per transient event per day. Also, milk decreased as number of triplen harmonics increased daily. Triplens are composed of the 3rd harmonic and odd numbered multiples of the 3rd harmonic, i.e., 3rd, 9th, 15th, 21st, 27th, 33rd, and 39th harmonics. Animal health, reproduction, and behavior were also affected by electricity in those herds. Those findings were reported to the Michigan Public Service Commission during proceedings of Case No. U-11684 brought by the Attorney General of Michigan against Consumers Energy Company in 1998, and Case No. 13934, "In the matter on the Commission's own motion to consider the implementation of standards or other remedial measures relating to stray voltage." Our findings were reported in ASAE, Presentation No. 03-3116, International Meetings, Las Vegas, NV, 2003; the American Dairy Science Association Meeting, Phoenix, AZ; and the Canadian Agriculture and Food Engineers (CASAE-CSGR), 2003.

Similar observation of inpaired health, evident from abnormal blood values, notably low fibrinogen (a blood clotting enzyme), low white blood cell numbers in some cows, abnormal decrease of segmented neutrophils in 7 of 8 cows sampled, all 8 cows had an increase in lymphocytes, and 6 had a decrease in monocyte counts from a herd in Minnesota (Daniel

Hartsell, DVM, Duane Dahlberg, Ph.D., David Lusty, and Robert Scott, DVM, *The Bovine Practitioner,* No 28, Sept., 1994).

Charging cows with 4 and 8 milliamps current, udder to ground, resulted in increased adrenal hormone, cortisol in blood, increased heart rate and blood pressure, and a delayed release of oxytocin, the milk let-down hormone produced by the pituitary gland at the base of the brain, compared to zero (0) mA controls, in experiments by Gorewit et al (1984).

In other trials, Aneshansley et al, reported that impedance of cows decreased from about 368 Ohms of 60-Hz voltage successively at 1000, 10,000, and to about 175 Ohms when exposed to 100,000 Hertz (Aneshansley et al, ASAE, 1995, 1990). Thus, cow impedance goes down and body current goes up as frequency of current increases. The permeability of biological tissue to magnetic fields is about the same as air (J. P. Reilly, *Applied Electricity from Electrical Stimulation to Electropathology*, 1998; and Clayton R. Paul, *Introduction to Electromagnetic Compatibility, 2nd Ed.*, John Wiley & Sons, Hoboken, NJ (2006).

Aneshansley and Gorewit (1999) reported at the Toronto, Ontario, ASAE Meetings that Holstein cows were responsive to peak-to-peak voltages, but not to RMS or peak voltages. That concurs with an earlier report that cows are not sensitive to shock of voltages at about 1000 Hertz or more. Cows and other animals develop a dopioid analgesic effect charterized as dopamine in brain tissue after prolonged exposure to electric and magnetic fields (Brown, M. R., G. E. Koop, and C. Rivier, *STRESS-Neurobiolgy and Neuroendocrinology*,© Marcel Dekker, Inc.,1991).

Electrical investigators and workers are aware that radio frequency (rf), microwaves (MW), and higher frequency communication signals (EMFs) are invisible, insensible to touch, sound, and other senses. Thus, most humans and animals are not sensitive (no shock reaction) to radio-frequency and microwave magnetic fields, such as used in radio, telephone, television, and cellular telephone communications.

Since Midwest utilities do not measure and claim they are unaware of any substantial research pertaining to the electropathic-neuroendocrine effects of electric and magnetic fields, they are incapable of conducting reliable investigations or stating valid conclusions about effects of electricity on animals and man.

We also measured electricity and observed decreased milk production of 7.5 lb daily per cow per year for each of five years – average milk per cow/day decreased from 85 lb to 43 lb (150-day DHIA average) over the five-year period while the utility claimed they could find no significant stray voltage. Reproduction: AI, 1st service conception was reduced from 51% the industry average, to 28%, and death of about one-half of the herd occurred in Case No. 16129, Tensen Family Farm v Consumers Energy, currently before the MPSC. The family is awaiting a decision from the Administrative Law Judge, who replaced the previous ALJ , and decides whether the Utilities will be required to correct the quality of the power supply by making repairs to the electrical installation, or simply blame the farmers for poor management and ignore the electrical interference reported by numerous investigators.

A similar report of impaired behavior, low milk production, and unexplained death of dairy cattle was reported by Löscher, W., and G. Käs, 1998, of Conspicuous behavioral abnormalities of a dairy cow herd near a TV and Radio Transmitting Antenna, published in Prakt Tierarzt 79:5, 437-444 (Practical Veterinary Surgeon, 1998) in Bavaria. When some ten cows were moved to another location the cattle largely recovered.

Some 1300 dairy farmers filed complaints with the Michigan Attorney General in 1995 against electrical distribution companies because of extraneous, uncontrolled current affecting the behavior, health, milk production, and profitability of their dairy herds. The Michigan Public Service Commission has invoked a set of rules in MPSC Cases U-11684, and U-13934, implemented in 2006, that are incapable of causing the utilities to find or to mitigate extraneous, uncontrolled voltages at frequencies other than 60 Hz. Thus, the MPSC uses the power of the State of Michigan to enforce Laws that are deceiving to Legislators, farmers, and public officials and therefore are unjust and a disgrace to Michigan's judicial system.

The deception of utility expert investigators was revealed in MPSC Case U-16129, Tensen v Consumers Energy by testimony of fraudulent practices by witnesses for defendants. Hopefully, a new Administrative Law Judge replacing the previous ALJ will arrive at the proper conclusions, and require changes in MPSC rules and Utility conduct.

A new revelation (8/1/2011) by Medical Authorities in California copyrighted by the American Medical Association should cause action by Health Authorities in Michigan and elsewhere, reported as follows:

Re: OnLine First: The Copyrighted AMA article **Maternal Exposure to Magnetic Fields During Pregnancy in Relation to the Risk of Asthma in Offspring**

Downloaded from: **Archives of Pediatric Adolescent Medicine**

Published on-line: August 1, 2011, by Authors: De Kun Li, MD, PhD; Hong Chen, MPH; Roxana Odouli, MSPH, Kaiser Permanente, Northern California.

MAIN OUTCOME MEASURES: Asthma was clinically diagnosed among 626 children who were followed up for as long as 13 years. All participants carried a meter to measure their MF levels during pregnancy.

RESULTS FROM THE ABSTRACT: "After Adjustment for potential confounders, a statistically significant linear dose response relationship was observed between increasing maternal median daily MF exposure level in pregnancy and an increased risk of asthma in offspring: every 1 – mG [milliGauss] increase of maternal MF level during pregnancy was associated with 15% increased rate of asthma in offspring (adjusted hazard ratio [aHR], 1.15; 95% confidence interval [CI], 1.04-1.27). Using the categorical MF level ≤ 0.3 mG during pregnancy, children whose mothers had a high MF level (> 2.0 mG) had more than a 3.5-fold increased rate of asthma [aHR, 3.52, 95% CI, 1.68-7.35), while children whose mothers had a medium MF level (>0.3-2.0 mG) had a 74% increased rate of asthma, (aHR, 1.74; 95% CI, 0.93-3.25). A statistically significant synergistic interaction was observed between the MF effect and a maternal history of asthma and birth order (first born).

CONCLUSION: Our findings provide new epidemiological evidence that high maternal MF levels in pregnancy may increase the risk of asthma in offspring. "

End of AMA Article

This is an extremely important finding because Asthma is a form of impaired immunological defense mechanism of humans and other animals. The mothers in this trial were exposed to relatively low levels of EMF in the range of 0.3-2 mG, the median level.

This evidence follows another research report from Poland by Wanda Stankiewicz, Marek P. Dabrowski, Elzibieta Sobiczewska and Stanislaw Szmigielski, 2010, who reported that impairment of immune effects of EMF were more severe in patients who were already under stress from another impairment such as liver disease. Exposure to EMF causes an electropathic stress in cattle and laboratory animals, i.e., EMF increases adrenal hormones (cortisol in blood of cows and humans) causing them to be more susceptible to infectious disease, invading organisms, diabetes, heart disease, and some forms of cancer as cited in the research of Gorewit et al, 1984; Hartsell, Dahlberg,, et al, 1994; and others in France showing a sympathetic nervous system response to EMF exposure. After prolonged chronic exposure the hypothalic pituitary-adrenocortical reaction may become fatigued, resulting in parasympathetic responses, i.e lower heart rate, blood pressure, and metabolic reactions.

The risk of cancer for those within 325 meters (about 1000 feet) of 220-KV to 400-kV lines exposed to 4 mG and above was 5.6 times higher than controls. For exposure to 2 mG or less the risk was 2 times, and for 2 mG or more the risk was 2.7, and for 3 mG or more the risk of leukemia increased to 3.8 times (380%) compared to the control level (Feychting et al, 1972) .

In Denver, Colorado, in a follow-up study in a sample of 88 homes to test the relationship of electric currents to leukemia, investigators found that the ½ of households with highest 180 Hz (3^{rd} harmonic) magnetic fields were 4.0 times more likely, and the highest ½ with harmonic currents composed of 3^{rd}, 5^{th}, and 7^{th} harmonic magnetic fields (180, 300, and 420 Hz) in living areas of homes had 4.3 times more leukemia than the ½ with the lowest harmonic magnetic fields (Kaune et al, 2002).

Similarly, Japanese investigators found that children with 4.0 mG or more EMF in their bedroom were 4.7 times more likely to have ALL (acute lymphoblastic anemia) and 2.6 times more likely to be stricken with AML (acute myelocytic anemia) plus ALL compared to children with 1 mG or less in their bedroom. The investigation included 54% of the children 15 yrs and younger in Japan (Kabuto et al, 2006).

A substantial body of research implicates EMF as a cause or co-factor in many diseases, often related to the central nervous system as follows:

ALZHEIMER'S DISEASE and EMFs

1996: Drs. Eugene Sobel and Zoreh Davanipour of the University of Southern California School of Medicine, Los Angeles., reported that **medium-to-high occupational exposures to EMF result in a four-fold increase in the rate of Alzheimer's.**

1996: Dr. Maria Feychting of the Karolinska Institute, Stockholm, Sweden. **Five-times increased rate of Alzheimer's is reported with occupational exposures.** Women operating sewing machines in the textile industry were among the highest victims.

1996: An occupational study of the National Institute of Occupational Health and Safety and Johns Hopkins University **finds higher death rates from Alzheimer's with medium-to-high occupation exposures (2 mG, milliGauss and higher).**

BREAST CANCER

1987: Dr. Richard Stevens, Battelle Pacific Northwest Labs, Richmond, WA. **EMFs reduce levels of the cancer-fighting hormone, melatonin. Lower levels are associated with breast cancer.**

1989-1992: **Epidemiological studies show an increase in male breast cancer among exposed workers, especially for those under 30 years of age.** Drs. Genevieve Matanoski of Johns Hopkins University, Baltimore, MD, Paul Demers of the Fred Hutchinson Cancer Research Center, Seattle, WA, and Tore Tynes and Aage Andersen of the Cancer Registry of Norway, Oslo.

1992: Dr. Sabine John of the Technical University of Munich, Germany. **EMFs increase the rate of breast cancer mitochondrial activity.**

1992: Dr. Robert Liburdy of the Lawrence Berkeley Laboratory, Berkeley, CA. **Low levels of EMFs decrease the amount of melatonin in blood**.

1993: Dr. Wolfgang Loscher of the School of Veterinary Medicine, Hannover, Germany. **EMFs increase the number of mammary tumors in laboratory animals in a dose-response relationship.**

1993: Drs. Dana Loomis and David Savitz of the University of North Carolina, Chapel Hill. **Female electrical workers have twice the expected number of deaths from breast cancer.**

1996-1998: The Stevens and Liburdy **melatonin studies are replicated**. For the first time, **a mechanism is demonstrated linking EMFs and cancer**, i.e., that **EMF reduce the amount of the cancer-fighting hormone, melatonin.** Dr. Carl Blackman of the Environment Protection Agency, Dr. Richard Luben of the University of California, Riverside, CA, Dr. Larry Anderson of Battelle Pacific Northwest Laboratory, Richmond, WA, and Drs. Scott Davis of Fred Hutchinson Cancer Research Center, Seattle, WA, and Dr. Richard Stevens of the Battelle Pacific Northwest Labs in Richland, WA.

1996: Dr. Patricia Coogan of Boston University School of Public Health, Boston, MA. **Another occupational study links female breast cancer and EMFs.**

1997: Dr. Maria Feychting of Karolinska Institute, Stockholm, Sweden. **Woman who are under 50 exposed to EMFs above 2 mG have 80% increased incidence of breast cancer.** When limited to estrogen-receptor-positive women, the incidence is 7.4 times the risk of breast cancer above 1 mG.

CANCER, ADULT - OTHER THAN BREAST CANCER

1989: Drs. Genevieve Matanoski, Patrick Breysse, and Elizabeth Elliott, Johns Hopkins University, Baltimore, MD. **An occupational study shows increased rates of prostate, colon and lung cancers, leukemia and lymphoma.**

1992 Dr. Birgitta Floderus of the National Institute of Occupational Health, Solna, Sweden. **Men exposed to 3 mG at work have three times the expected rate of chronic lymphocytic leukemia.**

1992: Dr. Richard Lovely of the Battelle Pacific Northwest Lab, Richmond, WA. **Men using electric razors have twice the rate of leukemia.**

1994: Dr. Gilles Theriault of McGill University, Montreal. Hydro-Quebec workers exposed to magnetic fields have more brain tumors and leukemia. A second study shows that **workers exposed to transients (intense pulses of high frequency radiation) have ten times the incidence of lung cancer compared to 1.6 times increase for those exposed to magnetic fields alone.**

1995: Drs. David Savitz and Dana Loomis of the University of North Carolina, Chapel Hill. **Utility workers with the highest EMF exposures have more than twice the expected rate of brain cancer than the least exposed workers.**

1995: Dr. Birgitta Floderus of the National Institute for Working Life, Solna, Sweden. **Individuals exposed to EMFs on the job** are found to have a small, but significant, elevation in risk for many types of cancer.

1995: Dr. Nancy Wertheimer, Dr. David Savitz of the University of North Carolina, Chapel Hill, and Ed Leeper find **quadrupled rates of leukemia in houses where ground currents at the plumbing** are present.

1997: Drs. Carin Stenlung and Birgitta Floderus, Karolinska Institute, Stockholm, Sweden: Rates of **testicular cancer are doubled for the 25% of male workers with the highest EMF exposures.**

1997: Drs. Ching-Yi Li of Ju-Jen Catholic University in Taipei, Taiwan, Gilles Theriault of McGill University in Montreal, Canada, and Ruey Lin of National Taiwan University in Taipei. **A 40% greater risk of leukemia and a 70% higher risk of ALL (acute lymphocytic leukemia) are found when the exposure is 2 mG or greater. A dose-response relationship is noted.**

1996: Dr. Anthony Miller of the University of Toronto, Canada: **The leukemia risk is 11 times as high for workers exposed to both electric and magnetic fields compared to 1.6 times for workers exposed to magnetic fields alone.**

2007: Drs. Lowenthal, Tuck, and Bray, University of Tasmania Medical School, Hobart, Australia reported that **residential exposure to electric power transmission lines increased risk of Lymphoproliferative (LPD) and Myeloproliferative (MPD) Diseases i.e. Leukemias and Lymphomas were 1.3 to 4.7 times higher depending on distance and age at time of exposure <300 meters from power lines.**

CELLULAR STUDIES

Dr. Ross Adey, formerly of the Veterans Administration Hospital, Loma Linda, CA. **EMFs disrupt communication between healthy adjacent cells, with potential implication for Alzheimer's.** Similar findings were reported by Drs. Carl Blackman of the Environmental Protection Agency, Robert Liburdy of Lawrence Berkeley Laboratory, Berkeley, CA, Ewa Lindstrom of the University of Umea, Sweden, and the National Institute of Occupational Health in Umea, Sweden.

1987: Drs. Craig Byus of the University of California, Riverside, and Ross Adey, formerly of the Veterans Administration Hospital, Loma Linda, CA. **Weak EMFs increase the action of an enzyme linked to cell growth in tumors.**

1995 Drs. Reba Goodman of Columbia University and Ann Henderson of Hunter College, New York City.: **Magnetic fields induce changes in gene expression.**

1998: Dr. Faith Uckun of Wayne Hughes Institute, St. Paul, MN. **EMFs alter the activity of protein kinases, enzymes involved in both normal cell function and cancer promotion.**

1997-1998: **Four laboratories report increased DNA breaks from power frequency EMFs, with implication for cancer. The hypothesis is that: EMF-induced free radicals may lead to an increase in DNA breaks or to a disruption of an enzyme repair**

mechanism. Drs. Henry Lai and Narendra Singh of the University of Washington, Seattle, Jerry Phillips of the Veterans Administration Medical Center, Loma Linda, CA, Yog Raj Ahuga of Mahavir Medical Research Center, Hyderabad, India, and Britt-Marie Svendenstal of Swedish University of Agricultural Sciences, Uppsala, Sweden.

CHEMICAL CARCINOGENS PROMOTED BY EMFs

1991: Dr. Chris Cain of the Veterans Administration Hospital, Loma Linda, CA. EMFs act with a known chemical carcinogen to promote tumor development.

1992: **The incidence of breast tumors increases from both static and AC magnetic fields interacting with a known chemical carcinogen in Russian animal studies.**

1994: **Patients were found to be more sensitive to ELF (Extremely Low Frequency) magnetic fields if sensitive to certain toxic chemicals . The two toxins were synergistic (two toxins have greater effect than either alone).** Drs. T Wang, L. H. Hawkins, Dr. William J. Rea. *GRAZ Conference*, Also, *Chemical Sensitivity,* Vols. 2-4, 1994-97.

1995: Dr. Craig Byus of the University of California, Riverside. **Laboratory animals treated with a chemical carcinogen develop more tumors in the presence of elevated EMFs.**

CHILDHOOD CANCER STUDIES

1979: Dr. Nancy Wertheimer and Ed Leeper. **For the first time, an increase in childhood cancer is linked with power line EMFs.** This study is replicated in 1986 by Dr. David Savitz of the University of North Carolina, Chapel Hill.

1990: **The Environmental Protection Agency drafts a report concluding that EMFs are a possible potential carcinogen.**

1991: Drs. Stephanie London and John Peters of the University of Southern California, Los Angeles. **An increased risk of childhood leukemia is found with use of electric hair dryers.**

1992: Drs. Anders Ahlbom and Maria Feychting of the Karolinska Institute in Stockholm, Sweden. **Children exposed to 3 mG magnetic fields in their homes have three times the expected rate of leukemia.**

1994: Dr. Allen Kraut of the University of Manitoba, Winnipeg. **A direct correlation is found in an epidemiology study comparing electricity usage in the provinces with the rates of childhood leukemia and brain cancers.**

1996: Combined studies by Drs. Anders Ahlbom and Maria Feychting of the Karolinska

Institute, Stockholm and Dr. Jorgen Olsen of the Danish Cancer Society, Copenhagen, **show two times the rate of leukemia at exposures of 2 mG or more and five times the rate for exposures of 5 mG or higher.**

1996: Dr. Daniel Wartenberg of the National Academy of Sciences finds **consistency in eleven childhood cancer studies showing elevated risk of cancer for children living near power lines and leukemia was linearly increased as EMF increased from 2 to 3 to 4 milliGauss.**

1997: Drs. Tore Tynes and Tor Haldorsen of the Institute of Epidemiological Cancer Research at the Cancer Registry of Norway, Oslo. **Children exposed to magnetic fields 0.5 mG or higher for three or more years during the first four years of life have an increased risk of leukemia.**

1997: Drs. Jorg Michaelis and Joachim Schuz of the University of Mainz, Germany. **Children living in magnetic fields above 2 mG have twice the risk of leukemia. Children under 4 years old have a seven times increased risk**.

1998: Dr. Chung-Yi Li of the College of Medicine at the Pu-Jen Catholic University, Taipei, and Drs. Wei-Chin Lee and Ruey Shiung Lin of National Taiwan University, Taipei. **A 2.7 times risk of childhood leukemia is found near power lines in magnetic fields 2 mG or higher.**

1998: The National Cancer Institute: **studies appliance use by children and finds increased childhood leukemia rates with all 25 appliances. Appliances include video games, curling irons, microwave ovens, sound systems with headsets, electric blankets, hair dryers and TVs (sitting closer than 6 feet).** There was no increased risk for use of stereos without headphones.

2006: Dr. Michinori Kabuto et al, **found that children 15 years and younger, with 4 mG (0.4 μTesla) or more EMF in their bedroom had 4.7 times more acute lymphoblastic leukemia (ALL) and 2.6 times more acute myelocytic leukemia (AML) plus ALL than children with 1 mG (0.1 μT) or less EMF in their bedrooms** in Japan. The area covered 54% of the children and discovered 312 cases of leukemia within a study period of 2.3 years in Japan.

2007 Investigators: Evci, ED, Bilgin MD, Akgar, S., Zencirci, SG, Ergin, F., Beser, E. **found remarkable electric and magnetic fields 5 cm distant exposure from depilatory heaters, hand-held hair dryers, and hood hair-dryers in 30 Hair Dresser Salons in a Turkish City,** *Envir Monit Assess.*

HEART / CARDIOVASCULAR EFFECTS

1998: Dr. Antonio Sastre, Midwest Research Institute (MRI), Kansas City, MO. **EMFs reduce the extent of heart-rate variability (HRV) and are linked to increased risk of death from arrhythmia and heart attacks among utility workers.**

1998: Szmigielski, S., A. Bortkiewicz, E. Gadzicka, M. Zmyslony, and R. Kubacki. 1998. **Alteration of diurnal rhythms of blood pressure and heart rate of workers exposed to radiofrequency electromagnetic fields.** *Blood Press Monit* 3(6):323-330.

1998: Dr. S. Braune, C. Wrocklage, J. Raczek, T. Gailus, C.H. Lucking, published in *Lancet*, the British medical journal, **that heart rate and blood pressure of Volunteer subjects increased when exposed to a Cellular telephone signal** (900 MHz, 2 Watt, 217 Hz frame repetition rate) at the ear for 35 minutes.

1999: Dr. David Savitz **published "Magnetic Field Exposure and Cardiovascular Disease Mortality (Increased) Among Electrical Utility Workers,"** in the American Journal of Epidemiology, 149, pp.135-142, January 15, 1999.

2007: D. Hillman, PhD, D. L. Hillman DO, Wm. J. Rea MD, Dr. Y. Pan, MD, W.O. English PE, and E. Rothwell DEE found that **heart rate, blood pressure and heart-rate variability (arrhythmia) increased when residents were exposed to (a) EMF from the utility ground wire in homes, (b) near 46-kV transmission lines on a farm, and (c) during a 2-4 mG EMF challenge in a medical laboratory with controlled electrical environment.**

LOU GEHRIG'S DISEASE (ALS - amyotrophic lateral sclerosis)

1997: Dr. David Savitz of the University of North Carolina, Chapel Hill. **An occupational study finds two or three times the risk for ALS among persons exposed to EMF.**

1998: Drs. Christoffer Johansen and Jorgen Olsen of the Danish Cancer Society. A Danish **study finds two times the rate of ALS among utility workers**.

NERVOUS AND IMMUNE SYSTEM ILLS

1998: Dr. Laurence Bonhomme-Faivre of Paul Brousse Hospital, Paris. **EMF occupational exposure is linked to fatigue, depression, irritability, and diminished libido, as well as a significant reduction in white blood cells.**

1998: **Short-term memory effects are seen with power frequency exposure**. A.W. Preece, K.A. Wesnes and G.R. Iwi. "The Effect of a 50 Hz Magnetic Field on Cognitive Function in Humans," International Journal of Radiation Biology, 74, pp.463-470, 1998.

1999: **Dr. Ross Adey is to receive the 1999 Hans Selye Award from the American Institute of Stress for his work on biological effects of weak EMFs.**

2009: Austrial Social Insurance for Occupational Risks (AUVA) commissioned the Vienna Medical School to assess the Risks of Cellular Telephone signals on human health. The studies verified that **EMF from cell phone radiation have an impact on Central Nervous System, Immune System, and Protein Synthesis increased in cells**. The increase in synthesis of cytoskeleton protein (cell wall proteins) occurred without heating which excludes a thermal effect. The protein synthesis changes began at SAR 0.1 W/Kg and were significant and reproducible at 2 W/kg according to reports by Profs. Wilhelm Mosgoller, Christopher Gernere, Hugo W. Rudiger who discussed possible breakage of DNA, which had been demonstrated earlier (diagnose-funk.org) The AUVA Report (courtesy Martin Weatherall, Ca).

REPRODUCTION - *INFERTILITY* - PREGNANCY-RELATED PROBLEMS

1988: Epidemiologists at Kaiser Permanente, Oakland, CA. **Women using VDTs for twenty or more hours weekly during the early months of pregnancy have more than double the rate of miscarriage (VDTs are visual display units. computer screens).**

1990: Dr. David Savitz of the University of North Carolina, Chapel Hill. **Prenatal exposures to electric blankets result in higher risk for leukemia, brain tumors and other cancers.**

1992: Dr. Mail Hietznen of the Institute of Occupational Health, Helsinki, Finland. **Women exposed to 3 mG magnetic fields from VDTs have close to three and a half times the expected rate of miscarriage.**

1992: Dr. Jukka Juutilainen, University of Kuopio, Finland. **Women in residences where magnetic fields at the front door are 6.3 mG or greater have a five fold increase in the rate of miscarriage.**

1995: Dr. Claire Infante-Rivard, McGill University, Montreal, Canada. **Children whose mothers used sewing machines during pregnancy have up to a sevenfold increase in rates of leukemia.**

1995: Dr. De-Kun Li of Kaiser Permanents, Oakland, CA, and Drs. Harvey Checkoway and Beth Mueller of the University of Washington, Seattle. **Electric blanket usage is associated in low-fertility women with four times the rate of congenital urinary tract anomalies in their newborns.**

1995: Dr. Jan Harry of the National Institute of Environmental Health Sciences. In neonates, **EMFs are associated with an increase in gene expression and subtle changes in the neural network of the brain.**

1998: Dr. Kathleen Belanger of Yale University, New Haven, CT. **A 5-year study shows twice the miscarriage rate for women using electric blankets.**

1998: Dr. Jukka Juutilainen of the University of Kuopio, Finland. This **study designed to detect early fetal loss shows five times the miscarriage rate for women using electric blankets.**

1998: The National Cancer Institute's childhood leukemia **study shows elevated rates of leukemia in children whose mothers use electric blankets, heating pads, or humidifiers during pregnancy.**

Dairy Cattle and other Animals:

Impairments of Behavior, Milk Production, Health and Reproduction:

1969: Professors L. B. Craine, M. H. Ehlers and D. K. Nelson, Washington State University, **reported deterioration of health and milk production of a dairy herd exposed to utility ground currents attached to domestic water supplies, and reduced water consumption of cattle exposed to voltage and current.** *Agricultural Engineering*.

1982: Dr. A. M. Lefcourt and R. M. Akers, **USDA Cows subjected to 5 milliAmperes current decreased milk production 11-17% compared to controls. Resistance of cows was circa 255-261 ohms not 500-? as assumed by utility experts,** J. Dairy Science.

1984: Dr. R.C. Gorewit, D.V. Henke Drenkard, and N. R. Scott. **Cows subjected to 4 and 8 milliampere current had increased heart rate and blood pressure; Cows exposed to 8 mA had increased adrenal hormone cortisol in blood, increased heart rate, increased blood pressure, and delayed but increased levels of pitiuitary hormone oxytocin in blood.**

1985: Drs. Robert D. Appleman and R. J. Gustafson, University of Minnesota, described "**Source of Stray Voltage and Effect on Cow Health and Performance**." *J. Dairy Science.*

1987: Drs. R. D. Appleman, R. J. Gustafson, and T. Brennan **found Dairy herds increased milk production 7.5 pounds per cow per day compared to previous year when the neutral wire was isolated from the dairy of herds where the service entrance neutral was above the threshold 1 Volt or more,** .ASAE Paper No. 87-3039. Also see USDA-ARS Pub. 696,1991, Sec. 3- pp 16, 17.

1994: Dr. Daniel Hartnell, DVM, Duane Dahlberg, Ph.D., David Lusty, and Robert Scott, DVM, Minnesota, **Found blood samples from cows stressed by ground currents had decreased fibrinogin (blood clotting enzyme), decrease in segmented neutrophils,**

increased lymphocytes (impaired immunity, stress response). Suggested 0.25-Volt was maximum threshold for cows. *The Bovine Practitioner.*

1998: Dr. W. Lôscher and Dr.G. Kás investigated farmer's complaint that **cows exposed to radio/TV transmission towers emitting 512.2-936.2 megaHertz frequency and power densities of 0.003-0.46 mW/cm² in Germany, exhibited abnormal behavior and nerve disorder symptoms, had reduced milk production and reproduction before death. Autopsy revealed acute heart and circulatory collapse, bleeding from several organs, but no acute or chronic inflammatory changes.** Results were similar to stray voltage experiences in dairy herds reported in the United States.

1999: Dave Stetzer, A Wisconsin power quality electrician, **discovered that electrical supplies on power lines were contaminated with transient, harmonic, and radiofrequency currents that were disturbing cows and horses on farms with less than 0.5 Volt, but the transients were dismissed as "Not a Stray Voltage Problem" by utility experts and WPSC** (Video of cow disturbance/ voltage).

2003: D. Hillman, D. Stetzer, M. H. Graham, C. H. Goeke, K. Mathson, H. Van Horn, C. Wilcox. **Study of 1705 cows for 517 days on five farms reveals milk production decreased in proportion to step potential current from 3rd, 5th, 7th, 42nd, and triplen harmonics,** ASAE Paper No. 033116, 2003, ASAE, St. Joseph, MI.

2008: D. Hillman: **found high frequency current and low voltage in water tank caused cows to refuse to drink adequate water while milk production decreased from 85-43 pounds per cow/day, reproduction efficiency decreased to 1/3 of normal, and many cows died over a period of five years.**

2008: Fred Thiel and, Master Electrician Larry Neubauer also **found 60 Hz cow contact voltage in milking parlor and stalls exceeded Michigan MPSC** *"Rules and Regulations Governing Animal Contact Current Mitigation" R 460.2701-R 460.2707* in the same Dairy herd in West Michigan. They **measured cow resistance and found it to be about 200 Ohms, one-half of MPSC Standard 500 Ohms. Utility refused to measure current or frequency of cow-contact voltage.**

The World Health Organization (WHO) urged member countries to pass laws to reduce exposure to electric and magnetic fields in homes, schools, and workplaces (Associated Press, June 2007).

Because four of Thumb Electric Company customers have filed complaints with the Director of Sanilac County Health Department, and the Medical Director for Sanilac and eight counties in the Thumb area of Michigan, a copy of our report to Dr Russell Bush, MD, MPH, is attached. It expressed resident's concern about the quality of electricity, which was confirmed by the testing of Mr. Stetzer, the subject of this report.

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Donald Hillman, Ph.D., Professor Emeritus, Michigan State University

750 Berkshire Lane
East Lansing, MI 48823
Ph: 517-351-9561
FAX: 517-351-1944
Email: donag1@aol.com

July 30, 2011

Dr. Russell L. Bush, MD, MPH
Medical Director, Thumb Area
Sanilac County Department of Health
720 4th Street
Lapeer, Michigan 48446

Dear Dr. Bush:

Thanks for your time and kind attention while hearing the complaints of three families from East Argyle Road in Sanilac County during our meeting July 26, 2011. The families have filed complaints with Sanilac County Health Department regarding 20-25 milliGauss of electricity radiating from the Thumb Electric power lines running through their properties. The John Szymanski family has an additional issue of excessive current from the neutral conductor permeating their dairy facility and interfering with the health and milk production of their dairy herd. A copy of our report is attached. The Nichol family had a similar experience with beef cattle and with human health as reported at the meeting.

The 4th party was Mr. Kenneth Zimmerman who lives at 381 Frieberger Rd, 4 miles West (M-46) and ½ North of Sandusky. He and his family of 7 children purchased the Jack Kaufman farm 12 years ago. Mr. Kaufman had the highest milk producing herd in Michigan for several years and had at least two bulls in AI Bull studs (Michigan Animal Breeders). He was served by Detroit Edison Company. Mr. Zimmerman engaged Thumb Electric Company (TEC) when he built the new dairy facilities because they had a 3-phase line running past the farm and he believed he needed the extra power compared to DTE's single-phase.

Unfortunately, a Zimmerman daughter died of liver cancer last May. While he has not intimated that electricity had a role in her illness, he is concerned that his dairy herd is not performing as expected.

From the brief testing that we conducted at the farm, July 26, I can tell you that the electricity is saturated with radio frequency (RF) current which can be a source of interference with animal and human health and with performance. We intend to conduct more testing before arriving at any conclusions. We did observe that the 3-phase lines run near a radio transmission tower at the corner of M-46 and Frieberger Road which may be the source of high-frequency current on the farm. We have observed that RFI (radio-frequency interference) occurs rather commonly since the large incursion of electronic devices, (circa 1970s) i.e., radio, television, computers, printers and variable speed drills, battery charges, and hundreds of other electronic devices including electronics in vehicles.

The Zimmerman family has neither radio nor television in their home. However, we measured 300 Microsurges of high-frequency current in an outlet using the Graham-Stetzer microsurge meter. You will note that Dr. Sam Millham, former Washington State Department of Health Epidemiologist, used the GS meter for locating a cancer cluster in a California School as cited in his book which I gave to you. We have considerable leukemia and other cancers in Michigan but nobody bothers to determine if electrical exposure is associated with their incidence.

I am enclosing six DVDs I have prepared over the past few years; four of them were presented at Environmental Health Conferences for in-service medical credit (24.5 AMA PRA Category 1 credits) sponsored by American Environmental Health Foundation founder, Dr. Wm. Rea, MD, Cardiologist and Toxicologist in Dallas, Texas, and the University of North Texas Health Science Center, Fort Worth, TX. I was asked to become a permanent member of that faculty, but declined in 2010 because of impaired health and commitments, such as those before us, that could not be ignored.

I was Professor and Extension Specialist in Dairy at MSU for 29 years before retiring in 1982. Dairy farmers asked me to help them determine the cause of some of their problems (which included fluorosis and iodine toxicity) with health and performance of their cattle. I have spent my retirement years researching and investigating the effects of uncontrolled, extraneous electricity (electricity where it should not be) and electromagnetic fields (EMF) on cattle, other animals, and man. This research was initiated when hundreds of Michigan farmers became involved in "stray voltage" cases and I was asked to calculate losses for over 100. Most of the cases were settled "out of court" thus depriving fellow citizens any knowledge of their findings.

Because electricity gains access through peripheral nerves to the central nervous system (CNS) and interrupts the autonomic nervous system (ANS) controlling endocrine glands that affect every function of the body, I have termed the problem, *The Electropathic Stress Syndrome*. Effects of stress on pituitary and adrenal hormone changes on animals and man were first described by Dr. Hans Selye, University of Montreal, in the 1950s. Dr. Andrew Marino et al (1972) demonstrated that exposure to low levels of induced electricity from overhead caused similar changes of corticosterone and other blood values in laboratory animals. Shocking of dairy cows at the udder with 4 and 8 milliamperes (mA) of 60-Hz current compared to 0 (zero) controls caused increased heart rate and blood pressure, and increased cortisol (adrenal hormone) in the blood. Release of oxytocin, the milk let-down hormone, was delayed by 8 mA electricity (Gorewit et al, 1984). Failure of cows to milk out completely was a common complaint of dairymen whose cows were suffering from stray voltage, as reported by Appleman and Gustafson (1985); and Whittlestone, W. G., in New Zealand had demonstrated electrical interference with the milk ejection hormone in 1951.

Professor Javier Burchard, DVM, Ph.D., and colleagues at McGill University, Montreal, Quebec, conducted a series of experiments exposing dairy cattle to 10 kV/m and 30 μT (microTesla) 60 Hz electric and magnetic fields, the results of which were published in *Bioelectromagnetics* 24:557-562, 2003, and the *Proceedings of the Stray Voltage and Dairy Farms Conference* sponsored by Cornell University Extension Service and ASAE, 2003.

Our study of 12 herds, "*Relationship of Electric Power Quality To Milk Production of Dairy Herds*," reported to the American Society of Agricultural Engineers (ASAE), Presentation Paper #03-3116, Las Vegas, NV, 2003, is enclosed and recorded on a DVD enclosed. Similar presentations were given at the American Dairy Science Association, Phoenix, AZ, and the Canadian Society of Food and Agricultural Engineers, Montreal, Quebec, 2003.

We studied the effect of a *Shielded-Neutral Isolation Transformer* installed between the Utility power supply and a dairy facility in Virginia and reported the results of eliminating the radiofrequency (rf) current on recovery of lost milk production and animal health at the International Conference on Production Diseases of Farm Animals, hosted by the College of Veterinary Medicine, Michigan State University in 2004 (DVD presentation is enclosed).

Also, with assistance of Electrical Engineer, William English, I studied the radiation of electricity from a 46-kV transmission line and traveled with Mr. Leo Chick to Dallas, TX, to confirm the cause of his health problem. There, Dr. Wm. Rea, MD, Cardiologist and Toxicologist, exposed him to a low-level of EMF (2-4 milliGauss) less than the 4.6-5 mG exposure under the transmission line calculated by Consumers Energy engineers. Dr. Rea recorded the increased heart rate, decreased Variability of the Heart (ECG) response resulting in arrhythmia, and hypertension as in the Chick Farm Report. We found 25 or more references to effects of EMF on cardiovascular responses in the literature, particularly during occupational exposure as in the electrical industry. We had searched for doctors in Michigan who could have or would measure the effects of low-level electricity on human heart rate or health, but none were found who had such experience.

While searching the bioelectric and medical literature about EMF effects on cattle, it soon became apparent that a large amount of literature was available on library shelves about effects of electricity on humans that had not been analyzed nor presented to the public. Thus, I have devoted my retirement years to pursuing that goal and to assisting citizens who believed they were suffering from electrical exposure by measuring electric current in homes, schools, and workplaces, and reporting to electric companies and to government officials, e.g., the Michigan Public Service Commission which was established by the Legislature to regulate electric utilities for protection of citizens.

Human Sensitivity to Electromagnetic Fields – Dr. W. Rea et al. (1991) screened 100 patients under environmentally controlled conditions for sensitivity to various electromagnetic frequencies (0.1 Hz to 5 MHz) and found 25 patients who reacted to active challenges but did not react to blanks. The 25 were re-challenged and 16 (64%) reacted positively to the active challenge. When evaluating frequency response, 31% of patients reacted to 0.1 Hz, 75% of the 16 patients reacted to 1 Hz, 75% to 2.5 Hz, 69% to 5 Hz, 69% to 10 Hz, 69% to 20 Hz, 63% to 60 Hz, and 69% to 10 kHz, 38% to 100 kHz, 50% to 1 MHz, and 31% reacted to 5 MHz. The intensity was circa 2900 nanoTesla (nT) at the floor level, 350 nT at the level of the chair seat and patient's knees, and 70 nT at hand level. The exposure period lasted approximately 3 minutes per challenge. Other details are in the report: *Journal of Bioelectricity* 10(1&2), 241-256 (1991).

The principal signs and symptoms produced in EMF challenge experiments were:

1. Neurological (tingling, sleepiness, headache, dizziness, unconsciousness)
2. Musculoskeletal (pain, tightness, spasm, fibrillation)
3. Cardiovascular (palpitation, flushing, tachycardia, edema), bleeding from nose*
4. Oral/Respiratory (pressure in ears, tooth pain, tightness in chest, dyspnea)
5. Gastrointestinal (nausea, belching)
6. Ocular (burning and tearing of eyes, interoculatory pressure, possibly glaucoma*)
7. Dermal (itching, burning, prickling pain)
8. Most reactions were neurological. Signs and symptoms of all patients were positive as was the autonomic nervous system dysfunction, as measured with the iriscorder (measured changes in pupil dimensions and reactions)
9. Examples of changes during the experiments were a 20% decrease in pulmonary function and a 40% decrease in heart rate

10. In the 16 patients with positive reactions to EMF challenges, two had delayed reactions; gradually became depressed, and finally became unconscious. Eventually, they awoke without treatment. Symptoms lasted from 5 hours to 3 days.

*Observations of other physicians.

I soon learned that Utilities were not interested in scientific proof that their product (electricity) permeated biological tissue essentially the same as it is conducted through air. I was asked by Assistant Attorney General Robert Mol to assist him and J. Peter Lark to accumulate the "stray voltage" information during Attorney General Frank Kelley's complaint against Consumers Energy (alias Consumers Power) in 1998, which I did *pro-bono* for 2-years. Assistant AG Michael Moody became the prosecuting attorney for the Attorney General, when Kelley retired R. Mol was transferred to the insurance division and Jennifer Granholm was elected AG and later became Governor.

Gov. Granholm appointed J. P. Lark to chairman of the MPSC, and he manipulated the MPSC "Rules and Regulations Governing Animal Contact Current Mitigation, Exhibit A" (enclosed). Unfortunately, several of the Rules are not consistent with scientific observation and are deceptive to farmers, electrical authorities, and the Legislature. Thus, we have the power of the State enforcing faulty Rules that are highly favorable to electric utilities and deceiving farmer complainants that they have no problem. Those facts were revealed in MPSC Case U-16129, Tensen Family Farm vs. Consumers Energy currently before the MPSC. Dairy farmers and other livestock farmers can lose their business because impaired animal health, decreased production, and increased extraordinary expenses caused by faulty current delivered onto their premises by the utility while the utilities claim they have no problem.

Chronic EMF exposure is a cause for chronic diseases such as chronic heart arrhythmia, high blood pressure (hypertension–considered epidemic by the American Heart Association), cancer, and diabetes; and all are increasing at epidemic proportions in the USA, according to the American Cancer Society and American Diabetes Association, 2005 reports. The percentage due to EMF is unknown, but hypertension has been increasing at every age from 20 years through age 85, according to the AHA. Based on the sensitivities of people recorded by Dr. Rea (1991), perhaps 16% of the random population was sensitive to EMF. Residents of Argyle Road exhibited the chronic electropathic stress syndrome in their complaints.

Dr. Martin Blank, Columbia University, NY, and Dr. Ted Litovitz, Catholic University of America, Washington D.C., have studied the stress reactions to electric and magnetic fields, summarized as follows:

- the stress response has been demonstrated in many cells and linked to changes in DNA and chromosomes.
- there are similarities in stress protein synthesis stimulated in the non-thermal ELF and thermal RF frequency ranges.
- the biochemical mechanism that is activated is the same non-thermal pathway in both ELF and RF and is not associated with the thermal response (BioInitiative Working Group, 2007).

The electropathic stress syndrome concept of a neuroendocrine response to EMF has also been demonstrated by protein changes in blood of animals, i.e., immunoreactive (IgA) proteins in cows, increased albumin in blood of laboratory animals, increased protein in cerebrospinal fluid, and changes of steroid hormones, of pituitary, pineal, adrenal, and genital glands of both cows and rats (Marino et al., 2000; Guy et al., 1985; Heynick et al., 2003; Reinemann et al., 1999).

Blood-Clotting Time increased 26.5% when anesthetized dogs were irradiated with 2450 MHz microwave EMF at the abdomen above the liver. When irradiation was repeated at 10-minute intervals, blood clotting time decreased 25% less than controls and 39.2% less than after single radiation (Richardson, A. W., 1959). The finding suggests that changes in blood viscosity may account for some of the "stress proteins" identified by Blank (2007) and Litovitz et al. (1993) caused by EMF exposure and electropathic stress syndrome that occurs in humans and livestock. Cerebral hemorrhage and coronary artery occlusion may be affected by microwave changes in viscosity of blood.

Dr. Litovitz warned members of congress in a Congressional Staff Briefing, July 12, 2001, that "a single exposure to EMF, such as visiting next to a high power line, may not do any harm; but if you are exposed daily, you had better move" (Litovitz video, 2001, in evidence). **This warning is a daily concern of the families on Argyle Road.** Blood viscosity is modified by medical titration with heparin, coumadin, and other drugs.

Knowledge that childhood and adult leukemia, lymphoma, and brain tumors have been associated with greater risk, odds ratios 2 to 4 times higher risk, among persons exposed to 4 mG or higher EMF (Kaune et al., 2002; Neutra et al., 2001; Ahlbom et al., 2000; Villeneuve et al., 2000; Robinson et al., 1999; Coghill, 1996; Verschaeve, 1995; Fechting and Ahlbom, 1993; London et al., 1991; Loomis et al., 1990; Thomas et al., 1987; Savitz et al., 1988; and Wertheimer and Leeper, 1979, 1982, 1995) as revealed by the following studies is a great concern for families living next to the power lines on Argyle road.

- Leukemia in children was linked to the proximity of the victim's home to power lines in Denver, Colorado (Wertheimer and Leeper, 1979). Subsequent studies have confirmed the relationship between power lines and incidence of leukemia and other cancers.
- A Back-to-Denver investigation by electrical engineers and epidemiologist (Kaune et al., 2002) confirmed that childhood leukemia was related to the intensity of electric and magnetic fields in a study of 88 homes and cancer victims compared to non-cancer homes. The engineers followed the current from the utility's down-grounds to the water pipes in homes and found that 180-Hz current (amperes) and 3rd, 5th, and 7th harmonics in the victim's principal living rooms (sleeping, eating, and family areas) were positively correlated with the incidence of leukemia. Children in the highest ½ of exposures were 4.3 times more likely to have leukemia than those in the lower ½ exposure.
- Carpenter et al. (2004) conducted a review of the EMF-leukemia research including the statistical meta-analysis of results from 35 studies (Ahlbom et al., 1993; Greenland et al., 2000; and Wartenberg, 2001) in **Table 6**. Carpenter et al. concluded that each of these studies have shown similar results: at exposure levels of 2-4 mG (0.2-0.4 μT) and above, the risk of childhood leukemia is significantly increased. Also, an apparent dose-dependent effect of EMF across these meta-analyses show that the risk of childhood leukemia increases with exposure threshold increasing from 0.2 to 0.3 to 0.4 μT.

This is important evidence supporting a "cause-and-effect" relationship, i.e., EMF causes leukemia in children. Secondly, the linear relationship indicates that the risk of childhood leukemia would increase in a continuous manner for each 0.1 μT increase in magnetic field strength as noted by Wartenberg et al. (2001).

Table 6. Courtesy of Dr. David Carpenter, Professor, Environmental Health & Toxicology, Professor Biomedical Sciences, and Director, Institute for Health and the Environment, School of Public Health, University of Albany, Rensselaer, NY (From: Bell, Rabinowitz, Baum, Gerber, and Carpenter, Testimony at the Connecticut Siting Council, Docket No. 272, March 16, 2004).

Study	**Studies/# Subjects**	**Threshold**	**Increased Risk (OR)**
Ahlbom et al., 1993	9 studies – 13,647	0.4 μT	2.0 (1.27-3.13), $P = 0.002$
Greenland et al, 2000	12 studies	0.3 μT	1.83 (1.34-2.49)
Wartenberg et al., 2001	14 studies – 9,697	0.2 μT	1.34 (1.07-1.67)

- A 2006 study showed that children exposed to > 0.4 μT (4 mG) in their bedrooms were 4.7 times more likely to be diagnosed with acute lymphoblastic leukemia (ALL) and 2.6 times more likely diagnosed with acute myelocytic leukemia (AML) +ALL compared to the reference level < 0.1 T (1 mG) (Kabuto et al., 2006). Approximately 54 percent of the Japanese population of children under age 15 were in the study. Furthermore, efforts were made to identify possible confounders, that could bias the results of these studies (e.g., air pollution, socio-economic conditions, water quality, traffic patterns, static magnetic fields, and resonance models), but no evidence of such confounders has been identified.
- A study conducted by the medical authorities in Naila, Germany, revealed that people living within 400 meters of a cell phone station, since it was erected 10 years earlier, had 3.4 times more cancer and died 8.5 years younger than people living outside of a 400-meter radius zone (Eger et al., 2004).
- EMF and NonHodgkins Lymphoma – Leukemia and lymphomas (tumors) are characterized by the abnormal proliferation and reduced differentiation of developing lymphocytes and other blood cells in peripheral blood, bone marrow, and tumor tissues. The diagnostic report for the lymphoma patient in the East Lansing study revealed: "cytogenetics tests of bone marrow cells were abnormal in culture cells stimulated by lymphoid mitogens. Two of the metaphases were abnormal due to multiple structural and numerical aberrations characterized by additional material on the short arm of one chromosome 2, trisomy 3 with one being abnormal, rearrangements of 6q, 8p and trisomy for chromosomes 7 and 18 and 2 markers. The spectrum of abnormalities are most consistent with the presence of a lymphoma or other lymphoid disorder. Skin biopsies of both lower left leg lateral and medial section morphological features were consistent with diffuse large B cell lymphoma. Otherwise, the patient was a chromosomally normal female, Karyotype 46, XX."
- Digital cell phone signals, 836 MTDA at very low intensities, 2.4 to 24 mW/kg equal to about 800 W/cm^2 power density caused DNA effects in human cells. DNA effects are defined as direct DNA damage and the rate at which DNA is repaired (Phillips, 1998).
- Induction of chromosome aberrations and microneuclei in blood cells was a sign that cell phone radiation did indeed cause 300% genetic changes in human blood cells and became significant signs of public health damage by cell phones reported by Ray Tice and Graham Hook from Research Triangle Park, North Carolina, in 1998. Their work was a follow-up of a study showing similar "comet" test genetic damage to blood cell DNA of rats exposed to radio frequency waves by Henry Lai and N. P. Singh at the University of Washington in 1994. Brain tumors were twice as high among cell phone users than in the general population, according to Carlo and Schram (2001).

Finally, the current radiating from Thumb Electric lines running through the properties of complainants is in violation of OSHA (Occupational Safety and Health Administration) regulation CPL 2-1.18A.

Currents Emitted from TEC lines along East Argyle Road Compared to OSHA Standards for Hazardous Current – Data collected from various locations below the power lines exceeded the level considered "hazardous current" by the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor Directive CPL 2-1.18A, Standards to Prevent Personal Electrical Injury – effective date: October 20, 1997. *Enforcement of the Electric Power Generation, Transmission, and Distribution Standard* states:

> **"Hazardous energy means a voltage at which there is sufficient energy to cause injury. If no precautions are taken to protect employees from hazards associated with involuntary reactions from shock, a hazard is presumed to exist if the induced voltage is sufficient to pass a current of 1 milliampere (mA) through a 500-Ohm resistor. The 500-Ohm resistor represents the resistance of an employee."**

OSHA may not have been aware that exposure of cows to 1 mA for two weeks (front to rear feet) caused blood serum Interleukin-1 levels to tend to increase ($P = 0.097$). Interleukin-2 levels tended to decrease ($P = 0.107$), serum immunoglobulin-A (IgA) increased ($P < 0.015$), and cortisol decreased ($P = 0.003$) in controlled experiments (Reinemann, 2003; Reinemann, Sheffield et al., 1999). Therefore, 20-25 milliGauss EMF derived from 1.6 to 2.0 amperes per square meter by the Trifield® Gauss Meter, is not a safe exposure level for animals or humans under the TEC lines.. Induced current near the TEC lines exceeded the OSHA standards of 1 milliampere (mA) considered hazardous current (and 6 mA "Let-go" threshold). Utility ROWs are under the jurisdiction of OSHA standards.

There is much more published evidence supporting the harmful effects of excessive exposure to electric and magnetic fields; some of the most recent are included in the enclosed material. References cited are in the Chick Farm Report, November 2007. However, all the research is in vain until some responsible authority will become sufficiently informed about the issues and require the utilities, i.e., Thumb Electric Company, Inc., Consumers Energy, and others to recognize the severity and consequences of their negligent electrical permeation of private premises and the humans and animals on those premises.

Michigan Public Health Code Act 368 of 1978, Section 333.2221 of the Health Code designates County Health Departments responsible to investigate environmental health hazards, nuisances, and sources of illness, and to require responsible perpetrators to stop, as you are aware.

The several families that complained about the high levels of current along Argyle Road were grateful for your attention and will look forward to a responsible resolution of the electrical nuisance and correction of the neglected hazard by Thumb Electric Company.

If I can be of further service please call on me.

Respectfully yours,

Donald Hillman

Donald Hillman, Ph.D.
Professor Emeritus, Michigan State University

cc. Ms. Dianna Schafer, MPH, Director, Sanilac County Department of Health

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 transmitter, 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

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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).

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.

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 electrosensitive 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

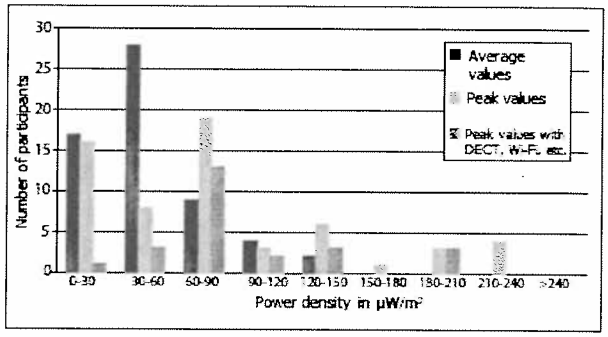

Fig. 1: Classification of participants based on average or peak value of the GSM power density level

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 $\mu W/m^2$ (peak value). It was higher in the residences of only two study participants: 270 $\mu W/m^2$ (average) or 320 $\mu W/m^2$ (peak), respectively. At these residences, the GSM exposure was approximately 10 $\mu W/m^2$.

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 $\mu W/m^2$ (Tab. 1).

In Figure 1 the exposure of the participants is given as power density levels in increments of 30 $\mu W/m^2$.

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.

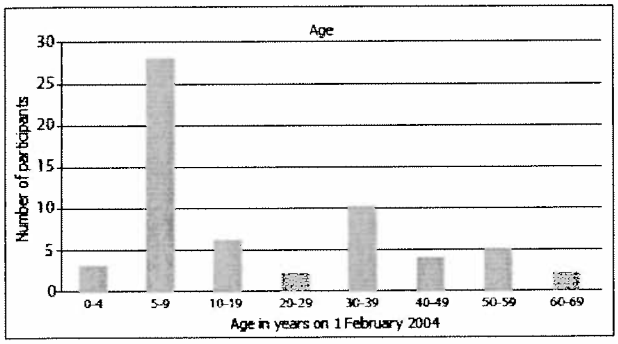

Fig. 2: Age distribution of study participants on 1 February 2004

	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

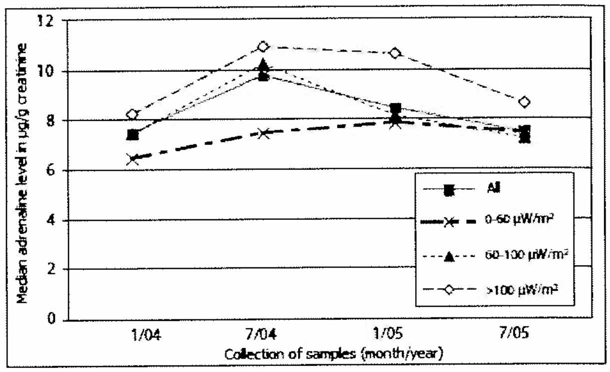

Fig. 3: Median adrenaline levels for all participating citizens of Rimbach whose cell phone base station exposure was above 100 µW/m², between 60 and 100 µW/m², or up to 60 µW/m². The power density levels refer to peak values of the GSM radiation exposure in front of a given residence.

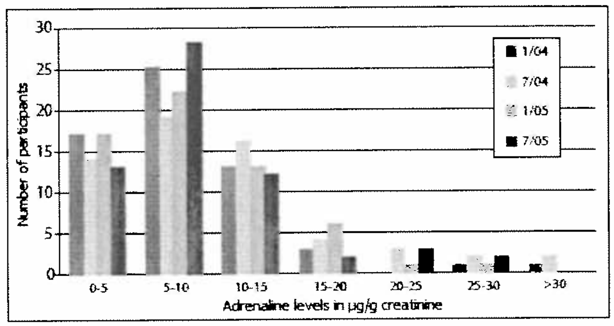

Fig. 4: Distribution of adrenaline levels in µg/g creatinine

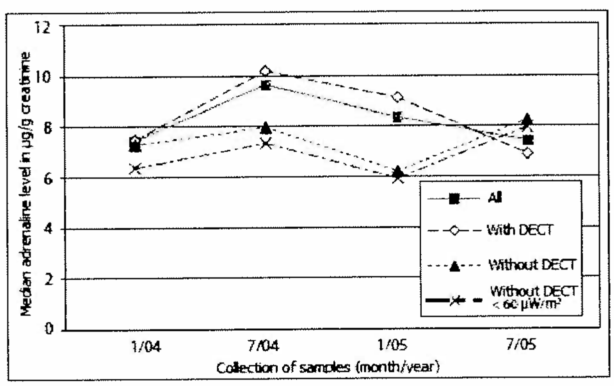

Fig. 5: Median adrenaline levels for all participating citizens of Rimbach who have a DECT phone, Wi-Fi, Bluetooth, or similar device, for those who do not have such wireless devices, and for the lowest exposure group without indoor wireless transmitters and with a GSM power density level up to 60 µW/m².

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.

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

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/m^2. 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.

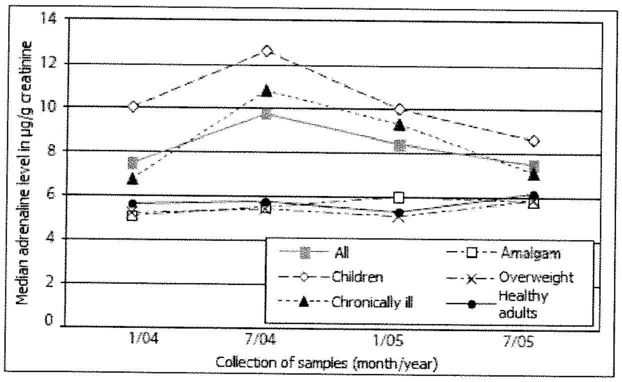

Fig. 6: Median adrenaline levels for participating children, for chronically ill subjects, for those with amalgam burden, and overweight subjects in Rimbach in comparison to the median levels of all study subjects and adults without chronic disease

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/m^2, there were 2.2 µg/g creatinine, at 60-100 µW/m^2 12.4 µg/g creatinine, and above 100 µW/m^2 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 µW/m²	Average	54.7	59.3	56.5	53.5
	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 µW/m²	Average	51.4	63.6	49.1	55.9
	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 µW/m²	Average	62.9	74.9	70.1	58.8
	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

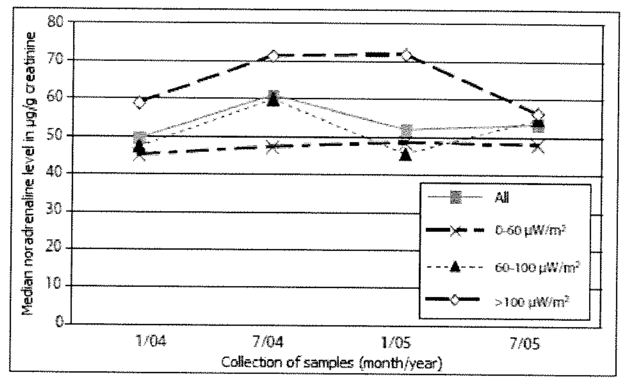

Fig. 7: Median noradrenaline levels in all participating citizens of Rimbach as a function of GSM power density levels (peak values)

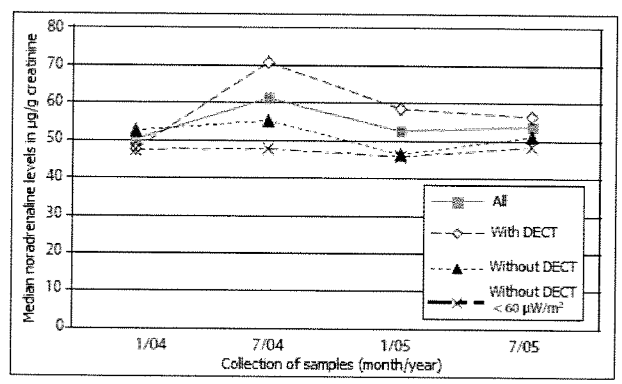

Fig. 8: Median noradrenaline values for subjects who had a DECT phone or other wireless devices at home, for those without indoor wireless devices, as well as for subjects without indoor wireless devices and with a GSM radiation exposure up to 60 µW/m^2 (peak value measured in front of residence)

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.

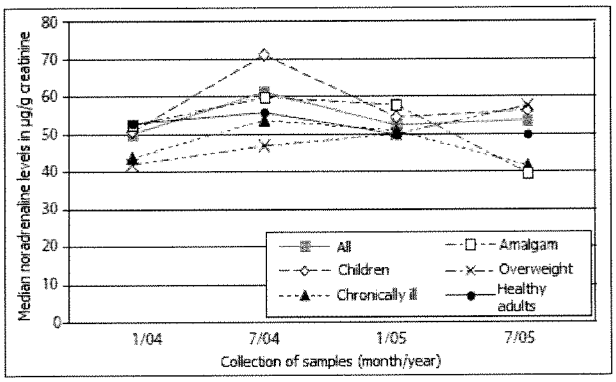

Fig. 9: Median noradrenaline levels of children, chronically ill subjects, those with amalgam burden and overweight subjects in Rimbach in comparison to the median values of all study subjects and healthy adults

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

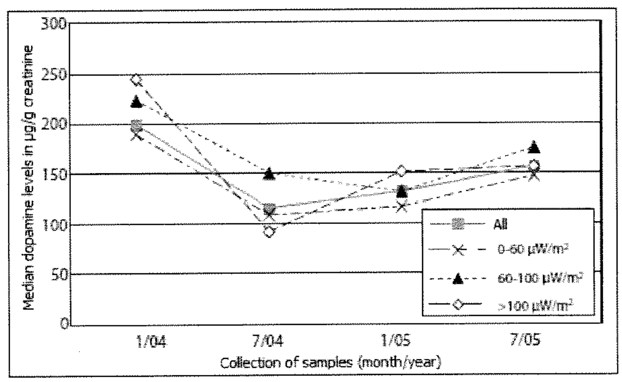

Fig. 10: Median dopamine levels for different GSM power density levels

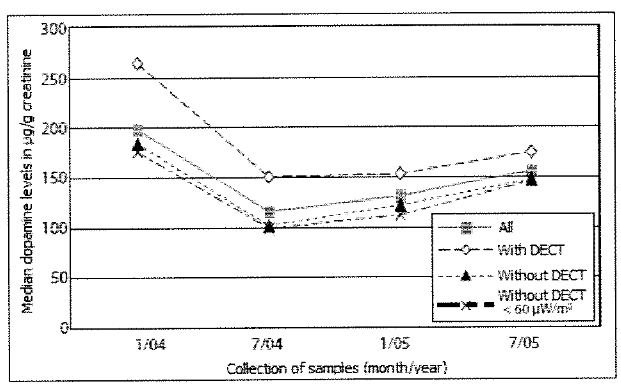

Fig. 11: Median dopamine levels for all participating citizens of Rimbach, for those with and without DECT phone, Wi-Fi, or Bluetooth, and for those without indoor wireless devices who had a GSM exposure level below 60 μW/m² (peak value).

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.

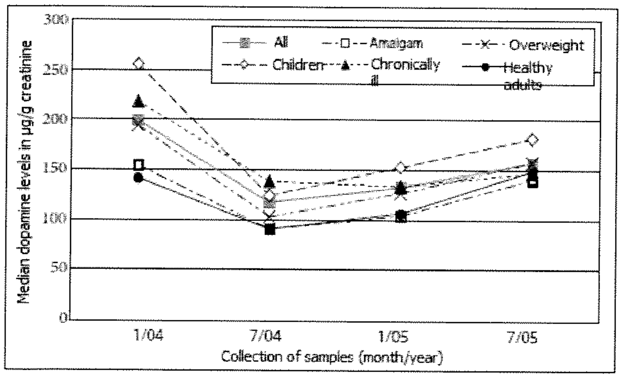

Fig. 12: Median dopamine levels of children, the chronically ill, with amalgam burden, overweight subjects, and healthy adults in Rimbach

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

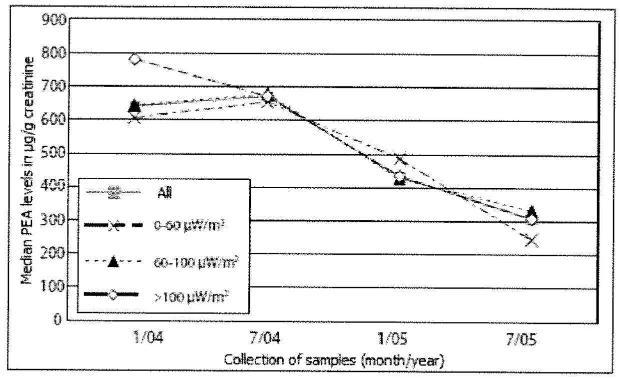

Fig. 13: Median phenylethylamine (PEA) levels for various GSM power density levels

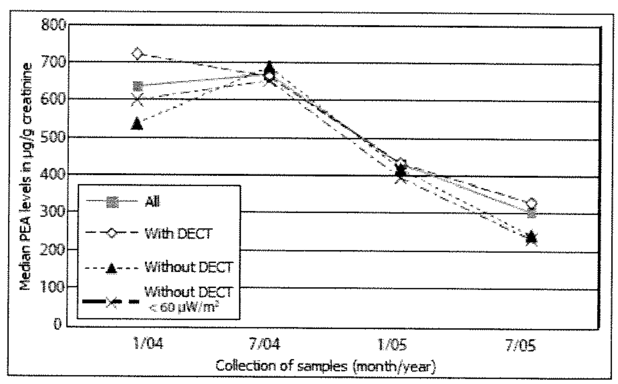

Fig. 14: Median phenylethylamine (PEA) concentrations in μg/g creatinine of subjects with and without indoor wireless devices at home and subjects without indoor wireless devices with a GSM power density level below 60 μW/m²

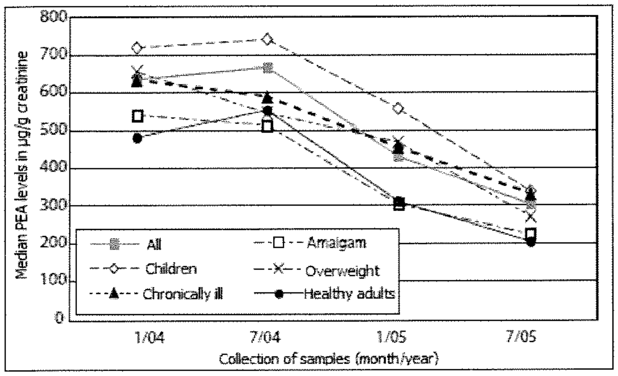

Fig. 15: Median phenylethylamine (PEA) concentrations in µg/g creatinine of children, the chronically ill, with amalgam burden, and overweight subjects, as well as health adults in Rimbach

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/m^2 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/m^2 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).

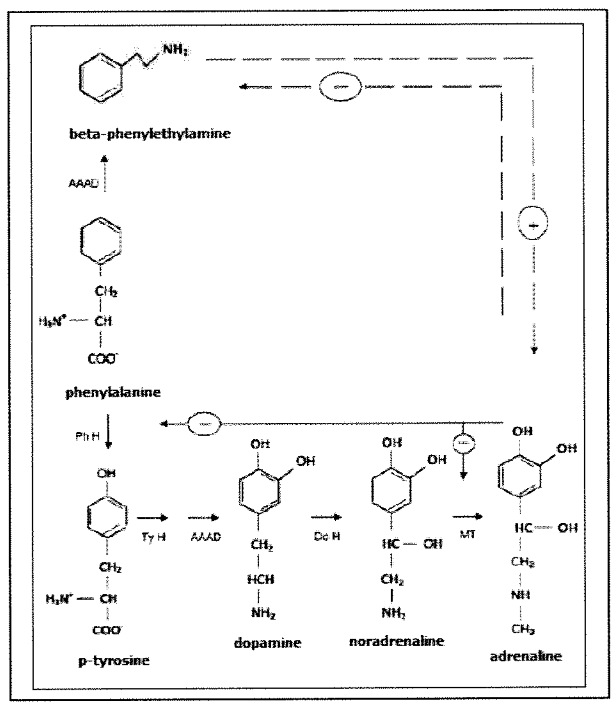

Fig. 16: Chemical structure of derivatives of the essential amino acid phenylalanine and the simplified synthesis pathways of catecholamines or phenylethylamine, respectively, simplified according to Löffler (15).

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).

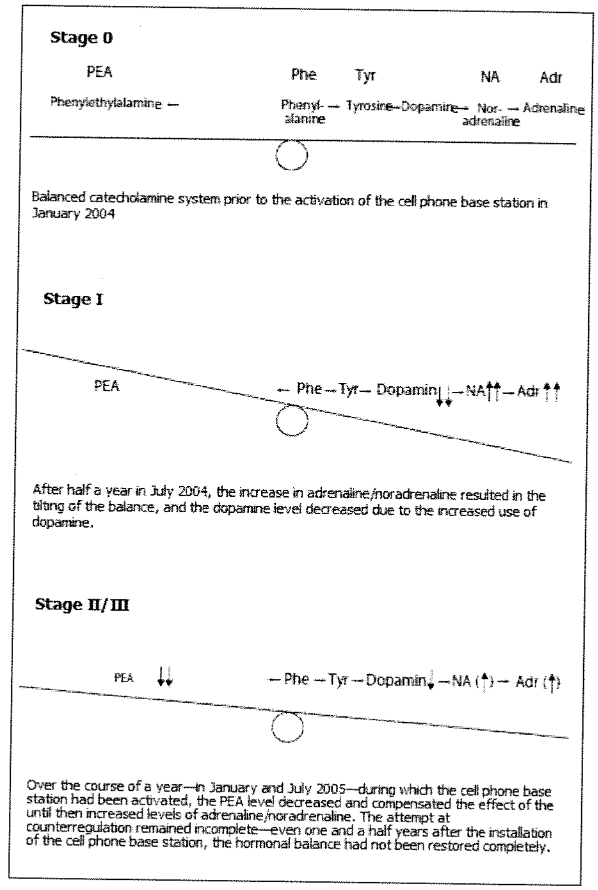

Fig. 17: Stage-like course of the stress response in Rimbach

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
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Contact:

Professor Dr. rer. nat. Dr. habil. Klaus Buchner
Straßbergerstraße 16
80809 München

Dr. med. Horst Eger (Korrespondenz)
Ärztlicher Qualitätszirkel „Elektromagnetische Felder in der Medizin - Diagnostik, Therapie, Umwelt'; (Code-Nr. 65143 KV Bayern)
Marktplatz 16
95119 Naila
E-mail: horst.eger@arcormail.de

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

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