



Magda Havas, B.Sc., Ph.D.
 Environmental & Resource Studies
 TRENT UNIVERSITY, PETERBOROUGH, ONTARIO, CANADA, K9J 7B8
 Phone: (705) 748-1011 ext. 7882, FAX: (705) 748-1569, e-mail mhavas@trentu.ca

Analysis of Health and Environmental Effects of Proposed San Francisco Earthlink Wi-Fi Network

Magda Havas, B.Sc., Ph.D.
 Environmental & Resource Studies, Trent University, Peterborough, ON, Canada
mhavas@trentu.ca

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Date: May 29, 2007
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 Regarding: Case No. 2007.0097E
 San Francisco Citywide Wireless Broadband Internet Access Network

Analysis of Health and Environmental Effects of Proposed San Francisco Earthlink Wi-Fi Network

With the advent of this proposal, San Francisco is considering converting the city into a wireless zone. Whatever decision is made should be based on the best available scientific evidence. Wi-Fi simply has not been around long enough to know how these particular frequencies and intensities are likely to affect people who are exposed to them on a daily basis for years at a time. San Francisco is on the forefront of a large population study with some unwilling participants.

The following pages present guidelines for radio frequency radiation in various countries; scientific studies that document the adverse effects of living near cell phone antennas (it is the closest we have to Wi-Fi antennas) for both humans and animals; and laboratory studies that demonstrate the harmful effects of radio frequency radiation. The levels showing adverse biological/health effects are compared with FCC guidelines and with calculations of likely exposure in San Francisco attributed to the Earthlink Wi-Fi Network as discussed in "Earthlink-Proposed San Francisco-Wide Wi-Fi Network: Observations and Calculations for Relation to Exposure Limits" prepared by Mitch Maifeld of Zenzic Research.

Many jurisdictions have had to deal with this issue and some of their recommendations regarding placement of radio frequency transmitters are also presented. While these apply to cell phone antennas they are relevant to Wi-Fi antennas. Physicians and scientists from around the world are asking governments to review the existing guidelines and to revisit the use of this technology to ensure its safety. These resolutions are summarized in the text and are presented in full in the Appendix.

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1. INTRODUCTION

During the *early part* of the 20th century the world underwent a **chemical revolution** and many new chemicals were formulated to promote the growth of plants (nitrogen), to kill pests (DDT), to keep our food cold (CFCs) and to prevent transformers from over heating (PCBs). After decades of use science showed that each of these chemicals had unwanted side effects including polluting water, killing birds, and putting holes in the ozone layer. Now these chemicals are banned or their use is strictly regulated.

During the *second half* of the 20th century the world underwent an **electromagnetic revolution** and many new frequencies were used for radio and TV broadcasting, radar, mobile phones¹ and for a variety of wireless devices. After decades of use science reported that this form of energy has unwanted side effects. Some of that evidence is provided in the pages that follow.

2. RADIO FREQUENCY GUIDELINES

Municipal councilors, who approve requests for the placement of antennas² within their jurisdiction, are told by both the telecommunication industry and by the federal government that this technology is safe as long as the radio frequency exposure remains below the federal guideline. The industry calculates the exposure in a particular area for approval and, once the antennas are erected, unannounced monitoring is seldom conducted to determine whether those values are correct.

The Federal Communications Commission (FCC) (22) Guideline is similar to the international guideline ICNIRP guideline (15) and is based on **short-term thermal effects**. This guideline is based on the assumption that if microwave³ energy does not heat tissue it is not harmful. **This assumption is incorrect**. Adverse biological effects have been documented at levels below federal guidelines and there are no federal guidelines for **non-thermal effects**, nor are there guidelines for **long-term exposure**. The technological developments and uses of wireless devices are running well ahead of the policy decisions necessary to ensure their safety.

¹ The term *mobile phones* refer to both cell phones and cordless phones.

² antennas are also known as base stations and are called masts in Europe; they may be placed on tall structures or specially constructed towers.

³ Note that microwave energy is within the radio frequency band of the electromagnetic spectrum and ranges from 300 MHz to 300 GHz. In this report radio frequency radiation (RFR) will be used when referring to energy associated with Wi-Fi and cell phone frequencies.

mhavas@trentu.ca

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According to Norbert Hankin, Chief EMF Scientist, U.S. Environmental Protection Agency:

"The U.S. Federal Communications Commission, (FCC's) exposure guidelines are considered protective of effects arising from a thermal mechanism but not from all possible mechanisms. Therefore, the generalisation by many that the guidelines protect human beings from harm by any or all mechanisms is not justified." (<http://www.protectschools.org/epa%20letter.pdf>)

Organizations that set safety standards such as ANSI/IEEE or ICNIRP are quick to point out that "safe" radio frequency exposure rests on the fact that exposure is too weak to produce a rise in body temperature, or a "thermal" effect. Whether non-thermal effects occur is no longer the issue, the issue is at what level do these non-thermal effects occur and what are the safe levels of long-term exposure.

Guidelines for exposure to environmental contaminants are similar in countries around the world. If these guidelines differ the difference is often within narrow limits or relates to specific conditions unique to a particular environment or a particular population. This is not the case for radio frequency radiation.

Radio frequency guidelines vary by orders of magnitude in countries around the world (Figure 1). The FCC guideline ranges from 200 to 1000 microW/cm² based on frequency and is much higher than the guidelines recommended in New Zealand, Italy, China, Bulgaria, Hungary, Russia, Switzerland, Austria and in New South Wales, Australia. Since the science upon which these guidelines are based remains the same, one way of interpreting this discrepancy is that some countries place a greater value on science and on preventative health regulations while others may place a greater value on commerce.

A number of adverse health effects have been documented at levels below the FCC guidelines, which include altered white blood cells in school children; childhood leukemia; impaired motor function, reaction time, and memory; headaches, dizziness, fatigue, weakness, and insomnia. At the frequency in question for Wi-Fi technology the guideline in the US is 1000 microW/cm² (or 1 milliW/cm²).

The current federal guideline is based on a short-term (6-minute) heating effect. An FCC guideline based on a 6-minute exposure is unrealistic for exposure that is likely to be 24/7 for decades. However, if this guideline is extrapolated for long-term exposure, the exposure limit decreases and approaches guidelines established by other countries (Table 1).

According to Table 1, if the goal is to protect people who use a wireless computer daily for one year, their exposure should not exceed **0.07 microW/cm²** (a value similar to the Salzburg guideline) and to protect them for 10 years their exposure should not exceed **0.007 microW/cm²**.

The FCC will tell you their guideline is not intended for long-term extrapolation in this manner. However, since the FCC doesn't have a long-term guideline and since the extrapolated values fit the scientific data for long-term health effects the 0.07 microW/cm² and 0.007 microW/cm² guidelines are more appropriate to determine 'relatively safe' exposure limits for the San Francisco population until more realistic and reliable guidelines are established that include non-thermal effects.

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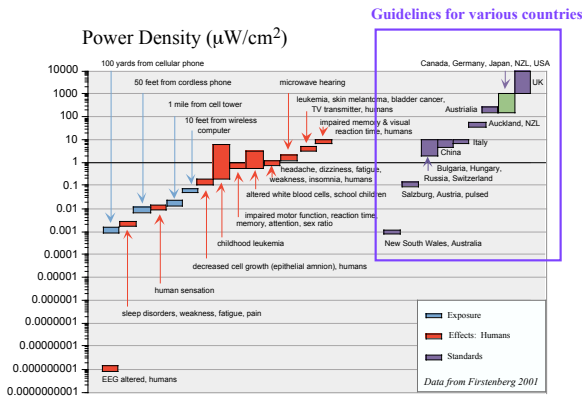


Figure 1. Guidelines, exposures and effects of radio frequency radiation at various power densities. Data from Firstenberg (6).

3. CELL PHONE ANTENNAS: HUMAN EXPOSURE

There have been no studies to date on the effects of exposure to Wi-Fi. This in itself is unusual since populations are already being exposed to this energy without any studies on how they might be affected. Since there is not yet enough information about exposure to Wi-Fi there is a need to rely on studies of exposure to similar types of radio frequency radiation. The closest case studies are those of exposure to cell phone antennas and cell phones.

As of 2007 there have been seven epidemiological studies of people living near cell phone antennas in Spain, the Netherlands, Israel, Germany and Austria and each one of these studies documents adverse health effects. Studies in Israel and Germany show increased risk of cancer and the others show increased symptoms of electrohypersensitivity. In all of the studies, exposures are orders of magnitude below the FCC guideline. Three of those studies are summarized below. Note the critical distances and, where available, exposures to RFR.

Table 1. FCC Guideline for radio frequency radiation extrapolated for longer exposure and compared with the Russian and Salzburg guidelines.

Exposure Time	Time (minutes)	Guideline (microW/cm ²)	Comments
6 minutes	6	1000	FCC guideline
1 minute	1	6000	extrapolation of FCC guideline for one minute exposure
30 minutes [casual computer use]	30	300	extrapolation of FCC guideline for 30 minute exposure
daily computer use [6 hours/day]	360	17	extrapolated FCC daily exposure limit
weekly computer use [6 hr/d x 5 d/week]	1,800	3.3	extrapolated FCC weekly exposure limit
monthly computer use [as above for 4 weeks]	7,200	0.83	Russian guideline
annual computer use [as above for 50 weeks]	90,000	0.07	Salzburg guideline
10-year computer use [as above for 10 years]	900,000	0.007	extrapolated FCC annual exposure limit
			extrapolated FCC 10-year exposure limit

Example 1: GERMANY (4)

The aim of this study was to examine whether people living close to cellular transmitter antennas were exposed to a greater risk of becoming ill with malignant tumors. The researchers found that the proportion of newly developing cancer cases was significantly higher among those patients who had lived within **400 meters (m)**⁴ from the cellular transmitter site during the past 10 years, compared to those patients living further away. They also found that the patients fell ill on average 8 years earlier. After five years' operation to the transmitting installation, the relative risk of getting cancer had increased by 3-fold for the residents of the area near the installation, compared with the inhabitants of Naila outside the area.

Example 2: SPAIN (27)

In this study the people who lived closest to the cellular antennas had the highest incidences of the following disorders: fatigue, sleep disturbances, headaches, feeling of discomfort, difficulty concentrating, depression, memory loss, visual disruptions, irritability, hearing disruptions, skin problems, cardiovascular disorders, and dizziness (See Figure 2).

Adverse health effects were reported at distances up to **300 m**. In this case, health is defined according to the World Health Organization definition as "the state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity". Note that these symptoms are commonly referred to as electrohypersensitivity (EHS).

⁴ 1 meter is similar to 1 yard.

Example 3: SPAIN revisited (25)

The study in Spain was repeated and this time exposure to radio frequency radiation was recorded. The scientists reported the following symptoms all statistically significant within **50 to 150 m** of the cell phone antenna at an average power density of **0.11 ± 0.19 microW/cm²**: headaches, sleep disturbances, irritability, difficulty concentrating, discomfort, depression, dizziness, appetite loss, and nausea.

Note that **0.11 microW/cm²** is considerably lower than the 6-minute exposure guidelines of **1000 microW/cm²** established by the FCC. This demonstrates that the FCC guideline does not protect the public from radio frequency radiation exposure.

Maifeld (22) calculated different scenarios for exposure of people in San Francisco if the Earthlink Wi-Fi Network becomes operational. All exposures are at levels below FCC guidelines. The San Francisco resident reading SFGate.com on her laptop computer while sitting on her balcony will be used for comparison. Maifeld (22) calculated that she might be exposed to **36 microW/cm²** from a combination of her laptop computer (**35 microW/cm²**) and (**1 microW/cm²**) the nearest antenna that might be 5 m (16 ft) away. Since every third node has a gateway co-located, in a worse case scenario she would be exposed to **41 microW/cm²** with the additional **5 microW/cm²** coming from the network node location. This value is 400 times higher than the exposure in the Oberfeld study (25). The power density exposure from the antenna alone (**1 microW/cm²**) is above levels where people experienced headaches, sleep disturbances, dizziness, etc at **0.11 microW/cm²**.

4. ELECTROHYPERSENSITIVITY (EHS)

Electrohypersensitivity (EHS) is now recognized by the World Health Organization (WHO) and is defined as:

"... a phenomenon where individuals experience adverse health effects while using or being in the vicinity of devices emanating electric, magnetic, or electromagnetic fields (EMFs)... Whatever its cause, EHS is a real and sometimes a debilitating problem for the affected persons, while the level of EMF in their neighborhood is no greater than is encountered in normal living environments. Their exposures are generally several orders of magnitude under the limits in internationally accepted standards." (23)

EHS is classified as a disability in Sweden and health care facilities with low exposure to electromagnetic fields and radio frequency radiation are available for sensitive individuals. Approximately 2% of the population has severe symptoms of EHS (see Appendix 1 for their stories). These people are unable to live in our modern society with its electrical and electronic appliances and with the increasing exposure to radio frequency radiation. Another 35% of the population has moderate symptoms represented by an impaired immune system and by chronic illness.

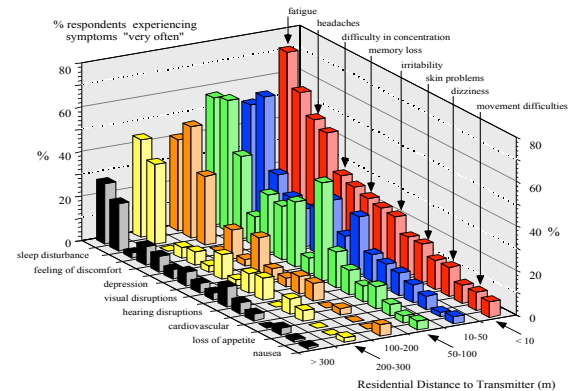


Figure 2. Response of residents living in the vicinity of a cellular phone base station in Spain (27).

Symptoms of EHS include: cognitive dysfunction (memory, concentration, problem-solving); balance, dizziness & vertigo; facial flushing, skin rash; chest pressure, rapid heart rate; depression, anxiety, irritability, frustration, temper; fatigue, poor sleep; body aches, headaches; ringing in the ear (tinnitus) and are consistent with chronic fatigue and fibromyalgia.

The Irish Doctors' Environmental Association (IDEA) in their position paper (16) on electromagnetic radiation recognizes that an increasing number of people are complaining with symptoms of EHS in Ireland. They request the Irish government to review research and management/treatments internationally; to establish a database for EHS; and to establish the strictest safety regulations for masts and transmitters (Appendix 8).

Environmental sensitivity attributed to electromagnetic exposure has recently been identified in a Canadian Human Rights Commission report (28). In this document both radio wave sickness (associated with radar workers) and electromagnetic hypersensitivities (associated with ground current, low frequency electromagnetic fields, telecommunications, and radio frequencies on power lines) are identified as environmental sensitivities.

San Francisco with a population of 744,000 people may have as many as 1500 people (2% of population) who are severely affected by radio frequency radiation and up to 26,000 individuals (35% of population) who have moderate sensitivities. Those individuals in San Francisco living in apartments at or near the level of node-only and gateway Wi-Fi locations (22) who suffer from EHS may be further adversely affected by the Earthlink Wi-Fi proposal.

5. CELL PHONE ANTENNAS: ANIMAL EXPOSURE

Animals are also affected by exposure to radio frequency radiation near cell phone antennas. Three examples are provided below. Note the levels and distances at which these associations occur.

Example 4: MICE (21)

Six pairs of mice were placed near an antenna park in Greece and 6 pairs were used as unexposed controls. They were mated 5 times. The exposed mice had progressively fewer newborns per dam and within 5 matings became irreversibly infertile. Exposure to radio frequency radiation at the antenna park was calculated to be between **1.05 to 0.17 microW/cm²**. Compare this with the Maifeld (22) calculations of **41 microW/cm²** for the woman sitting on her balcony while using her wireless computer and the **1.4 microW/cm²** for the city employee working at his desk with a wireless router.

Example 5: COWS (20)

A study funded by the Bavarian State Government in Germany followed reports of adverse health effects in dairy cattle after a Telecoms mast had been erected for TV and cell phone transmission. Scientists documented a significant drop in milk yield and behavioral disorders in some of the cows that related to the microwave transmissions from the mast. When the cattle were moved to a farm 20 km away, their milk yield and behavior returned to normal within days. When the cattle were returned to the mast environment their symptoms returned as well. Fodder analysis and the amount of feed could not account for the changes among the cattle. Analysis of aborted fetal material did not find any pathogens causing the abortion based on microscope and cultural examination and on serological tests. Autopsy of dead cows reported acute heart and circulatory collapse with internal bleeding from several organs. Exposure to RFR at the stable entrance was **80 microW/cm²** and the highest reading reported on the farm near the stable was **350 microW/cm²**. These values are much lower than the FCC guidelines of **1000 microW/cm²** and also exceed the exposures used in Maifeld's scenarios (22) for San Francisco.

Example 6: BIRDS (1)

Recent evidence suggests that wildlife near mobile phone antennas may also be affected by radio frequency radiation. White storks nesting within **200 m** of a cell phone antenna were compared with those nesting more than **300 m** away. Nesting, breeding, and hatching success were significantly reduced for those birds near the cell phone antenna. The number of young per pair for nests near the antenna was significantly lower than for those farther away (0.86 vs. 1.6, ~50% decrease, P=0.001). Nests with no chicks increased from 3.3% (reference population) to 40% for those within **200 m** of the antennas. Near the antennas, the nesting pairs were more aggressive with each other, were less successful at building nests, and had more chick deaths in the early stages. Level of radio frequency exposure was not provided.

These studies show that animals and birds, living within 200 m of a cell phone antenna are adversely affected. Note that all three species (mice, cows, white storks) had reproductive problems. Radio frequency exposure has also been suggested for the decline of the European

house sparrow (5) and the potential bee colony collapses (8) in recent years. The addition of 2,200 antennas on light and utility poles may adversely affect bird populations in San Francisco as well.

6. MOBILE PHONES AND WIRELESS COMPUTERS

Antennas communicate with mobile phones and Wi-Fi antennas communicate with wireless computers. Exposure to radio frequency of the brain near mobile phones and of the body near wireless computers is a concern. Several studies have documented an increased risk of brain tumors, as well as tumors of nerve cells associated with hearing and seeing among cell phone users. These studies generally show a statistically significant increase in tumors on the same side of the head that one exposes to the cell phone (ipsilateral) for at least a 10-year period.

Example 7: META-STUDY OF MOBILE PHONES AND CANCER (18)

Kundi et al. (18) reviewed 9 studies that examined cancers among cell phone users including 4 from the US, 2 from Sweden, and 1 from each of Denmark, Finland, and Germany. All studies have methodological deficiencies: too short duration of mobile phone use, exposure not rigorously determined, and possibility of recall error. The authors conclude that all studies with reasonable latencies found an increased cancer risk associated with mobile phone use. Estimates of relative risk ranged from 1.3 to 4.6. What this means is a 30% to 360% increased risk. Highest overall risks were for acoustic neuroma⁵ (3.5 or 250%) and uveal melanoma⁶ (4.2 or 320%). There was an enhanced risk for increased latency period, i.e. the longer you used your phone the greater the risk of developing a tumor.

Example 8: Industry-funded Mobile Phone Study (19)

The most recent study of cancer risk and mobile phone use (19) was partially funded by Manufacturers' Forum and the GSM Association. What this study reported was a 40% statistically significant increased risk of ipsilateral (same side of the head) glioma⁷ within 10 years of cell phone use.

Exposure to video display terminals (VDT) in wired computers has been associated with miscarriages (9) and with symptoms of electrodermal skin problems (17). Comprehensive studies of the effects of exposure to wireless computers have not yet been conducted. Since a wireless laptop computer can expose a user to **35 microW/cm²** (22) these studies are very much needed. They should be conducted before cities become Wi-Fi meccas and before they are used in classrooms.

⁵ associated with hearing

⁶ associated with vision

⁷ A glioma is a primary tumor that affects the glial (non-neuronal) cells in the brain.

7. LABORATORY AND EPIDEMIOLOGICAL STUDIES

Dr. Henry Lai (Washington State University) compiled a list of studies that document biological effects of radio frequency radiation at low intensities (Table 2).

Table 2. Studies reporting biological effects of radiofrequency radiation (RFR) at low intensities (see Appendix 2 for more information).

- (1) Balode (1996)- blood cells from cows from a farm close and in front of radar showed significantly higher level of severe genetic damage.
- (2) Boscol et al. (2001)- RFR from radio transmission stations (**5 microW/cm²**) affects immunological system in women. [Note this is below scenario of **41 microW/cm²** for San Francisco (22)]
- (3) Chiang et al. (1989)- people lived and worked near radio antennae and radar installations showed deficits in psychological and short-term memory tests.
- (4) de Pomerai et al. (2000, 2002) reported an increase in a molecular stress response in cells after exposure to a RFR at a SAR⁸ of **0.001 W/kg**. This stress response is a basic biological process that is present in almost all animals - including humans. [Compare to **0.08 W/kg FCC Guideline**.]
- (5) de Pomerai et al. (2003) RFR damages proteins at **0.015-0.020 W/kg**. [Compare to **0.08 W/kg FCC Guideline**.]
- (6) D'Inzeo et al. (1988)- very low intensity RFR (**2-4 microW/cm²**) affects the operation of acetylcholine-related ion-channels in cells. These channels play important roles in physiological and behavioral functions. [Note this is below scenario of **41 microW/cm²** for San Francisco (22)]
- (7) Dolk et al. (1997)- a significant increase in adult leukemias was found in residence who lived near the Sutton Coldfield television (TV) and frequency modulation (FM) radio transmitter in England.
- (8) Dutta et al. (1989) reported an increase in calcium efflux in cells after exposure to RFR at **0.005 W/kg**. Calcium is an important component of normal cellular functions. [Compare to **0.08 W/kg FCC Guideline**.]
- (9) Fesenko et al. (1999) reported a change in immunological functions in mice after exposure to RFR at a power density of **1 microW/cm²**. [Note this is below scenario of **41 microW/cm²** for San Francisco and is the exposure from a nearby antenna (22).]

⁸ SAR (specific absorption rate): USA guideline for non-occupational, whole body exposure is 0.08 W/kg (watts/kilogram).

- (10) Hjollund et al. (1997)- sperm counts of Danish military personnel, who operated mobile ground-to-air missile units that use several RFR emitting radar systems (maximal mean exposure **10 microW/cm²**), were significantly low compared to references. [Note this is below scenario of **41 microW/cm²** for San Francisco (22)]

- (11) Hocking et al. (1996)- an association was found between increased childhood leukemia incidence and mortality and proximity to TV towers.
- (12) Ivaschuk et al. (1999)- short-term exposure to cellular phone RFR of very low SAR (**0.026 W/kg**) affected a gene related to cancer. [Compare to **0.08 W/kg FCC Guideline**.]
- (13) Kolodynski and Kolodynska (1996)- school Children lived in front of a radio station had less developed memory and attention, their reaction time was slower, and their neuromuscular apparatus endurance was decreased.
- (14) Kwee et al. (2001)- 20 minutes of cell phone RFR exposure at **0.0021 W/kg** increased stress protein in human cells. [Compare to **0.08 W/kg FCC Guideline**.]
- (15) Lebedeva et al. (2000)- brain wave activation was observed in human subjects exposed to cellular phone RFR at **60 microW/cm²**. [Note this is above the scenario of **41 microW/cm²** for San Francisco (22) but below the FCC guidelines of **1000 microW/cm²**.]
- (16) Magras and Xenos (1999) reported a decrease in reproductive function in mice exposed to RFR at power densities of **0.168 - 1.053 microW/cm²**. [Note this is below scenario of **41 microW/cm²** for San Francisco and is at or below the exposure from a nearby (**1 microW/cm²**) Wi-Fi antenna (22).]
- (17) Mann et al. (1998)- a transient increase in blood cortisol was observed in human subjects exposed to cellular phone RFR at **20 microW/cm²**. Cortisol is a hormone involved in stress reaction. [Note this is below scenario of **41 microW/cm²** for San Francisco (22)]
- (18) Marinelli et al. (2004)- exposure to 900-MHz RFR at **0.0035 W/kg** affected cell's self-defense responses. [Compare to **0.08 W/kg FCC Guideline**.]
- (19) Michelozzi et al. (1998)- leukemia mortality within **3.5 km** (5,863 inhabitants) near a high power radio-transmitter in a peripheral area of Rome was higher than expected.
- (20) Michelozzi et al. (2002)- childhood leukemia higher at a distance up to **6 km** from a radio station.
- (21) Navakatikian and Tomashevskaya (1994)- RFR at low intensities (**10-100 microW/cm²**; **0.0027-0.027 W/kg**) induced behavioral and endocrine changes in rats. Decreases in blood concentrations of testosterone and insulin were reported. [Note this is below scenario of **41 microW/cm²** for San Francisco (22) and below **0.08 W/kg FCC Guideline**.]
- (22) Novoselova et al. (1999)-low intensity RFR (**1 microW/cm²**) affects functions of the immune system. [Note this is below scenario of **41 microW/cm²** for San Francisco and is the same as the exposure from the nearest antenna (22).]

- (23) Novoselova et al. (2004)- chronic exposure to RFR (**1 microW/cm²**) decreased tumor growth rate and enhanced survival in mice. [Note this is below scenario of **41 microW/cm²** for San Francisco and is the same as the exposure from the nearest antenna (22).]
- (24) Park et al. (2004) higher mortality rates for all cancers and leukemia in some age groups in the area near the AM radio broadcasting towers.
- (25) Persson et al. (1997) reported an increase in the permeability of the blood-brain barrier in mice exposed to RFR at **0.0004 - 0.008 W/kg**. The blood-brain barrier envelops the brain and protects it from toxic substances. [Compare to **0.08 W/kg FCC Guideline**.]
- (26) Phillips et al. (1998) reported DNA damage in cells exposed to RFR at SAR of **0.0024 - 0.024 W/kg**. [Compare to **0.08 W/kg FCC Guideline**.]
- (27) Polonga-Moraru et al. (2002) change in membrane of cells in the retina (eye) after exposure to RFR at **15 microW/cm²**. [Note this is below scenario of **41 microW/cm²** for San Francisco (22)]
- (28) Pyrasopoulou et al. (2004) exposure to cell phone radiation during early gestation at SAR of **0.0005 W/kg (5 microW/cm²)** affected kidney development in rats. [Note this is below scenario of **41 microW/cm²** for San Francisco (22)]
- (29) Salford et al. (2003)- nerve cell damage in brain of rats exposed for 2 hrs to GSM signal at **0.02 W/kg**. [Compare to **0.08 W/kg FCC Guideline**.]
- (30) Santini et al. (2002)- increase in complaint frequencies for tiredness, headache, sleep disturbance, discomfort, irritability, depression, loss of memory, dizziness, libido decrease, in people who lived within **300 m** of mobile phone base stations.
- (31) Sarimov et al. (2004)- GSM microwaves affect human lymphocyte chromatin similar to stress response at **0.0054 W/kg**. [Compare to **0.08 W/kg FCC Guideline**.]
- (32) Schwartz et al. (1990)- calcium movement in the heart affected by RFR at SAR of **0.00015 W/kg**. Calcium is important in muscle contraction. Changes in calcium can affect heart functions. [Compare to **0.08 W/kg FCC Guideline**.]
- (33) Somosy et al. (1991)- RFR at **0.024 W/kg** caused molecular and structural changes in cells of mouse embryos. [Compare to **0.08 W/kg FCC Guideline**.]
- (34) Stagg et al. (1997)- glioma cells exposed to cellular phone RFR at **0.0059 W/kg** showed significant increases in thymidine incorporation, which may be an indication of an increase in cell division. [Compare to **0.08 W/kg FCC Guideline**.]
- (35) Stark et al. (1997)- a two- to seven-fold increase of salivary melatonin concentration was observed in dairy cattle exposed to RFR from a radio transmitter antenna.

- (36) Tattersall et al. (2001)- low-intensity RFR (**0.0016 - 0.0044 W/kg**) can modulate the function of a part of the brain called the hippocampus, in the absence of gross thermal effects. The changes in excitability may be consistent with reported behavioral effects of RFR, since the hippocampus is involved in learning and memory. [Compare to **0.08 W/kg FCC Guideline**.]
- (37) Vangelova et al. (2002)- operators of satellite station exposed to low dose (0.1127 J/kg) of RFR over a 24-hr shift showed an increased excretion of stress hormones.
- (38) Velizarov et al. (1999) showed a decrease in cell proliferation (division) after exposure to RFR of **0.000021 - 0.0021 W/kg**. [Compare to **0.08 W/kg FCC Guideline**.]
- (39) Veyret et al. (1991)- low intensity RFR at SAR of **0.015 W/kg** affects functions of the immune system. [Compare to **0.08 W/kg FCC Guideline**.]
- (40) Wolke et al. (1996)- RFR at **0.001W/kg** affects calcium concentration in heart muscle cells of guinea pigs. [Compare to **0.08 W/kg FCC Guideline**.]

All of the 40 reports, reviewed in the table above by Dr. Henry Lai, document biological effects or associations, many of them adverse or undesirable, at exposure to radio frequency radiation below the FCC guidelines for both power density (**1000 microW/cm²**) and specific absorption rate (**0.08 W/kg**). Of the 12 studies that provide power density data, 11 document effects below **41 microW/cm²** (scenario of woman using her laptop computer on her balcony); 6 document effects below **5 microW/cm²** (exposure to multiple Wi-Fi antennas); and 3 document effects below **1 microW/cm²** (exposure to 1 Wi-Fi antenna) (22). People in San Francisco living in apartments at or near the level of node-only and gateway Wi-Fi locations, who suffer from EHS, may be adversely affected by the radiation from the antennas in the Earthlink Wi-Fi proposal.

Firstenberg (6) also compiled a list of studies showing biological effects at levels below federal guidelines for radio frequency radiation (Table 3).

Table 3. Reported biological effects associated with radio frequency radiation. [Data from Firstenberg (6).]

Power Density (µW/cm ²)	Reported Biological Effects	References
0.000000000001	Altered genetic structure in E. Coli	Belyaev 1996
0.0000000001	Threshold of human sensitivity	Kositsky 2001
0.000000001	Altered EEG in human subjects	Blise 1978
0.0000000027	Growth stimulation in <i>Vicia fabus</i>	Brauer 1950
0.00000001	Effects on immune system in mice	Bundyak 1994
0.00000002	Stimulation of ovulation in chickens	Kondra 1970
0.000005	Effect on cell growth in yeast	Grundler 1992
0.00001	1/100 millionth of FCC guidelines	
0.00001	Conditioned "avoidance" reflex in rats	Kositsky 2001
0.000027	Premature aging of pine needles	Selga 1996
0.002	Sleep disorders, abnormal blood pressure, nervousness, weakness, fatigue, limb pain, joint pain, digestive problems, fewer schoolchildren promoted	Alpeter 1995, 1997
0.0027	Growth inhibition in <i>Vicia fabus</i>	Brauer 1950
0.0027 to 0.065	Smaller tree growth rings	Balodis 1996
0.01	1/1000th of FCC guidelines	
0.01	Human sensation	Kolbun 1987
0.06	Altered EEG, disturbed carbohydrate metabolism, enlarged adrenals, altered adrenal hormone levels, structural changes in liver, spleen, testes, and brain—in white rats and rabbits	Dumanskiy 1974
0.06	Slowing of the heart, change in EEG in rabbits	Serlyuk, Reported in McRee 1980
0.1	Increase in melatonin in cows	Stark 1997
0.1 to 1.8	Decreased life span, impaired reproduction, structural and developmental abnormalities in duckweed plants	Magare 1996
0.13	Decreased cell growth (human epithelial amnion cells)	Kwee 1997
0.168	Irreversible sterility in mice	Magras 1997
0.2 to 8.0	Childhood leukemia near transmitters	Hocking 1996
0.3	Impaired motor function, reaction time, memory and attention of schoolchildren, and altered sex ratio of children (fewer boys)	Kolodinskiy 1996
0.6	Change in calcium ion efflux from brain tissue	Dutia 1986
0.6	Cardiac arrhythmias and sometimes cardiac arrest (frogs)	Frey 1968
4	Altered white blood cell activity in schoolchildren	Chang 1989
1	Headache, dizziness, irritability, fatigue, weakness, insomnia, chest pain, difficulty breathing, indigestion (humans—occupational exposure)	Simonenko 1998
1	Stimulation of white cells in guinea pigs	Shandala 1978
2	"Microwave hearing"—clicking, buzzing, chirping, hissing, or high-pitched tones	Frey 1963, 1969, 1971, 1973, 1988, Justeson 1979, Olsen 1980, Wieske 1963, Lin 1978
2.5	Breakdown of blood-brain barrier (used a digital cellular phone to provide the radiation)	Salford 1997
5	Leukemia, skin melanoma and bladder cancer near TV and FM transmitter	Dolk 1997
5	Biochemical and histological changes in liver, heart, kidney, and brain tissue	Belokrinskiv 1982
10	1% of FCC guideline	
10	Damaged mitochondria, nucleus of cells in hippocampus of brain	Belokrinskiv 1982a
10	Impaired memory and visual reaction time in people living near transmitters	Chang 1989
10	Decreased size of litter, increased number of stillborns in mice	Il'Chevich (reported in McRee 1980)
10	Redistribution of metals in the lungs, brain, heart, liver, kidney, muscles, spleen, bones, skin, blood	Shutenko 1981
1000	FCC Guideline, 6-minute exposure based on heating	

8. SITING OF CELL PHONE ANTENNAS

Communities worldwide are struggling with siting of cell phone base stations. Where should these antennas be placed for optimum reception and minimal health effects? Many of these communities have yet to be confronted with Wi-Fi antennas.

Example 9: INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS (IAFF)

The International Association of Fire Fighters (IAFF) ratified Resolution 15 in Boston, August 2004. Resolution 15 states that:

The IAFF oppose the use of fire stations as base stations for antennas and towers for the conduction of cell phone transmissions until such installations are proven not to be hazardous to the health of our members." (14).

This resolution was prompted by a study of abnormal brain activity and ill health among of fire fighters in California who worked for less than 5 years at a fire hall with cell phone antennas on the roof. Extensive medical testing showed that the fire fighters experienced confusion, loss of short-term memory, inability to focus, migraine headaches, insomnia, "brain fog," infertility, slowed reaction time, depression, tremors, and vertigo. The SPECT scan of their brain shows abnormal changes that could not be explained by exposure to chemicals.

Example 10: SCHOOLS

The Vancouver, British Columbia School Board passed a resolution in January 2005 as follows:

Be it resolved that:

- no further installations of cellular antenna be permitted on any school building or school grounds regularly used by students, and
- Incompatible Land Uses Near Schools be amended to include any installation of cellular antenna within 305 m (1000 ft) of a school as an incompatible use and that VSB be so notified of any potential installation.

The county of Palm Beach, Florida, the City of Los Angeles, California, and the country of New Zealand have all prohibited cell phone base stations and antennas near schools due to safety concerns (14).

The decision not to place cell antennas near schools is based on the likelihood that children are more susceptible to this form of radiation. Light and utility poles in San Francisco are found near schools and therefore the Earthlink Wi-Fi Network would result in increased exposures for children that are inconsistent with these policies.

Example 11: UNITED KINGDOM

Belfast City Council ratified decisions of its Development Committee (Aug 18, 1999) that no transmitter masts should be permitted on any Council Property, due to unknown risk and substantial public concern.

Wyre Borough Council, Lancashire believed it was unsuitable to site telecommunication towers 190 m from primary school and 40 m from houses.

Scotland Planning Authorities adopted "Precautionary Policy" due to "perceived inadequate official advice from Government Departments"

In England & Wales, the Local Government Association (LGA) advised member authorities to adopt "Precautionary Approach". This decision making process was based on the concept that waiting for "conclusive scientific evidence" before acting is potentially flawed.

Recent reports from the UK indicate cancer clusters near mobile phone masts and these masts are now being removed. One such example is provided in Appendix 3.

Sir William Stewart, the chairman of the Health Protection Agency (HPA) in the UK is asking that Wi-Fi exposure be reviewed. In his comments about the 2000 Stewart Report (29) he stated that:

"There may be changes, for example in cognitive function . . . there were some indications that there may be cancer inductions . . . there were some molecular biology changes within the cell and these were issues that we had to bear in mind."

<http://www.telegraph.co.uk/news/main.jhtml?sessionid=PDE5M33FHNW0HOFIOMFSFFWAVCB00IV0?xml=/news/2007/05/21/nwif21.xml>

9. RESOLUTIONS & APPEALS

Physicians (7, 13, 16) and scientists (2, 3, 26) have issued statements that biological effects from low-intensity RF radiation are scientifically established and are asking governing bodies in Europe and North America to re-examine our use of wireless technology and reduce existing radio frequency guidelines. These Appeals and Resolutions are presented in Appendices 4 to 9. Several are summarized below.

More than 3000 physicians have signed the **Freiburger Appeal (7)**. These doctors have observed among their patients an increased incidence of disorders including headaches, chronic exhaustion, agitation, sleeplessness, tinnitus, susceptibility to infection, nervous and connective tissue pains that they associate with increased exposure to high frequency microwave radiation from mobile phone base stations and mobile phones (both cell phones and cordless phones).

Below are direct quotes from this document:

Our therapeutic efforts to restore health are becoming increasingly less effective: the unimpeded and continuous penetration of radiation into living and working areas,

mhavas@trentu.ca

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1. Anticipatory Action
2. Right to Know
3. Alternative Assessment
4. Full Cost Accounting
5. Participatory Decision Process

This document states that, *"There is a duty to take anticipatory action to prevent harm. Government, business, and community groups, as well as the general public, share this responsibility."*

11. CERTIFICATE OF DETERMINATION

An important issue that relates to the *Certificate of Determination of Exemption/Exclusion from Environmental Review, Planning Department, City and County of San Francisco*, April 20, 2007 has yet to be raised and needs to be addressed.

Placing antennas near or on utility power lines may result in the wires acting as antennas and re-directing the radio frequency radiation. This has been documented in Italy (30). Measurements at a school near Huntington Beach California showed that the radio frequency radiation from a cell phone tower was re-radiating from the nearby high voltage transmission lines. It was also re-radiating from the metal fence that surrounded the school. This type of re-radiation can produce hotspots that are not normally calculated in exposure metrics since the exact configuration of the antennas and the surrounding structures need to be known and the Earthlink providers have yet to determine where specifically the antennas will be placed.

Radio frequency radiation can travel along electrical wires. This can affect power quality (referred to as dirty electricity) and result in adverse health effects. Milham and Morgan (24) investigated a potential cancer cluster at La Quinta Middle School in La Quinta, California. They found that 13 rooms in the school had very high levels of "dirty electricity" and the risk of cancer in these rooms was much higher than in "electrically clean" rooms. Teachers who never taught in these "dirty" rooms had a 1.8-fold risk of cancer while those who taught in these rooms had a 5.1-fold risk of cancer, and those who taught in these rooms and had been employed at this school for more than 10 years had a 7.1-fold risk of cancer.

Poor power quality can affect teacher health and wellbeing as well as student behavior as documented at Willowood School in Toronto, Canada. Improvement of power quality was associated with improved symptoms among both teachers and students in a blind study⁹ (10). Poor power quality can also exacerbate symptoms of multiple sclerosis, diabetes (11) and asthma (12).

Radio frequency on power lines is an area that clearly needs more research. See Letter X in Appendix 1. Overhead power lines and electrical conduits for MUNI are prevalent throughout

⁹ "Blinding" is a basic tool of science used to minimize the placebo effect and the introduction of bias in research. In a single blind study the subject being tested is unaware if they are part of a test group or a control group.

mhavas@trentu.ca

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particularly bedrooms, an essential place for relaxation, regeneration and healing, causes uninterrupted stress and prevents the patient's thorough recovery.

In the face of this disquieting development, we feel obliged to inform the public of our observations . . .

What we experience in the daily reality of our medical practice is anything but hypothetical! We see the rising number of chronically sick patients also as the result of an irresponsible "safety limits policy", which fails to take the protection of the public from the short- and long-term effects of mobile telephone radiation as its criterium for action. Instead, it submits to the dictates of a technology already long recognized as dangerous. For us, this is the beginning of a very serious development through which the health of many people is being threatened.

We will no longer be made to wait upon further unreal research results - which in our experience are often influenced by the communications industry, while evidential studies go on being ignored. We find it to be of urgent necessity that we act now!

Above all, we are, as doctors, the advocates for our patients. In the interest of all those concerned, whose basic right to life and freedom from bodily harm is currently being put at stake, we appeal to those in the spheres of politics and public health.

The Helsinki Appeal (13) was a call for the European Parliament to adopt new safety standards, reject ICNIRP standards (15), and apply the Precautionary Principle to EMFs. The Helsinki Appeal can be found in Appendix 7.

The Benevento Resolution (2) requested among other things that wireless-free zones be established in cities, in public buildings (schools, hospitals, residential areas) and on public transit, to permit access by persons who are hypersensitive to electromagnetic energy (Appendix 9). This would not be possible with a city-wide Wi-Fi network such as the one Earthlink proposes for San Francisco.

10. PRECAUTIONARY PRINCIPLE

Until appropriate guidelines can be introduced a number of international and national agencies are recommending adoption of the Precautionary Principle that was presented at the Rio Conference on Environment and Development in Brazil in 1992. The precautionary principle has been recommended for both radio frequency radiation and electromagnetic fields.

The Precautionary Principle (PP) states that:

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capability. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

San Francisco's Precautionary Principle identifies 5 essential elements to decision-making as follows (City and County of San Francisco Environment Code, Chapter 1, Section 101.):

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San Francisco and the Earthlink Wi-Fi Network may result in further instances of dirty electricity adversely affecting city residents.

12. SUMMARY

Laboratory studies of radio frequency radiation as well as epidemiological studies of people who live near cell phone antennas and/or use wireless technology indicate adverse biological effects. These effects include increase in cancers, DNA breaks, impaired reproduction, increased permeability of the blood-brain barrier, altered calcium flux, changes in enzyme activity, neurological disorders, altered brainwave activity, insomnia, decreased memory, inattention, slower reaction time, tinnitus, dizziness, skin disorders, headaches, chronic pain, chronic fatigue, respiratory problems and arrhythmia. A growing population is becoming sensitive to electromagnetic energy and some of these people are affected by radio frequency radiation and are unable to live near antennas. Animals that live near cell phone and broadcast antennas are also affected by RF radiation, which manifests itself in reproductive impairment and behavioral abnormalities.

The cancers and symptoms of EHS occur at levels well below the FCC guidelines for frequency radiation. These guidelines are based on short-term (6-minute) thermal effects and are inadequate to protect the population from long-term, non-thermal exposure. The FCC guidelines conform to ICNIRP guidelines (15) but are much higher (i.e. less protective) than guidelines in other countries.

Metal objects such as wiring in the home, fences, poles, roofs, filing cabinets can redirect RFR and create hot spots or interfere with reception. For this reason calculations of exposure may not be as reliable as actual measurements. Appeals and resolutions from physicians and scientist request governments to provide the strictest guidelines for RF exposure and address the growing number of people developing a sensitivity to this form of energy.

13. RECOMMENDATION

The Board of Supervisors of the City and County of San Francisco should adopt the precautionary principle in their decision regarding the Earthlink Wi-Fi Network. The scientific evidence indicates that exposure to radio frequency radiation near cell phone antennas and in laboratory studies is associated with and/or causes adverse biological and health effects at levels well below federal guidelines and at levels to which people who use wireless computers are likely to be exposed. Policy makers and the public should heed the warning that this form of energy, at current exposures, is far from benign and should act accordingly to protect human health and the environment.

Since cumulative radio frequency exposures are unknown from currently operating antennas and towers, a baseline analysis is important to determine what these current exposure conditions are at present. This should be done prior to approval of a Wi-Fi system. An exposure assessment should be done in accordance with the California Environmental Quality Act (CEQA) guidelines to determine that there are no health risks.

mhavas@trentu.ca

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Blanketing San Francisco with yet another source of radio frequency radiation in addition to the existing cell phone, broadcast, and essential police, fire, ambulance communication antennas is likely to result in a growing number of people becoming ill.

Those who have to make decisions about where antennas should be placed are seldom provided with all the facts. Often they are given conflicting information and side with the industry because they don't want to stand in the way of "progress." The oath of office that most public officials take requires protecting public health and may require swimming against the tide in order to do what is right.

The Board of Supervisors will be shown studies that document no adverse effects of this technology and they will be told the scientific evidence is contradictory and inconclusive. The underlying assumption is that until science can prove this form of energy is harmful, until scientists understand the mechanisms involved, until every study shows the same thing, we should allow human exposure. That approach could be tantamount to the costly history lesson of smoking and lung cancer, asbestos exposure and mesothelioma; DDT and loss of bird populations.

Science does not have all the answers and the understanding of mechanism is incomplete. However, according to the Precautionary Principle "threats of serious or irreversible damage" is all that is needed to act.

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15 APPENDICES

1. Black on White: Voices and Witnesses about Electro-Hypersensitivity
2. Studies documenting biological effects of radio frequency radiation at low intensities. Compiled by Dr. Henry Lai, University of Washington.
3. Sunday Times, 2007. Cancer clusters at phone masts
4. Salzburg Resolution, 2000.
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6. Freiburger Appeal, 2002.
7. Helsinki Appeal, 2005.
8. IDEA 2005
9. Benevento Resolution, 2006.

Appendix 1

BLACK ON WHITE: VOICES AND WITNESSES ABOUT ELECTRO-HYPERSENSITIVITY, THE SWEDISH EXPERIENCE

Rigmor Granlund-Lind and John Lind
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© Mimers Brunn Kunskapsförlaget,
Translation: Jeffrey Ganelen: Diagrams: Jan Rennerfelt
SALA 2004, MIMERS BRUNN, KUNSKAPSFÖRLAGET, SWEDEN
mimersbrunn@spray.se

A list of symptoms doesn't convey the reality of what life is like for someone who has electrohypersensitivity. Below people with EHS share their stories of what it means to be sensitivity to electromagnetic energy. The cost is far greater than ill health. It involves impaired family life, social isolation, loss of productive work, and loss of dignity.

Being so severely electro-hypersensitive is like being a hermit in an infernal hell. (Letter 54)

I am a nurse anesthetist by profession and in September 1993, I began working with a computer expert to design a booking program for an operation ward. Worked three days a week with this. Tuesday-Thursday. Worked with two computers simultaneously, of the model where the computer is situated on the table under the monitor.

Had only worked a few weeks when the problems began, with eye irritation and headaches. Then came one symptom after the other in rapid succession, such as a throbbing in my teeth in both the upper and lower jaws, mild dizziness, mild nausea, ice-cold feet, sleep disorders, sweating and shivering during the night and extreme tiredness. The headaches were terrible on Fridays, after three working days, but decreased during the weekends and had nearly vanished on Tuesday, when I began working again. During weekends, I had to lie down in the middle of the day. Was extremely tired.

There was a ten-day break from working with the computers between Christmas and New Year, and during those days, one symptom after the other disappeared. Since I have a sister who is electro-hypersensitive, I now understood what it was all about. Realized that I had to stop working with computers. It was with deep regret that I asked not to work with computers, because the work was perfectly suited to me. The headaches, dizziness, nausea, sweating, shivers and the cold feet had disappeared during the ten-day break, but it took three weeks before the sleep disorder disappeared and an additional couple of weeks before my teeth felt normal again. (Letter 19)

One and a-half years ago, i.e. the fall of 1998, I developed electro-hypersensitivity and sensitivity to cell phones and transmitters. If I am in the vicinity of someone talking on a cell phone, I come down with influenza-like symptoms, with pain throughout my body, a feeling of fever without actually having a fever, headaches and a sore throat. These symptoms disappear after one or two days, but can remain longer if the exposition to the mobile radiation had been extensive.

When I ride the bus or the subway during rush hour, there are often so many people talking on phones at the same time that it is impossible to maintain an adequate distance from them.

mhasvas@trentu.ca

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Even transmitters around the city are a problem. Some bus stops are located so close to transmitters that I can't wait there, but instead have to walk several bus stops away to find one I can wait at. If I am in a building located opposite a transmitter, the same symptoms arise.

Since I have never had any previous problems whatsoever with electrical apparatus, I have tried to find out if anything in my surroundings has changed. I discovered that cellular telephone transmitters were erected in October 1997 in the TV mast situated a few hundred meters from my apartment. As early as the summer of 1998, I began to feel a bit tired and became progressively more tired until the autumn, but never thought that it could be a preliminary stage to electro-hypersensitivity. I only understood this when it was determined that I suffered from electro-hypersensitivity.

I have now reached the conclusion that my electro-hypersensitivity was brought on by the fact that I was constantly exposed at home to microwave radiation from the transmitter. (Letter 295)

In January 1998, we received a letter from the local housing authority informing us that they wanted to build a new mast and a technical shed on a site approximately 90 meters from our house, located in a residential area. This inquiry went out to our closest neighbors, since according to the current development plan the land may only be used for parks or gardens. A mast had been located at the same location for approximately 15-20 years. One neighbor wondered whether it might disrupt TV reception, but otherwise we didn't think it would cause any inconvenience. The letter did not say a single word about what the mast would contain.

The new mast was erected a week after midsummer and in the middle of July, during the summer break, I began to feel ill. I woke up in the middle of the night due to a tingling sensation in my skin and a headache, and I was drenched in sweat. There was pain in my joints, bone structure, muscles, rashes on my arms, and I became tired and had trouble concentrating. My whole body came to a "stop". I walked around the house at night, trying to find the place where I was least bothered. When I was in town, I noticed that I felt ill in the vicinity of fluorescent lamps and large speakers. The only change that had occurred in my environment was the new mast. (Letter 377)

Back in 1978, I first felt the high frequency field from my transmitting equipment. I knew nothing of the risks at that time. At the beginning, my problems were harmless, but they became progressively more severe: Nausea, dizziness, headaches, visual problems, balance, memory and speech, depending upon the strength of the field. The problem first occurred at 145 MHz and thereafter, in order, on amateur bandwidths 28, 21, 14, 7, 3.5 and 1.8 MHz. I mainly sent telegraphy at high speeds but also made use of SSB11 telephony. On VHF 145 MHz, I only used FM telephony. On the high frequency bands, my transmitter power was high, the antenna configuration large.

After a while I also became hypersensitive to low frequency fields as well as TV and computer screens, fluorescent lamps, cellular phones etc. In the course of time I also developed severe heart problems, which were significantly related to being exposed to EM fields. Very strong atrial fibrillation in which the heart rate reaches up to 230 beats per minute and where the heart races completely out of control. (Letter 22)

A person suffering from electro-hypersensitivity was offered the chance to rent a cottage deep in the forest, far from any neighbors. The cottage had been connected to the electric power lines thirty years ago, but these were now disconnected. The power lines were situated approximately 300 meters away.

The first day, the person sat outdoors for several hours and came to the conclusion that the environment was good and that it didn't cause any problems. The next day, the person tested the indoor environment. After just a short time came the comment, "I can't stay here".

When measured, the old electrical installation that had been left proved to be a perfect antenna for high-frequency airborne signals!

mhasvas@trentu.ca

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Once the electrical installation was dismantled, the problem disappeared and the situation has remained stable for four years. (Letter X)

Some of my experiences with electro-hypersensitivity deal with microwave radiation, which has become a major problem. You can gain control of the rest of electricity (it can be turned off, moved and isolated). Mobile telephone antennas transmit constantly and penetrate just about everything. If one becomes sensitive to microwaves, then airplanes also become a major problem, with their radar and transponders that more or less knock you out. It wouldn't surprise me if the nervous system of someone suffering from electro-hypersensitivity were overloaded. (Letter 400)

Then came the next setback. Cellular telephones had made their way into our so idyllic life. Summer guests began to come, and with them cellular phones, to this private road, with a mast situated three kilometers from our house. That was the start of another "hell". The symptoms: disrupted speech ability, breathing difficulties, heart palpitations, difficulty walking. I couldn't stay at home. I had to leave in the middle of the night and go to my son in Lund.

This was repeated several times. On one occasion I went to the emergency ward, and was allowed to stay overnight. The tests taken didn't show anything abnormal. The way the doctors treated me was very degrading.

Since then, the neighbors have shown a great deal of consideration for the circumstances. Moreover, we have been allowed to put up a sign with the text: Cellular phone free zone. Permission was given by all the members of the road association. (Letter 355)

Cellular telephony is absolutely the biggest problem for us. In the beginning of the 90's going outside was enough to be rid of the symptoms. But the situation today is different. I, and many with me, often feel worse outdoors. The only times I can feel myself to be completely free of symptoms today is in such places as air-raid shelters, with thick concrete walls and ceilings, when the electricity inside has been shut off. In areas where there is no coverage for cellular phones, such as in western Orsa Fimmark, I feel fine everywhere. (Letter 229)

The symptoms that I get from microwaves include dizziness, nausea, weakness, tremors, impaired hearing, tunnel vision, speech impairments, and if I don't make my way to a place with a lower microwave level, eventually unconsciousness. The recovery time after a period of unconsciousness can be quite extended depending upon the exposure, sometimes many weeks.

There are two sources of microwaves that, probably due to their modulation, have a powerful effect on me: mobile telephony and radar and communications systems for aircraft. (Letter 337)

Today, the environment has deteriorated for those of us with electro-hypersensitivity, primarily because of the increasing use of cellular phones. Transmitters for mobile telephony will soon be everywhere; on buildings and roofs in densely built-up areas, on masts in forests and in the countryside, so that nature is full of microwave radiation. There are people with cellular phones stuck to their ears or in their pockets in stores, in public places, on the streets and sidewalks, so that you are surrounded by permanent and mobile radiation heaters. This makes life a real misery for those of us with electro-hypersensitivity.

I have moved quite often in recent years to try to get away from the problems, but I am still searching for someplace where there is an electricity-free environment without necessarily being a pure wilderness with no infrastructure. (Letter 407)

We who are writing this are a mast refugee family, all of whom have been severely afflicted by radiation from a mobile base station. After moving, the mother and children have recovered almost completely and the symptoms only recur in connection with prolonged exposure

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to masts or cellular phones. The son cannot watch TV or use a computer since it makes him feel sick. Nor can he spend extended periods of time in an urban environment or with friends.

He is 9-years old and has a tough life ahead of him as electro-hypersensitive. The father received a severe radiation injury due to frequent use of cellular phones. And when he was in the apartment with a base station transmitter outside of the bedroom window, he developed total electro-hypersensitivity, and today he can only be outdoors for short periods wearing a specially-made protective suit, the rest of the time he spends in a protective room with candles as the only form of illumination. (Letter 327)

For the past few days I have been sleeping in the car beneath a large rock on a beach in Spain. I do so to avoid such symptoms as pressure over my chest, cramps, difficulties thinking, abnormal tiredness and sleep disorders. When subjected to extended exposure to microwaves, there is blood in my nose and throat. In certain instances, a feeling of paralysis in my legs and difficulties walking.

My situation changed when I began reacting to a mast that was erected about 400 meters from my home, a transmitter for GSM's mobile telephone system.

This forced me to leave both my home and my job. Afterwards, I searched all over Sweden for another place to live, but was obliged to leave them as the expansion of the mobile telephone system caught up with me. I finally took to living and sleeping in a car.

I spent the winter in Spain, which I am now doing for the second year. This year, however, I have had to live in a car in order to find new locations. The expansion of mobile telephony is going very quickly here as well.

When I am able to find a "clean" spot, I am practically healthy, even though I am affected fairly badly when I can't get away. My body and psyche can't take an unlimited amount of damage. Microwaves are not a natural part of our environment. I think I should have the right to live in Sweden - don't I? (Letter 221)

Having an electro-hypersensitive person in the family affects the whole family. There are a lot of things we can't do that all the normal families take for granted. We can't even invite mother home for dinner, because she doesn't feel well in my apartment and can't spend time here. We can't do any of the small, simple things as an entire family, such as going shopping, going to the movies or visiting relatives, because mother can't join us. (Letter 145)

I was not able to visit my sick mother, be at her deathbed or attend her funeral due to my electro-hypersensitivity. I haven't been able to go to doctors or hospitals to receive care, visit relatives, friends, acquaintances for the past ten years. I cannot take care of my errands in the community myself, since the technology there is harmful to me. I am as good as cut off from society and social contact.

Where am I to go when my husband is no longer by my side? There are times when I need assistance 24-hours a day, when dizziness knocks me completely out of commission. And where am I to go in a few years? There are no homes for the elderly that have gone through EMF-reduction, but there seems to be a National Board of Health and Welfare that has had EMF-reduction. (Letter 273)

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Appendix 2

STUDIES SHOWING ADVERSE BIOLOGICAL EFFECTS OF RADIO FREQUENCY RADIATION AT LOW INTENSITIES.

Compiled by Dr. Henry Lai, University of Washington.

Source of literature and abstracts (Table 2):

(1) Balode, Z., Assessment of radio-frequency electromagnetic radiation by the micronucleus test in bovine peripheral erythrocytes. *Sci Total Environ* 180(1):81-85, 1996.

Previous bioindication studies in the Skrunda Radio Location Station area have focused on the somatic influence of electromagnetic radiation on plants, but it is also important to study genetic effects. We have chosen cows as test animals for cytogenetical evaluation because they live in the same general exposure area as humans, are confined to specific locations and are chronically exposed to radiation. Blood samples were obtained from female Latvian Brown cows from a farm close to and in front of the Skrunda Radar and from cows in a control area. A simplified alternative to the Schiff method of DNA staining for identification of micronuclei in peripheral erythrocytes was applied. Microscopically, micronuclei in peripheral blood erythrocytes were round in shape and exhibited a strong red colour. They are easily detectable as the only coloured bodies in the uncoloured erythrocytes. From each individual animal 2000 erythrocytes were examined at a magnification of x 1000 for the presence of micronuclei. The counting of micronuclei in peripheral erythrocytes gave low average incidences, 0.6 per 1000 in the exposed group and 0.1 per 1000 in the control, but statistically significant ($P < 0.01$) differences were found in the frequency distribution between the control and exposed groups.

(2) Boscol P, Di Sciascio MB, D'Ostilio S, Del Signore A, Reale M, Conti P, Bavazzano P, Paganelli R, Di Gioacchino M. Effects of electromagnetic fields produced by radiotelevision broadcasting stations on the immune system of women. *Sci Total Environ* 273(1-3):1-10, 2001.

The object of this study was to investigate the immune system of 19 women with a mean age of 35 years, for at least 2 years (mean = 13 years) exposed to electromagnetic fields (ELMFs) induced by radiotelevision broadcasting stations in their residential area. In September 1999, the ELMFs (with range 500 KHz-3 GHz) in the balconies of the homes of the women were (mean \pm S.D.) 4.3 ± 1.4 V/m. Forty-seven women of similar age, smoking habits and atopy composed the control group, with a nearby resident ELMF exposure of < 1.8 V/m. Blood lead and urinary trans-trans muconic acid (a metabolite of benzene), markers of exposure to urban traffic, were higher in the control women. The ELMF exposed group showed a statistically significant reduction of blood NK CD16+/-CD56+ cytotoxic CD3(-)CD8+, B and NK activated CD3(-)HLA-DR+ and CD3(-)CD25+ lymphocytes. 'In vitro' production of IL-2 and interferon-gamma (INF-gamma) by peripheral blood mononuclear cells (PBMC) of the ELMF exposed group, incubated either with or without phytohemagglutinin (PHA), was significantly lower; the 'in vitro' production of IL-2 was significantly correlated with blood CD16+/-CD56+ lymphocytes. The stimulation index (S.I.) of blastogenesis (ratio between cell proliferation with and without PHA) of PBMC of ELMF exposed women was lower than that of the control subjects. The S.I. of blastogenesis of the ELMF exposed group (but not blood NK lymphocytes and the 'in vitro' production of IL-2 and INF-gamma by PBMC) was significantly correlated with the ELMF levels. Blood lead and urinary trans-trans muconic acid were barely correlated with immune parameters: the urinary metabolite of benzene of the control group was only correlated with CD16+/-CD56+ cells indicating a slight effect of traffic on the immune system. In conclusion, this study demonstrates that high frequency ELMFs reduce cytotoxic activity in the peripheral blood of women without a dose-response effect.

(3) Chiang H, Yao GD, Fang QS, Wang KQ, Lu DZ, Zhou YK. Health effects of environmental electromagnetic fields. *J Bioelectromagnetics* 8:127-131, 1989.

We investigated the effects of exposure to environmental electromagnetic fields (EMFs) in 1170 subjects. Neurological phagocytosis was enhanced in the low-intensity exposure groups, but reduced significantly at relatively higher intensities. Visual reaction time was prolonged and the scores of short-term memory tests were lower in some high-intensity exposure groups. EMFs may affect the central nervous and immune systems in man.

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(4) de Pomerai D, Daniells C, David H, Allan J, Duce I, Mutwakil M, Thomas D, Sewell P, Tattersall J, Jones D, Candido P. Non-thermal heat-shock response to microwaves. *Nature* 405:417-418, 2000.

Nematode worms (*C. elegans*) exposed overnight to 750-MHz microwaves at a SAR of 0.001 W/kg showed an increased in heat shock proteins (HSPs). (Heat shock proteins are induced in most organisms by adverse conditions (such as heat or toxins) that cause damage to cellular proteins, acting as molecular chaperones to rescue damaged proteins). The authors give several arguments that the microwave-induced effect on HSPs is non-thermal and suggest that 'current exposure limits for microwave equipment may need to be reconsidered.'

(5) de Pomerai DI, Dawe A, Djerbib L, Allan, Brunt G, Daniells C. Growth and maturation of the nematode *Caenorhabditis elegans* following exposure to weak microwave fields. *Enzyme Microbiol Tech* 30:73-79, 2002.

Prolonged exposure to weak microwave fields (750-1000 MHz, 0.5 W) at 25°C induces a heat-shock response in transgenic *C. elegans* strains carrying *hsp16* reporter genes [1]. A comparable response to heat alone requires a substantially higher temperature of 28°C, suggesting that microwave heating of worms or of the system as a whole might provide a sufficient explanation, although this can be ruled out by indirect arguments [1]. Here we investigate two further biological consequences of prolonged microwave exposure at 25°C in synchronised cultures of wild-type worm larvae, namely alterations in (i) growth rate (GR) and (ii) the proportion of worms later maturing into egg-bearing adults (MP). Both of these parameters are significantly increased following microwave exposure (GR by 8.11%, and MP by 28.40%), whereas both are significantly decreased (GR by 10% and MP almost abolished) after mild heat treatment at 28°C for the same period. It follows that the biological consequences of microwave exposure are opposite to, and therefore incompatible with, those attributable to mild heating. This evidence does not in itself necessitate a non-thermal mechanism, but does eliminate explanations that invoke the bulk heating of tissues by microwaves. This latter, however, remains the sole basis for current regulations governing microwave exposure.

(5) de Pomerai DI, Smith B, Dawe A, North K, Smith T, Archer DB, Duce IR, Jones D, Candido EP. Microwave radiation can alter protein conformation without bulk heating. *FEBS Lett* 22:543(1-3):93-97, 2003.

Exposure to microwave radiation enhances the aggregation of bovine serum albumin in vitro in a time- and temperature-dependent manner. Microwave radiation also promotes amyloid fibril formation by bovine insulin at 60 degrees C. These alterations in protein conformation are not accompanied by measurable temperature changes, consistent with estimates from field modelling of the specific absorbed radiation (15-20 mW kg(-1)). Limited denaturation of cellular proteins could explain our previous observation that modest heat-shock responses are induced by microwave exposure in *Caenorhabditis elegans*. We also show that heat-shock responses both to heat and microwaves are suppressed after RNA interference ablating heat shock factor function.

(6) D'Inzeo G, Bernardi P, Eusebi F, Grassi F, Tamburello C, Zani BM. Microwave effects on acetylcholine-induced channels in cultured chick myotubes. *Bioelectromagnetics* 9(4):363-372, 1988.

The behavior of cultured myotubes from chick embryos exposed to microwaves has been experimentally analyzed. Recordings of acetylcholine-induced currents have been obtained via patch-clamp techniques using both cell-attached (single-channel current recording) and whole-cell (total current recording) configurations. During the exposure to low-power microwaves the frequency of the ACh-activated single channel openings decreased, while the ACh-induced total current showed a faster falling phase. Channel open time and conductance were not affected by microwave irradiation. It is concluded that the exposure to microwaves increases the rate of desensitization and decreases the channel opening probability. The nonthermal origin and the molecular interaction mechanisms governing these electromagnetic-induced effects are discussed.

(7) Dolk H, Shaddick G, Walls P, Grundy C, Thakrar B, Kleinschmidt I, Elliott P. Cancer incidence near radio and television transmitters in Great Britain. I. Sutton Coldfield transmitter. *Am J Epidemiol* 145(1):1-9, 1997.

A small area study of cancer incidence in 1974-1986 was carried out to investigate an unconfirmed report of a "cluster" of leukemias and lymphomas near the Sutton Coldfield television (TV) and frequency modulation (FM) radio transmitter in the West Midlands, England. The study used a national database of postcoded cancer

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registrations, and population and socioeconomic data from the 1981 census. Selected cancers were hematopoietic and lymphatic, brain, skin, eye, male breast, female breast, lung, colorectal, stomach, prostate, and bladder. Expected numbers of cancers in small areas were calculated by indirect standardization, with stratification for a small area socioeconomic index. The study area was defined as a 10 km radius circle around the transmitter, within which 10 bands of increasing distance from the transmitter were defined as a basis for testing for a decline in risk with distance, and an inner area was arbitrarily defined for descriptive purposes as a 2 km radius circle. The risk of adult leukemia within 2 km was 1.83 (95% confidence interval 1.22-2.74), and there was a significant decline in risk with distance from the transmitter ($p = 0.001$). These findings appear to be consistent over the periods 1974-1980, 1981-1986, and were probably largely independent of the initially reported cluster, which appeared to concern mainly a later period. In the context of variability of leukemia risk across census wards in the West Midlands as a whole, the Sutton Coldfield findings were unusual. A significant decline in risk with distance was also found for skin cancer, possibly related to residual socioeconomic confounding, and for bladder cancer. Study of other radio and TV transmitters in Great Britain is required to put the present results in wider context. No causal implications can be made from a single cluster investigation of this kind.

(8) Dutta SK, Ghosh B, Blackman CF. Radiofrequency radiation-induced calcium ion efflux enhancement from human and other neuroblastoma cells in culture. *Bioelectromagnetics* 1989;10(2):197-202

To test the generality of radiofrequency radiation-induced changes in $45Ca^{2+}$ efflux from avian and feline brain tissues, human neuroblastoma cells were exposed to electromagnetic radiation at 147 MHz, amplitude-modulated (AM) at 16 Hz, at specific absorption rates (SAR) of 0.1, 0.05, 0.01, 0.005, 0.001, and 0.0005 W/kg. Significant $45Ca^{2+}$ efflux was obtained at SAR values of 0.05 and 0.005 W/kg. Enhanced efflux at 0.05 W/kg peaked at the 13-16 Hz and at the 57.5-60 Hz modulation ranges. A Chinese hamster-mouse hybrid neuroblastoma was also shown to exhibit enhanced radiation-induced $45Ca^{2+}$ efflux at a SAR of 0.05 W/kg, using 147 MHz, AM at 16 Hz. These results confirm that amplitude-modulated radiofrequency radiation can induce responses in cells of nervous tissue origin from widely different animal species, including humans. The results are also consistent with the reports of similar findings in avian and feline brain tissues and indicate the general nature of the phenomenon.

(9) Fesenko, EE, Makar, VR, Novoselova, EG, Sadovnikov, VB. Microwaves and cellular immunity. I. Effect of whole body microwave irradiation on tumor necrosis factor production in mouse cells. *Bioelectrochem Bioenerg* 49(1):29-35, 1999.

Whole body microwave sinusoidal irradiation of male NMRI mice with 8.15-18 GHz (1 Hz within) at a power density of 1 microW/cm² caused a significant enhancement of TNF production in peritoneal macrophages and splenic T lymphocytes. Microwave radiation affected T cells, facilitating their capacity to proliferate in response to mitogenic stimulation. The exposure duration necessary for the stimulation of cellular immunity ranged from 5 h to 3 days. Chronic irradiation of mice for 7 days produced the decreasing of TNF production in peritoneal macrophages. The exposure of mice for 24 h increased the TNF production and immune proliferative response, and these stimulatory effects persisted over 3 days after the termination of exposure. Microwave treatment increased the endogenously produced TNF more effectively than did lipopolysaccharide, one of the most potential stimuli of synthesis of this cytokine. The role of microwaves as a factor interfering with the process of cell immunity is discussed.

(10) Hjolland NH, Bonde JP, Skotte J. Semen analysis of personnel operating military radar equipment. *Reprod Toxicol* 11(6):897, 1997.

This is a preliminary survey of semen quality among Danish military personnel operating mobile ground-to-air missile units that use several microwave emitting radar systems. The maximal mean exposure was estimated to be 0.01 mW/cm². The median sperm density of the military personnel was significantly low compared to the references. The difference is either due to chance, uncontrolled bias, or nonthermal effects of transitory microwaves.

(11) Hocking B, Gordon IR, Grain HL, Hatfield GE. Cancer incidence and mortality and proximity to TV towers. *Med J Aust* 165(11-12):601-605, 1996. (Published erratum appears in *Med J Aust* 166(2):80, 1997.)

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OBJECTIVE: To determine whether there is an increased cancer incidence and mortality in populations exposed to radiofrequency radiations from TV towers. DESIGN: An ecological study comparing cancer incidence and mortality, 1972-1990, in nine municipalities, three of which surround the TV towers and six of which are further away from the towers. (TV radiofrequency radiation decreases with the square of the distance from the source.) Cancer incidence and mortality data were obtained from the then Commonwealth Department of Human Services and Health. Data on frequency, power, and period of broadcasting for the three TV towers were obtained from the Commonwealth Department of Communications and the Arts. The calculated power density of the radiofrequency radiation in the exposed area ranged from 8.0 microW/cm² near the towers to 0.2 microW/cm² at a radius of 4km and 0.02 microW/cm² at 12 km. SETTING: Northern Sydney, where three TV towers have been broadcasting since 1956. OUTCOME MEASURES: Rate ratios for leukaemia and brain tumour incidence and mortality, comparing the inner with the outer areas. RESULTS: For all ages, the rate ratio for total leukaemia incidence was 1.24 (95% confidence interval [CI], 1.09-1.40). Among children, the rate ratio for leukaemia incidence was 1.58 (95% CI, 1.07-2.34) and for mortality it was 2.32 (95% CI, 1.35-4.01). The rate ratio for childhood lymphatic leukaemia (the most common type) was 1.55 (95% CI, 1.00-2.41) for incidence and 2.74 (95% CI, 1.42-5.27) for mortality. Brain cancer incidence and mortality were not increased. CONCLUSION: We found an association between increased childhood leukaemia incidence and mortality and proximity to TV towers.

(12) Ivaschuk OI, Jones RA, Ishida-Jones T, Haggren W, Adey WR, Phillips JL. Exposure of nerve growth factor-treated PC12 rat pheochromocytoma cells to a modulated radiofrequency field at 836.55 MHz: effects on c-jun and c-fos expression. *Bioelectromagnetics* 18(3):223-229, 1997.

Rat PC12 pheochromocytoma cells have been treated with nerve growth factor and then exposed to athermal levels of a packet-modulated radiofrequency field at 836.55 MHz. This signal was produced by a prototype time-domain multiple-access (TDMA) transmitter that conforms to the North American digital cellular telephone standard. Three slot average power densities were used: 0.09, 0.9, and mW/cm². Exposures were for 20, 40, and 60 min and included an intermittent exposure regimen (20 min on/20 min off), resulting in total incubation times of 20, 60, and 100 min, respectively. Concurrent controls were sham exposed. After extracting total cellular RNA, Northern blot analysis was used to assess the expression of the immediate early genes, c-fos and c-jun, in all cell populations. No change in c-fos transcript levels were detected after 20 min exposure at each field intensity (20 min was the only time period at which c-fos message could be detected consistently). Transcript levels for c-jun were altered only after 20 min exposure to 9 mW/cm² (average 38% decrease).

(13) Kolodynski AA, Kolodynska VV. Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia. *Sci Total Environ* 180(1):87-93, 1996.

This paper presents the results of experiments on school children living in the area of the Skrunda Radio Location Station (RLS) in Latvia. Motor function, memory and attention significantly differed between the exposed and control groups. Children living in front of the RLS had less developed memory and attention, their reaction time was slower and their neuromuscular apparatus endurance was decreased.

(14) Kwee S, Raskmark P, Velizarov P. Changes in cellular proteins due to environmental non-ionizing radiation. I. Heat-shock proteins. *Electro- and Magnetobiology* 20: 141-152, 2001.

This paper describes the effect of weak microwave fields on the amounts of heat-shock proteins in cell cultures at various temperatures. The field was generated by signal simulation of the Global System for Mobile communications (GSM) of 960 MHz, used in portable phones. Transformed human epithelial amnion (AMA) cells, growing on glass coverslips, were exposed in a transverse electromagnetic (TEM) cell to a microwave field, generating a specific absorption rate (SAR) of 2.1 mW kg⁻¹ in the cells. Exposure temperatures were 35, 37, and 40 \pm 0.1°C, respectively, and the exposure time was 20 min. The heat-shock proteins Hsp-70 and Hsp-27 were detected by immuno-fluorescence. Higher amounts of Hsp-70 were present in the cells exposed at 35 and 37°C than in the sham-exposed cells. These effects can be considered to be athermal, since the field strength was much lower than the safety standard for absence of heat generation by microwave fields. There was no significant response in the case of Hsp-27.

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(15) Lebedeva NN, Sulimov AV, Sulimova OP, Kotrovskaya TI, Galits T. Cellular phone electromagnetic field effects on bioelectric activity of human brain. *Crit Rev Biomed Eng* 28(1-2):323-337, 2000.

24 volunteers participated in the experiments. The investigation of EEG reactions to cellular phone (EMF frequency 902.4 MHz and intensity 0.06 mW/cm²) was conducted. Two experiments were performed with each subject—cellular phone exposure and Placebo Duration of the experiment was 60 min: 15 min—background; 15 min—EMF exposure or Placebo; 30 min—after exposure. EEG was recorded in 16 standard leads with "eyes open" and "eyes closed". Special software with non-linear dynamics was developed for EEG analyses. One parameter, multichannel (global) correlation dimension, was calculated. The changes of these parameters can be evidence of brain functional state changes. As a result of EEG record processing, a significant increase of global correlation dimension during the exposure and after exposure period was discovered, more pronounced in the case of "eyes closed". That can be viewed as the manifestation of cortex activation under phone EMF exposure.

(16) Magras IN, Xenos TD. RF radiation-induced changes in the prenatal development of mice. *Bioelectromagnetics* 18(6):455-461, 1997.

The possible effects of radiofrequency (RF) radiation on prenatal development has been investigated in mice. This study consisted of RF level measurements and in vivo experiments at several places around an "antenna park." At these locations RF power densities between 168 nW/cm² and 1053 nW/cm² were measured. Twelve pairs of mice, divided in two groups, were placed in locations of different power densities and were repeatedly mated five times. One hundred eighteen newborns were collected. They were measured, weighed, and examined macro- and microscopically. A progressive decrease in the number of newborns per dam was observed, which ended in irreversible infertility. The prenatal development of the newborns, however, evaluated by the crown-rump length, the body weight, and the number of the lumbar, sacral, and coccygeal vertebrae, was improved.

(17) Mann K, Wagner P, Brunn G, Hassan F, Hiemke C, Roschke J. Effects of pulsed high-frequency electromagnetic fields on the neuroendocrine system. *Neuroendocrinology* 67(2):139-144, 1998.

The influence of pulsed high-frequency electromagnetic fields emitted from a circularly polarized antenna on the neuroendocrine system in healthy humans was investigated (900 MHz electromagnetic field, pulsed with 217 Hz, average power density 0.02 mW/cm²). Nocturnal hormone profiles of growth hormone (GH), cortisol, luteinizing hormone (LH) and melatonin were determined under polysomnographic control. An alteration in the hypothalamo-pituitary-adrenal axis activity was found with a slight, transient elevation in the cortisol serum level immediately after onset of field exposure which persisted for 1 h. For GH, LH and melatonin, no significant effects were found under exposure to the field compared to the placebo condition, regarding both total hormone production during the entire night and dynamic characteristics of the secretion pattern. Also the evaluation of the sleep EEG data revealed no significant alterations under field exposure, although there was a trend to an REM suppressive effect. The results indicate that weak high-frequency electromagnetic fields have no effects on nocturnal hormone secretion except for a slight elevation in cortisol production which is transient, pointing to an adaptation of the organism to the stimulus.

(18) Marinelli F, La Sala D, Ciccotti G, Cattini L, Trimarchi C, Putti S, Zamparelli A, Giuliani L, Tomasetti G, Cinti C. Exposure to 900 MHz electromagnetic field induces an imbalance between pro-apoptotic and pro-survival signals in T-lymphoblastoid leukemia CCRF-CEM cells. *J Cell Physiol*. 1982(2):324-332, 2004.

It has been recently established that low-frequency electromagnetic field (EMFs) exposure induces biological changes and can be associated with increased incidence of cancer, while the issue remains unresolved as to whether high-frequency EMFs can have hazardous effect on health. Epidemiological studies on association between childhood cancers, particularly leukemia and brain cancer, and exposure to low- and high-frequency EMF suggested an etiological role of EMFs in inducing adverse health effects. To investigate whether exposure to high-frequency EMFs could affect in vitro cell survival, we cultured acute T-lymphoblastoid leukemia cells (CCRF-CEM) in the presence of unmodulated 900 MHz EMF, generated by a transverse electromagnetic (TEM) cell, at various exposure times. We evaluated the effects of high-frequency EMF on cell growth rate and apoptosis induction, by cell viability (MTT) test, FACS analysis and DNA ladder, and we investigated pro-apoptotic and pro-survival signaling pathways possibly involved as a function of exposure time by Western blot analysis. At short exposure times (2-12 h), unmodulated 900 MHz EMF induced DNA breaks and early activation of both p53-dependent and -independent apoptotic pathways while longer continuous exposure (24-48 h) determined silencing of pro-apoptotic signals and

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activation of genes involved in both intracellular (Bcl-2) and extracellular (Ras and Akt1) pro-survival signaling. Overall our results indicate that exposure to 900 MHz continuous wave, after inducing an early self-defense response triggered by DNA damage, could confer to the survivor CCRF-CEM cells a further advantage to survive and proliferate.

(19) Michelozzi P, Ancona C, Fusco D, Forastiere F, Perucci CA. Risk of leukemia and residence near a radio transmitter in Italy. *Epidemiology* 9 (Suppl) 354p, 1998.

We conducted a small area study to investigate a cluster of leukemia near a high power radio-transmitter in a peripheral area of Rome. The leukemia mortality within 3.5 km (5,863 inhabitants) was higher than expected (SMR=2.5, 95% confidence interval 1.07-4.83); the excess was due to a significant higher mortality among men (7 cases observed, SMR=3.5). The results of the Stone's test, after adjusting for socio-economic confounding, showed a significant decline in risk with distance from the transmitter only among men (p=0.005), whereas the p-value for both sexes was p=0.07.

(20) Michelozzi P, Capon A, Kirchmayer U, Forastiere F, Biggeri A, Barca A, Perucci CA. Adult and childhood leukemia near a high-power radio station in Rome, Italy. *Am J Epidemiol* 155(12):1096-1103, 2002.

Some recent epidemiologic studies suggest an association between lymphatic and hematopoietic cancers and residential exposure to high-frequency electromagnetic fields (100 kHz to 300 GHz) generated by radio and television transmitters. Vatican Radio is a very powerful station located in a northern suburb of Rome, Italy. In the 10-km area around the station, with 49,656 residents (in 1991), leukemia mortality among adults (aged >14 years; 40 cases) in 1987-1998 and childhood leukemia incidence (eight cases) in 1987-1999 were evaluated. The risk of childhood leukemia was higher than expected for the distance up to 6 km from the radio station (standardized incidence rate = 2.2, 95% confidence interval: 1.0, 4.1), and there was a significant decline in risk with increasing distance both for male mortality (p = 0.03) and for childhood leukemia (p = 0.036). The study has limitations because of the small number of cases and the lack of exposure data. Although the study adds evidence of an excess of leukemia in a population living near high-power radio transmitters, no causal implication can be drawn. There is still insufficient scientific knowledge, and new epidemiologic studies are needed to clarify a possible leukemogenic effect of residential exposure to radio frequency radiation.

(21) Navakaitian MA, Tomashevskaya LA. Phasic behavioral and endocrine effects of microwaves of nonthermal intensity. In "Biological Effects of Electric and Magnetic Fields, Volume 1," D.O. Carpenter (ed) Academic Press, San Diego, CA, 1994, pp.333-342.

Microwaves at nonthermal levels are able to induce behavioral and endocrine changes at low power densities (0.01-0.1 mW/cm²). Our studies have demonstrated several phases of inhibition and activation. We suggest that inhibition of behavior by microwaves has many mechanisms depending on the strength and duration of exposure, and most inhibitory effects from direct actions on the nervous system. Activation, on the other hand, is correlated well with decreases in serum concentrations of testosterone and insulin. CW microwaves, however, have no influence on the secretion of insulin.

(22) Novoselova EG, Fesenko EE, Makar VR, Sadovnikov VB. Microwaves and cellular immunity. II. Immunostimulating effects of microwaves and naturally occurring antioxidant nutrients. *Bioelectrochem Bioenerg* 49(1):37-41, 1999.

The effect of 8.15-18 GHz (1 Hz within) microwave radiation at a power density of 1 microW/cm² on the tumor necrosis factor (TNF) production and immune response was tested. A single 5 h whole-body exposure induced a significant increase in TNF production in peritoneal macrophages and splenic T cells. The mitogenic response in T lymphocytes increased after microwave exposure. The activation of cellular immunity was observed within 3 days after exposure. The diet containing lipid-soluble nutrients (beta-carotene, alpha-tocopherol and ubiquinone Q9) increased the activity of macrophages and T cells from irradiated mice. These results demonstrate that irradiation with low-power density microwaves stimulates the immune potential of macrophages and T cells, and the antioxidant treatment enhances the effect of microwaves, in particular at later terms, when the effect of irradiation is reduced.

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(23) Novoselova EG, Ogay VB, Sorokina OV, Glushkova OV, Sinotova OA, Fesenko EE. The production of tumor necrosis factor in cells of tumor-bearing mice after total-body microwave irradiation and antioxidant diet. *Electromag. Biol. Med.* 23:167-180, 2004.

The effects of repeated treatment with weak microwaves (MW) (8.15-18 GHz, 1 μW/cm², 1.5 h daily) and diet with antioxidants (AO) (β-carotene, α-tocopherol, and ubiquinone Q₉) on production of tumor necrosis factor (TNF) in macrophages and T lymphocytes of healthy and tumor-bearing mice (TBM) were studied. Tumor size and mortality of TBM were also followed. Microwave radiation and antioxidant diet stimulated production of TNF in cells from healthy mice. At early stages, tumor growth induced TNF production in mouse cells; however, this effect decreased as tumors grew. In TBM exposed to MW, TNF production was higher than in unirradiated TBM. Oppositely, AO diet induced TNF production in healthy mice but did not affect TNF secretion in TBM. Accordingly, prolonged treatment of TBM to MW, but not to AO diet, decreased tumor growth rate and increased overall animal longevity. These results suggest that diminished tumor growth rate due to extremely low-level MW exposure of mice carrying tumors, at least in part, was caused by enhancement in TNF production and accumulation of plasma TNF.

(24) Park SK, Ha M, Im H-J. Ecological study on residences in the vicinity of AM radio broadcasting towers and cancer death: preliminary observations in Korea. *International Archives of Occupational and Environmental Health* 77(6):387-394, 2004.

Objectives Public health concern about the health effects of radio-frequency electromagnetic fields (RF-EMFs) has increased with the increase in public exposure. This study was to evaluate some health effect of RF exposure by the AM radio broadcasting towers in Korea.

Methods We calculated cancer mortality rates using Korean death certificates over the period of 1994-1995 and population census data in ten RF-exposed areas, defined as regions that included AM radio broadcasting towers of over 100 kW, and in control areas, defined as regions without a radio broadcasting tower inside and at least 2 km away from the towers.

Results All cancers-mortality was significantly higher in the exposed areas [direct standardized mortality rate ratio (MRR)=1.29, 95%CI=1.12-1.49]. When grouped by each exposed area and by electrical power, MRRs for two sites of 100 kW, one site of 250 kW and one site of 500 kW, for all subjects, and for one site of 100 kW and two sites of 250 kW, for male subjects, showed statistically significant increases without increasing trends according to the groups of electric power. Leukemia mortality was higher in exposed areas (MRR=1.70, 95% CI=0.84-3.45), especially among young adults aged under 30 years (0-14 years age group, MRR=2.29, 95% CI=1.05-5.98; 15-29 age group, MRR=2.44, 95% CI=1.07-5.24).

Conclusions We observed higher mortality rates for all cancers and leukemia in some age groups in the area near the AM radio broadcasting towers. Although these findings do not prove a causal link between cancer and RF exposure from AM radio broadcasting towers, it does suggest that further analytical studies on this topic are needed in Korea.

(25) Persson BRR, Salford LG, Brun A. Blood-brain barrier permeability in rats exposed to electromagnetic fields used in wireless communication. *Wireless Network* 3:455-461, 1997.

Biological effects of radio frequency electromagnetic fields (EMF) on the blood-brain barrier (BBB) have been studied in Fischer 344 rats of both sexes. The rats were not anesthetized during the exposure. The brains were perfused with saline for 3-4 minutes, and thereafter perfusion fixed with 4% formaldehyde for 5-6 minutes. Whole coronal sections of the brains were dehydrated and embedded in paraffin and sectioned at 5 micrometers. Albumin and fibrinogen were demonstrated immunohistochemically and classified as normal versus pathological leakage. In the present investigation we exposed male and female Fischer 344 rats in a Transverse Electromagnetic Transmission line chamber to microwaves of 915 MHz as continuous wave (CW) and pulse-modulated with different pulse power and at various time intervals. The CW-pulse power varied from 0.001 W to 10 W and the exposure time from 2 min to 960 min. In each experiment we exposed 4-6 rats with 2-4 controls randomly placed in excited and non-excited TEM cells, respectively. We have in total investigated 630 exposed rats at various modulation frequencies and 372 controls. The frequency of pathological rats is significantly increased (p<0.0001) from 62/372 (ratio 0.17 ± 0.02) for control rats to 244/630 (ratio: 0.39 ± 0.043) in all exposed rats. Grouping the exposed animals according to the level or specific absorption energy (J/kg) give significant difference in all levels above 1.5 J/kg. The exposure was

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915 MHz microwaves either pulse modulated (PW) at 217 Hz with 0.57 ms pulse width, at 50 Hz with 6.6 ms pulse width or continuous wave (CW). The frequency of pathological rats (0.17) among controls in the various groups is not significantly different. The frequency of pathological rats was 17/480 (0.35 ± 0.03) among rats exposed to pulse modulated (PW) and 74/149 (0.50 ± 0.07) among rats exposed to continuous wave exposure (CW). These results are both highly significantly different to their corresponding controls (p<0.0001) and the frequency of pathological rats after exposure to pulsed radiation (PW) is significantly less (p<0.002) than after exposure to continuous wave radiation (CW).

(26) Phillips JL, Ivashchuk O, Ishida-Jones T, Jones RA, Campbell-Beachler M, and Haggren W. DNA damage in Molt-4 T-lymphoblastoid cells exposed to cellular telephone radiofrequency fields in vitro. *Bioelectrochem. Bioenerg.* 45:103-110, 1998.

Molt-4 T-lymphoblastoid cells have been exposed to pulsed signals at cellular telephone frequencies of 813.5625 MHz (iDEN signal) and 836.55 MHz (TDMA signal). These studies were performed at low SAR (average = 2.4 and 24 microwatt/g for iDEN and 2.6 and 26 microwatt/g for TDMA) in studies designed to look for athermal RF effects. The alkaline comet, or single cell gel electrophoresis, assay was employed to measure DNA single-strand breaks in cell cultures exposed to the radiofrequency (RF) signal as compared to concurrent sham-exposed cultures. Tail moment and comet extent were calculated as indicators of DNA damage. Statistical differences in the distribution of values for tail moment and comet extent between exposed and control cell cultures were evaluated with the Kolmogorov-Smirnov distribution test. Data points for all experiments of each exposure condition were pooled and analyzed as single groups. It was found that: 1) exposure of cells to the iDEN signal at an SAR of 2.4 microwatt/g for 2 h or 21 h significantly decreased DNA damage; 2) exposure of cells to the TDMA signal at an SAR of 2.6 microwatt/g for 2 h and 21 h significantly decreased DNA damage; 3) exposure of cells to the iDEN signal at an SAR of 24 microwatt/g for 2 h and 21 h significantly increased DNA damage; 4) exposure of cells to the TDMA signal at an SAR of 26 microwatt/g for 2 h significantly decreased DNA damage. The data indicate a need to study the effects of exposure to RF signals on direct DNA damage and on the rate at which DNA damage is repaired.

(27) Polgea-Moraru R, Kovacs E, Iliescu KR, Calota V, Sajin G. The effects of low level microwaves on the fluidity of photoreceptor cell membrane. *Bioelectrochemistry* 56(1-2):223-225, 2002.

Due to the extensive use of electromagnetic fields in everyday life, more information is required for the detection of mechanisms of interaction and the possible side effects of electromagnetic radiation on the structure and function of the organism. In this paper, we study the effects of low-power microwaves (2.45 GHz) on the membrane fluidity of rod photoreceptor cells. The retina is expected to be very sensitive to microwave irradiation due to the polar character of the photoreceptor cells [Biochim. Biophys. Acta 1273 (1995) 217] as well as to its high water content [Stud. Biophys. 81 (1981) 39].

(28) Pyrasopoulou A, Kotoula V, Cheva A, Hytiroglou P, Nikolakaki E, Magras IN, Xenos TD, Tsioubikas TD, Karkavelas G. Bone morphogenetic protein expression in newborn rat kidneys after prenatal exposure to radiofrequency radiation. *Bioelectromagnetics* 25(3):216-227, 2004.

Effects of nonthermal radiofrequency radiation (RFR) of the global system of mobile communication (GSM) cellular phones have been as yet mostly studied at the molecular level in the context of cellular stress and proliferation, as well as neurotransmitter production and localization. In this study, a simulation model was designed for the exposure of pregnant rats to pulsed GSM-like RFR (0.4 GHz), based on the different resonant frequencies of man and rat. The power density applied was 5 microW/cm², in order to avoid thermal electromagnetic effects as much as possible. Pregnant rats were exposed to RFR during days 1-3 postcoitum (p.c.) (embryogenesis, pre-implantation) and days 4-7 p.c. (early organogenesis, peri-implantation). Relative expression and localization of bone morphogenetic proteins (BMP) and their receptors (BMPR), members of a molecular family currently considered as major endocrine and autocrine morphogens and known to be involved in renal development, were investigated in newborn kidneys from RFR exposed and sham irradiated (control) rats. Semi-quantitative duplex RT-PCR for BMP-4, -7, BMPR-IA, -IB, and -II showed increased BMP-4 and BMPR-IA, and decreased BMPR-II relative expression in newborn kidneys. These changes were statistically significant for BMP-4, BMPR-IA, and -II after exposure on days 1-3 p.c. (P < .001 each), and for BMP-4 and BMPR-IA after exposure on

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days 4-7 p.c. ($P < 0.01$ and $P = 0.05$, respectively). Immunohistochemistry and in situ hybridization (ISH) showed aberrant expression and localization of these molecules at the histological level. Our findings suggest that GSM-like RFR interferes with gene expression during early gestation and results in aberrations of BMP expression in the newborn. These molecular changes do not appear to affect renal organogenesis and may reflect a delay in the development of this organ. The differences of relative BMP expression after different time periods of exposure indicate the importance of timing for GSM-like RFR effects on embryonic development.

(29) Salford LG, Brun AR, Eberhardt JL, Malmgren L, Persson BRR. Nerve cell damage in mammalian brain after exposure to microwaves from GSM mobile phones. *Environ Health Persp* Online January 29, 2003.

The possible risks of radio-frequency electromagnetic fields for the human body is a growing concern for the society. We have earlier shown that weak pulsed microwaves give rise to a significant leakage of albumin through the blood-brain barrier (BBB). Now we have investigated whether a pathological leakage over the BBB might be combined with damage to the neurons. Three groups of each 8 rats were exposed for 2 hours to GSM mobile phone electromagnetic fields of different strengths. We found, and present here for the first time, highly significant ($p < 0.002$) evidence for neuronal damage in both the cortex, the hippocampus and the basal ganglia in the brains of exposed rats.

(30) Santini R, Santini P, Danze JM, Le Ruz P, Seigne M. Study of the health of people living in the vicinity of mobile phone base stations: I. Influence of distance and sex. *Pathol Biol (Paris)* 50(6):369-373, 2002. [Article in French]

A survey study using questionnaire was conducted in 530 people (270 men, 260 women) living or not in vicinity of cellular phone base stations, on 18 Non Specific Health Symptoms. Comparisons of complaints frequencies (CHI-SQUARE test with Yates correction) in relation with distance from base station and sex, show significant ($p < 0.05$) increase as compared to people living > 300 m or not exposed to base station, till 300 m for tiredness, 200 m for headache, sleep disturbance, discomfort, etc. 100 m for irritability, depression, loss of memory, dizziness, libido decrease, etc. Women significantly more often than men ($p < 0.05$) complained of headache, nausea, loss of appetite, sleep disturbance, depression, discomfort and visual perturbations. This first study on symptoms experienced by people living in vicinity of base stations shows that, in view of radioprotection, minimal distance of people from cellular phone base stations should not be < 300 m.

(31) Sarimov R, Malmgren L.O.G., Markova, E., Persson, B.R.R., Belyaev, I.Y. Nonthermal GSM microwaves affect chromatin conformation in human lymphocytes similar to heat shock. *IEEE Trans Plasma Sci* 32:1600-1608, 2004.

Here we investigated whether microwaves (MWs) of Global System for Mobile Communication (GSM) induce changes in chromatin conformation in human lymphocytes. Effects of MWs were studied at different frequencies in the range of 895-915 MHz in experiments with lymphocytes from seven test-mothers. Exposure was performed in transverse electromagnetic transmission line cell (TEM-cell) using a GSM test-mobile phone. All standard modulations included 2 W output power in the pulses, specific absorbed rate (SAR) being 5.4 mW/kg. Changes in chromatin conformation, which are indicative of stress response and genotoxic effects, were measured by the method of anomalous viscosity time dependencies (AVTD). Heat shock and treatment with the genotoxic agent camptothecin, were used as positive controls. 30-min exposure to MWs at 900 and 905 MHz resulted in statistically significant condensation of chromatin in lymphocytes from 1 of 3 tested donors. This condensation was similar to effects of heat shock within the temperature window of 40-50°C. Analysis of pooled data from all donors showed statistically significant effect of 30-min exposure to MWs. Stronger effects of MWs were found following 1-h exposure. In replicated experiments, cells from four out of five donors responded to 905 MHz. Responses to 915 MHz were observed in cells from 1 out of 5 donors, $p < 0.002$. Dependent on donor, condensation, 3 donors, or decondensation, 1 donor, of chromatin was found in response to 1-h exposure. Analysis of pooled data from all donors showed statistically significant effect of 1-h exposure to MWs. In cells from one donor, this effect was frequency-dependent ($p < 0.01$). Effects of MWs correlated statistically significantly with effects of heat shock and initial state of chromatin before exposure. MWs at 895 and 915 MHz affected chromatin conformation in transformed lymphocytes. The conclusion-GSM microwaves under specific conditions of exposure affected human lymphocytes similar to stress response. The data suggested that the MW effects differ at various GSM frequencies and vary between donors.

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(32) Schwartz JL, House DE, Mealing GA. Exposure of frog hearts to CW or amplitude-modulated VHF fields: selective efflux of calcium ions at 16 Hz. *Bioelectromagnetics* 11(4):349-358, 1990.

Isolated frog hearts were exposed for 30-min periods in a Crawford cell to a 240-MHz electromagnetic field, either continuous-wave or sinusoidally modulated at 0.5 or 16 Hz. Radiolabeled with calcium (⁴⁵Ca), the hearts were observed for movement of Ca²⁺ at calculated SARs of 0.15, 0.24, 0.30, 0.36, 1.50, or 3.00 mW/kg. Neither CW radiation nor radiation at 0.5 Hz, which is close to the beating frequency of the frog's heart, affected movement of calcium ions. When the VHF field was modulated at 16 Hz, a field-intensity-dependent change in the efflux of calcium ions was observed. Relative to control values, ionic effluxes increased by about 18% at 0.3 mW/kg (P less than .01) and by 21% at 0.15 mW/kg (P less than .05), but movement of ions did not change significantly at other rates of energy deposition. These data indicate that the intact myocardium of the frog, akin to brain tissue of neonatal chicken, exhibits movement of calcium ions in response to a weak VHF field that is modulated at 16 Hz.

(33) Somogyi Z, Thurcozy G, Kubasova T, Kovacs J, Szabo LD. Effects of modulated and continuous microwave irradiation on the morphology and cell surface negative charge of 3T3 fibroblasts. *Scanning Microsc* 5(4):1145-1155, 1991.

Mouse embryo 3T3 cells were irradiated with 2450 MHz continuous and low frequency (16 Hz) square modulated waves of absorbed energy ranging from 0.0024 to 2.4 mW/g. The low frequency modulated microwave irradiation yielded more morphological cell changes than did the continuous microwave fields of the same intensity. The amount of free negative charges (cationized ferritin binding) on cell surfaces decreased following irradiation by modulated waves but remained unchanged under the effect of a continuous field of the same dose. Modulated waves of 0.024 mW/g dose increased the ruffling activity of the cells, and caused ultrastructural alteration in the cytoplasm. Similar effects were experienced by continuous waves at higher (0.24 and 2.4 mW/g) doses.

(34) Stagg RB, Thomas WJ, Jones RA, Adey WR. DNA synthesis and cell proliferation in C6 glioma and primary glial cells exposed to a 836.55 MHz modulated radiofrequency field. *Bioelectromagnetics* 18(3):230-236, 1997.

We have tested the hypothesis that modulated radiofrequency (RF) fields may act as a tumor-promoting agent by altering DNA synthesis, leading to increased cell proliferation. In vitro tissue cultures of transformed and normal rat glial cells were exposed to an 836.55 MHz, packet-modulated RF field at three power densities: 0.09, 0.9, and 9 mW/cm², resulting in specific absorption rates (SARs) ranging from 0.15 to 59 mW/g. TEM-mode transmission-line cells were powered by a prototype time-domain multiple-access (TDMA) transmitter that conforms to the North American digital cellular telephone standard. One sham and one energized TEM cell were placed in standard incubators maintained at 37 degrees C and 5% CO₂. DNA synthesis experiments at 0.59-59 mW/g SAR were performed on log-phase and serum-starved semiconfluent cultures after 24 h exposure. Cell growth at 0.15-15 mW/g SAR was determined by cell counts of log-phase cultures on days 0, 1, 5, 7, 9, 12, and 14 of a 2 week protocol. Results from the DNA synthesis assays differed for the two cell types. Sham-exposed and RF-exposed cultures of primary rat glial cells showed no significant differences for either log-phase or serum-starved condition. C6 glioma cells exposed to RF at 5.9 mW/g SAR (0.9 mW/cm²) exhibited small (20-40%) significant increases in 38% of [³H]thymidine incorporation experiments. Growth curves of sham and RF-exposed cultures showed no differences in either normal or transformed glial cells at any of the power densities tested. Cell doubling times of C6 glioma cells (sham (21.9 ± 1.4 h) vs. field (22.7 ± 1.2 h)) also demonstrated no significant differences that could be attributed to altered DNA synthesis rates. Under these conditions, this modulated RF field did not increase cell proliferation of normal or transformed cultures of glial origin.

(35) Stark KD, Krebs T, Altpeter E, Manz B, Griot C, Abelin T. Absence of chronic effect of exposure to short-wave radio broadcast signal on salivary melatonin concentrations in dairy cattle. *J Pineal Res* 22(4):171-176, 1997.

A pilot study was conducted to investigate the influence of electromagnetic fields in the short-wave range (3-30 MHz) radio transmitter signals on salivary melatonin concentration in dairy cattle. The hypothesis to be tested was whether EMF exposure would lower salivary melatonin concentrations, and whether removal of the EMF source would be followed by higher concentration levels. For this pilot study, a controlled intervention trial was designed. Two commercial dairy herds at two farms were compared, one located at a distance of 500 m (exposed), the other at a distance of 4,000 m (unexposed) from the transmitter. At each farm, five cows were monitored with respect to their salivary melatonin concentrations over a period of ten consecutive days. Saliva samples were collected at two-

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hour intervals during the dark phase of the night. As an additional intervention, the short-wave transmitter was switched off during three of the ten days (off phase). The samples were analyzed using a radioimmunoassay. The average nightly field strength readings were 21-fold greater on the exposed farm (1.59 mV/m) than on the control farm (0.076 mV/m).

The mean values of the two initial nights did not show a statistically significant difference between exposed and unexposed cows. Therefore, a chronic melatonin reduction effect seemed unlikely. However, on the first night of re-exposure after the transmitter had been off for three days, the difference in salivary melatonin concentration between the two farms (3.89 pg/ml, CI: 2.04, 7.41) was statistically significant, indicating a two- to seven-fold increase of melatonin concentration. Thus, a delayed acute effect of EMF on melatonin concentration cannot completely be excluded. However, results should be interpreted with caution and further trials are required in order to confirm the results.

(36) Tattersall JE, Scott IR, Wood SJ, Nettell JJ, Bevir MK, Wang Z, Somasiri NP, Chen X. Effects of low intensity radiofrequency electromagnetic fields on electrical activity in rat hippocampal slices. *Brain Res* 904(1):43-53, 2001.

Slices of rat hippocampus were exposed to 700 MHz continuous wave radiofrequency (RF) fields (25.2-71.0 V m⁻¹), 5-15 min exposure) in a stripline waveguide. At low field intensities, the predominant effect on the electrically evoked field potential in CA1 was a potentiation of the amplitude of the population spike by up to 20%, but higher intensity fields could produce either increases or decreases of up to 120 and 80%, respectively, in the amplitude of the population spike. To eliminate the possibility of RF-induced artefacts due to the metal stimulating electrode, the effect of RF exposure on spontaneous epileptiform activity induced in CA3 by 4-aminopyridine (50-100 µg/ml) was investigated. Exposure to RF fields (50.0 V m⁻¹) reduced or abolished epileptiform bursting in 36% of slices tested. The maximum field intensity used in these experiments, 71.0 V m⁻¹, was calculated to produce a specific absorption rate (SAR) of between 0.0016 and 0.0044 W kg⁻¹ in the slices. Measurements with a Luxtron fiberoptic probe confirmed that there was no detectable temperature change (± 0.1 degrees C) during a 15 min exposure to this field intensity. Furthermore, imposed temperature changes of up to 1 degrees C failed to mimic the effects of RF exposure. These results suggest that low-intensity RF fields can modulate the excitability of hippocampal tissue in vitro in the absence of gross thermal effects. The changes in excitability may be consistent with reported behavioural effects of RF fields.

(37) Vangelova K, Israel M, Mihaylov S. The effect of low level radiofrequency electromagnetic radiation on the excretion rates of stress hormones in operators during 24-hour shifts. *Cent Eur J Public Health* 10(1-2):24-28, 2002.

The aim of the study was to investigate the effect of long term exposure to low level radiofrequency (RF) electromagnetic (EM) radiation on the excretion rates of stress hormones in satellite station operators during 24-hour shifts. Twelve male operators at a satellite station for TV communications and space research were studied during 24-hour shifts. Dosimetric evaluation of the exposure was carried out and showed low level exposure with specific absorption of 0.1127 J.kg⁻¹. A control group of 12 unexposed male operators with similar job task and the same shift system were studied, too. The 11-oxycorticosteroids (11-OCS), adrenaline and noradrenaline were followed by spectrofluorimetric methods on 3-hour intervals during the 24-hour shifts. The data were analyzed by tests for interindividual analysis, Cosinor analysis and analysis of variance (ANOVA). Significant increase in the 24-hour excretion of 11-OCS and disorders in its circadian rhythm, manifested by increase in the mesor, decrease in the amplitude and shift in the acrophase were found in the exposed operators. The changes in the excretion rates of the catecholamines were significant and showed greater variability of both variables. The long term effect of the exposure to low-level RF EM radiation evoked pronounced stress reaction with changes in the circadian rhythm of 11-OCS and increased variability of catecholamines secretion. The possible health hazards associated with observed alteration in the stress system need to be clarified by identification of their significance and prognostic relevance.

(38) Velizarov S, Raskmark P, Kwee S. The effects of radiofrequency fields on cell proliferation are non-thermal. *Bioelectrochem Bioenerg* 48(1):177-180, 1999.

The number of reports on the effects induced by radiofrequency (RF) electromagnetic fields and microwave (MW) radiation in various cellular systems is still increasing. Until now no satisfactory mechanism has been proposed to

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explain the biological effects of these fields. One of the current theories is that heat generation by RF/MW is the cause, in spite of the fact that a great number of studies under isothermal conditions have reported significant cellular changes after exposure to RF/MW. Therefore, this study was undertaken to investigate which effect MW radiation from these fields in combination with a significant change of temperature could have on cell proliferation. The experiments were performed on the same cell line, and with the same exposure system as in a previous work [5]. Kwee, P. Raskmark, Changes in cell proliferation due to environmental non-ionizing radiation: 2. Microwave radiation, *Bioelectrochem. Bioenerg.*, 44 (1998), pp. 251-255]. The field was generated by signal simulation of the Global System for Mobile communications (GSM) of 960 MHz. Cell cultures, growing in microtiter plates, were exposed in a specially constructed chamber, a Transverse Electromagnetic (TEM) cell. The Specific Absorption Rate (SAR) value for each cell well was calculated for this exposure system. However, in this study the cells were exposed to the field at a higher or lower temperature than the temperature in the field-free incubator i.e., the temperature in the TEM cell was either 39 or 35 ± 0.1 degrees C. The corresponding sham experiments were performed under exactly the same experimental conditions. The results showed that there was a significant change in cell proliferation in the exposed cells in comparison to the non-exposed (control) cells at both temperatures. On the other hand, no significant change in proliferation rate was found in the sham-exposed cells at both temperatures. This shows that biological effects due to RF/MW cannot be attributed only to a change of temperature. Since the RF/MW induced changes were of the same order of magnitude at both temperatures and also comparable to our previous results under isothermal conditions at 37 degrees C, cellular stress caused by electromagnetic fields could initiate the changes in cell cycle reaction rates. It is widely accepted that certain classes of heat-shock proteins are involved in these stress reactions.

(39) Veyret B, Bouthet C, Deschaux P, de Seze R, Geffard M, Jousset-Dubien J, le Diraosen M, Moreau JM, Caristan A. Antibody responses of mice exposed to low-power microwaves under combined, pulse-and-amplitude modulation. *Bioelectromagnetics* 12(1):47-56, 1991.

Irradiation by pulsed microwaves (9.4 GHz, 1 microsecond pulses at 1,000/s), both with and without concurrent amplitude modulation (AM) by a sinusoid at discrete frequencies between 14 and 41 MHz, was assessed for effects on the immune system of Balb/C mice. The mice were immunized either by sheep red blood cells (SRBC) or by glutaric-anhydride conjugated bovine serum albumin (GA-BSA), then exposed to the microwaves at a low rms power density (30 microW/cm²; whole-body-averaged SAR approximately 0.015 W/kg). Sham exposure or microwave irradiation took place during each of five contiguous days, 10 h/day. The antibody response was evaluated by the plaque-forming cell assay (SRBC experiment) or by the titration of IgM and IgG antibodies (GA-BSA experiment). In the absence of AM, the pulsed field did not greatly alter immune responsiveness. In contrast, exposure to the field under the combined-modulation condition resulted in significant, AM-frequency-dependent augmentation or weakening of immune responses.

(40) Wolke S, Neibig U, Elsner R, Gollnick F, Meyer R. Calcium homeostasis of isolated heart muscle cells exposed to pulsed high-frequency electromagnetic fields. *Bioelectromagnetics* 17(2):144-153, 1996.

The intracellular calcium concentration ([Ca²⁺]_i) of isolated ventricular cardiac myocytes of the guinea pig was measured during the application of pulsed high-frequency electromagnetic fields. The high-frequency fields were applied in a transverse electromagnetic cell designed to allow microscopic observation of the myocytes during the presence of the high-frequency fields. The [Ca²⁺]_i was measured as fura-2 fluorescence by means of digital image analysis. Both the carrier frequency and the square-wave pulse-modulation pattern were varied during the experiments (carrier frequencies: 900, 1,300, and 1,800 MHz pulse modulated at 217Hz with 14 percent duty cycle; pulsation pattern at 900 MHz: continuous wave, 16 Hz, and 50 Hz modulation with 50 percent duty cycle and 30 kHz modulation with 80 percent duty cycle). The mean specific absorption rate (SAR) values in the solution were within one order of magnitude of 1 mW/kg. They varied depending on the applied carrier frequency and pulse pattern. The experiments were designed in three phases: 500 s of sham exposure, followed by 500 s of field exposure, then chemical stimulation without field. The chemical stimulation (K⁺ -depolarization) indicated the viability of the cells. The K⁺ depolarization yielded a significant increase in [Ca²⁺]_i. Significant differences between sham exposure and high-frequency field exposure were not found except when a very small but statistically significant difference was detected in the case of 900 MHz/50 Hz. However, this small difference was not regarded as a relevant effect of the exposure.

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From The Sunday Times, April 22, 2007
<http://www.timesonline.co.uk/tol/news/uk/article1687491.ece>

Cancer clusters at phone masts

Daniel Foggo

SEVEN clusters of cancer and other serious illnesses have been discovered around mobile phone masts, raising concerns over the technology's potential impact on health.

Studies of the sites show high incidences of cancer, brain hemorrhages and high blood pressure within a radius of 400 yards of mobile phone masts.

One of the studies, in Warwickshire, showed a cluster of 31 cancers around a single street. A quarter of the 30 staff at a special school within sight of the 90ft high mast have developed tumors since 2000, while another quarter have suffered significant health problems.

The mast is being pulled down by the mobile phone after the presentation of the evidence operator O2 by local protesters. While rejecting any links to ill-health, O2 admitted the decision was "clearly rare and unusual".

Phone masts have provoked protests throughout Britain with thousands of people objecting each week to planning applications. There are about 47,000 masts in the UK.

Dr John Walker, a scientist who compiled the cluster studies with the help of local campaigners in Devon, Lincolnshire, Staffordshire and the West Midlands, said he was convinced they showed a potential link between the angle of the beam of radiation emitted from the masts' antennae and illnesses discovered in local populations.

"Masts should be moved away from conurbations and schools and the power turned down," he said.

Some scientists already believe such a link exists and studies in other European countries suggest a rise in cancers close to masts. In 2005 Sir William Stewart, chairman of the Health Protection Agency, said he found four such studies to be of concern but that the health risk remained unproven.

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SALZBURG RESOLUTION ON MOBILE TELECOMMUNICATION BASE STATIONS

International Conference on Cell Tower Siting
 Linking Science & Public Health
 Salzburg, June 7-8, 2000
www.land-sbg.gv.at/celltower

1. It is recommended that development rights for the erection and for operation of a base station should be subject to a permission procedure. The protocol should include the following aspects:
 - Information ahead and active involvement of the local public
 - Inspection of alternative locations for the siting
 - Protection of health and wellbeing
 - Considerations on conservation of land- and townscape
 - Computation and measurement of exposure
 - Considerations on existing sources of HF-EMF exposure
 - Inspection and monitoring after installation.
2. It is recommended that a national database be set up on a governmental level giving details of all base stations and their emissions.
3. It is recommended for existing and new base stations to exploit all technical possibilities to ensure exposure is as low as achievable (ALATA-principle) and that new base stations are planned to guarantee that the exposure at places where people spend longer periods of time is as low as possible, but within the strict public health guidelines.
4. Presently the assessment of biological effects of exposures from base stations in the low-dose range is difficult but indispensable for protection of public health. There is at present evidence of no threshold for adverse health effects. Recommendations of specific exposure limits are prone to considerable uncertainties and should be considered preliminary. For the total of all high frequency irradiation a limit value of 100 mW/m² (10 µW/cm²) is recommended.

For preventive public health protection a preliminary guideline level for the sum total of exposures from all ELF pulse modulated high-frequency facilities such as GSM base stations of 1 mW/m² (0.1 µW/cm²) is recommended.

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Disclaimer: The Resolution represents the personal opinion of the undersigning scientist and public health specialist and not that of the organization they are affiliated to.

Dr. Ekkehardt Altpeter	Inst. for Social- and Preventive Medicine, University of Bern	Bern, Switzerland
Dr. Carl Blackman	US Environmental Protection Agency Research Triangle Park,	North Carolina, USA
Dr. Neil Cherry	Lincoln University Christchurch	Christchurch, New Zealand
Prof. Dr. Huai Chiang	Zhejiang University School of Medicine Microwave Lab	Hangzhou, China
Dr. Bill P. Curry	EMSciTek Consulting Co.	Glen Ellyn, Illinois, USA
Dr. Dr. Livio Giuliani ¹	National Institute of Occupational Safety and Prevention (ISPESL)	Rome, Italy
Prof. Dr. Yuri Grigoriev	Centre of Electromagnetic Safety, Institute of Biophysics	Moscow, Russia
Dr. Helene Irvine	Greater Glasgow Health Board, Dept. of Public Health	Glasgow, Scotland, UK
Dr. Christoph König	Federal State of Salzburg, Public Health Dept., Environmental Health	Salzburg, Austria
Prof. Dr. Michael Kundi	University of Vienna, Inst. for Environmental Health	Vienna, Austria
Ronald Macfarlane	Health Promotion and Environmental Protection Office, Toronto Public Health	Toronto, Canada
Dr. Malcolm MacGarvin	Environment Agency	Glenlivet, Scotland, UK
Dr. Fiorenzo Marinelli ¹	Ist. di Citomorfologia C.N.R.	Bologna, Italy
Prof. Dr. Wilhelm Mosgöller	University of Vienna, Inst. for Cancer Research	Vienna, Austria
Dr. Gerd Oberfeld	Federal State of Salzburg, Public Health Dept., Environmental Health	Salzburg, Austria
Dr. Colin Ramsay	Scottish Center for Infection and Environmental Health (SCIEH)	Glasgow, Scotland, UK
MA Cindy Sage	Sage Associates	Santa Barbara, CA, USA
Dr. Luis Slesin	Microwave News	New York, USA
Prof. Dr. Stan Szmigielski ¹	Department of Microwave Safety, Military Institute of Hygiene and Epidemiology	Warsaw, Poland

¹ This preliminary guideline level of 1 mW/m² (0.1 µW/cm²) is, by the participants marked with a (1), understood as an operational level for one facility (e.g. a cell tower).

Further Signatures given after the Conference

Prof. Dr. Olle Johansson Department of Neuroscience, Karolinska Institute Stockholm, Sweden

mhavas@trentu.ca

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CATANIA RESOLUTION

September 2002, <http://www.emrpolicy.org/faq/catania.pdf>

The Scientists at the International Conference "State of the Research on Electromagnetic Fields – Scientific and Legal Issues," organized by ISPESL*, the University of Vienna, and the City of Catania, held in Catania (Italy) on September 13–14, 2002, agree to the following:

1. Epidemiological and *in vivo* and *in vitro* experimental evidence demonstrates the existence for electromagnetic field (EMF) induced effects, some of which can be adverse to health.
2. We take exception to arguments suggesting that weak (low intensity) EMF cannot interact with tissue.
3. There are plausible mechanistic explanations for EMF-induced effects, which occur below present ICNIRP and IEEE guidelines and exposure recommendations by the EU.
4. The weight of evidence calls for preventive strategies based on the precautionary principle. At times the precautionary principle may involve prudent avoidance and prudent use.
5. We are aware that there are gaps in knowledge on biological and physical effects, and health risks related to EMF, which require additional independent research.
6. The undersigned scientists agree to establish an international scientific commission to promote research for the protection of public health from EMF and to develop the scientific basis and strategies for assessment, prevention, management and communication of risk, based on the precautionary principle.

Fiorella Belpoggi, Fondazione Ramazzini, Italy
 Carl F. Blackman, President of the Bioelectromagnetic Society (1990-1991), Raleigh, USA
 Martin Blank, Department of Physiology, Columbia University, New York, USA
 Emilio Del Giudice, INFN Milano, Italy
 Livio Giuliani, University Camerino, Italy
 Settimio Grimaldi, CNR-INMM, Roma, Italy
 Lenart Hardell, Department of Oncology, University Hospital, Örebro, Sweden
 Michael Kundi, Institute of Environmental Health, University of Vienna, Austria
 Henry Lai, Department of Bioengineering, University of Washington, USA
 Abraham R. Liboff, Department of Physics, Oakland University, USA
 Wolfgang Löscher, Department of Pharmacology, Toxicology and Pharmacy, School of Veterinary Medicine, Hannover, Germany
 Kjell Hansson Mld, National Institute of Working Life, Umeå, Sweden
 Wilhelm Mosgöller, Institute for Cancer Research, University of Vienna, Austria
 Eihu D. Richter, Unit of Occupational and Environmental Medicine, Hebrew-University-Hadassah, Jerusalem, Israel
 Umberto Scapagnini, Neuropharmacology, University of Catania, Italy, Member of the European Parliament
 Stanislaw Szmigielski, Military Institute of Hygiene and Epidemiology, Warsaw, Poland
 * = Istituto Superiore per la Prevenzione e la Sicurezza del Lavoro, Italy
 (National Institute for Prevention and Work Safety, Italy)

mhavas@trentu.ca

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Appendix 6

FREIBURGER APPEAL (GERMANY)
October 2002

Out of great concern for the health of our fellow human beings do we - as established physicians of all fields, especially that of environmental medicine - turn to the medical establishment and those in public health and political domains, as well as to the public.

- We have observed, in recent years, a dramatic rise in severe and chronic diseases among our patients, especially:
- Learning, concentration, and behavioural disorders (e.g. attention deficit disorder, ADD)
- Extreme fluctuations in blood pressure, ever harder to influence with medications
- Heart rhythm disorders
- Heart attacks and strokes among an increasingly younger population
- Brain-degenerative diseases (e.g. Alzheimer-s) and epilepsy
- Cancerous afflictions: leukemia, brain tumors

- Moreover, we have observed an ever-increasing occurrence of various disorders, often misdiagnosed in patients as psychosomatic:
- Headaches, migraines
- Chronic exhaustion
- Inner agitation
- Sleeplessness, daytime sleepiness
- Tinnitus
- Susceptibility to infection
- Nervous and connective tissue pains, for which the usual causes do not explain even the most conspicuous symptoms

- Since the living environment and lifestyles of our patients are familiar to us, we can see especially after carefully-directed inquiry a clear temporal and spatial correlation between the appearance of disease and exposure to pulsed high -frequency microwave radiation (HFMR), such as:
- Installation of a mobile telephone sending station in the near vicinity
- Intensive mobile telephone use
- Installation of a digital cordless (DECT) telephone at home or in the neighborhood

- We can no longer believe this to be purely coincidence, for:
- Too often do we observe a marked concentration of particular illnesses in correspondingly HFMR-polluted areas or apartments;
- Too often does a long-term disease or affliction improve or disappear in a relatively short time after reduction or elimination of HFMR pollution in the patient's environment;
- Too often are our observations confirmed by on-site measurements of HFMR of unusual intensity.

On the basis of our daily experiences, we hold the current mobile communications technology (introduced in 1992 and since then globally extensive) and cordless digital telephones (DECT standard) to be among the fundamental triggers for this fatal development. One can no longer evade these pulsed microwaves. They heighten the risk of already-present chemical/physical influences, stress the body's immune system, and can bring the body's still-functioning regulatory mechanisms to a halt. Pregnant women, children, adolescents, elderly and sick people are especially at risk.

Our therapeutic efforts to restore health are becoming increasingly less effective: the unimpeded and continuous penetration of radiation into living and working areas particularly bedrooms, an essential

place for relaxation, regeneration and healing causes uninterrupted stress and prevents the patient's thorough recovery.

In the face of this disquieting development, we feel obliged to inform the public of our observations especially since hearing that the German courts regard any danger from mobile telephone radiation as "purely hypothetical" (see the decisions of the constitutional court in Karlsruhe and the administrative court in Mannheim, Spring 2002).

What we experience in the daily reality of our medical practice is anything but hypothetical! We see the rising number of chronically sick patients also as the result of an irresponsible " safety limits" policy, which fails to take the protection of the public from the short- and long-term effects of mobile telephone radiation as its criterion for action. Instead, it submits to the dictates of a technology already long recognized as dangerous. For us, this is the beginning of a very serious development through which the health of many people is being threatened. We will no longer be made to wait upon further unreal research results - which in our experience are often influenced by the communications industry while evidential studies go on being ignored. We find it to be of urgent necessity that we act now!

Above all, we are, as doctors, the advocates for our patients. In the interest of all those concerned, whose basic right to life and freedom from bodily harm is currently being put at stake, we appeal to those in the spheres of politics and public health.

Please support the following demands with your influence:

- New health-friendly communications techniques, given independent risk assessments before their introduction and, as immediate measures and transitional steps:
- Stricter safety limits and major reduction of sender output and HFMR pollution on a justifiable scale, especially in areas of sleep and convalescence
- A say on the part of local citizens and communities regarding the placing of antennae (which in a democracy should be taken for granted)
- Education of the public, especially of mobile telephone users, regarding the health risks of electromagnetic fields
- Ban on mobile telephone use by small children, and restrictions on use by adolescents
- Ban on mobile telephone use and digital cordless (DECT) telephones in preschools, schools, hospitals, nursing homes, events halls, public buildings and vehicles (as with the ban on smoking)
- Mobile telephone and HFMR-free zones (as with auto-free areas)
- Revision of DECT standards for cordless telephones with the goal of reducing radiation intensity and limiting actual use time, as well as avoiding the biologically critical HFMR pulsation
- Industry-independent research, finally with the inclusion of amply available critical research results and our medical observations.

Undersigned omitted (more than 3000 signatures)

Appendix 7

HELSINKI APPEAL (FINLAND): 2005
http://www.emrpolicy.org/news/headlines/helsinki_appeal_05.pdf

Dear Member of the European Parliament,

We, undersigned physicians and researchers, feel great concern about the Precautionary Principle not being sufficiently applied to the electromagnetic fields, especially in the radio- and microwave frequency bands.

New applications of wireless technologies are continually being introduced, regardless of the fact that there are plenty of qualified scientific reports reporting possible health risks. According to several studies, both in the cell and animal studies, mobile phone and other RF radiation can induce various disturbances, such as increasing the permeability of the blood-brain-barrier. Also disorders of EEG (electroencephalography) and cognitive functions and in the production of the cell proteins have been reported. The latest epidemiological study by Stefan Lönn, with the well known Swedish professor Anders Ahlbom as a co-author, suggests that the risk of acoustic neurinoma (a nerve tumor in the ear) may increase more than three-fold after 10 years of the mobile phone use.

Unfortunately, the consequences of these disturbances for common health are an open question. This is a matter of great concern. The present safety standards of ICNIRP (International Commission of Non-Ionizing Radiation Protection) do not recognize the biological effects caused by non-ionizing radiation except those induced by the thermal effect. In the light of recent scientific information, the standards recommended by ICNIRP have become obsolete and should be rejected. Especially children and other persons at risk should be taken into account when re-evaluating the limits. This was also suggested in the Freiburg Appeal of 2002, which was signed by more than 3000 European colleagues.

We appeal to you as a member of the European Parliament to act promptly for the adoption of the new safety standard in the European Union.

Another question of importance regards the REFLEX study (Risk evaluation of potential environmental hazards from low-energy electromagnetic field (EMF) exposure using sensitive in-vitro methods), which is carried out by 12 research teams from European universities and other organizations. For example, the REFLEX study showed evidence of genotoxic effects of mobile phone radiation. EU has partly funded REFLEX. The REFLEX study has not been published in the scientific publications, nor refunded. It is absolutely necessary that the REFLEX project will be continued. However, the project should be targeted more to the non-thermal effects and be involved with those researchers, who have already been working in the field of the biological, non-thermal effects.

The European Community should take prompt measures for solving the refunding of the NEW REFLEX project.

Appendix 8

SENSITIVITY TO NON-IONISING RADIATION IN IRELAND

Irish Doctors' Environmental Association (IDEA).
E-mail: IDEA@eircom.net ; Website: http://www.ideaireland.org

January 2005

Irish Doctors' Environmental Association (IDEA)
Position Paper on Electro-Magnetic Radiation

The Irish Doctors' Environmental Association believes that a sub-group of the population are particularly sensitive to exposure to different types of electro-magnetic radiation. The safe levels currently advised for exposure to this non-ionizing radiation are based solely on its thermal effects. However, it is clear that this radiation also has non-thermal effects, which need to be taken into consideration when setting these safe levels. The electro-sensitivity experienced by some people results in a variety of distressing symptoms which must also be taken into account when setting safe levels for exposure to non-ionizing radiation and when planning the siting of masts and transmitters.

- 1. An increasing number of people in Ireland are complaining of symptoms which, while they may vary in nature, intensity and duration, can be demonstrated to be clearly related to exposure to electro-magnetic radiation (EMR).
2. International studies on animals over the last 30 years have shown the potentially harmful effects of exposure to electro-magnetic radiation. In observational studies, animals have shown consistent distress when exposed to EMR. Experiments on tissue cultures and rats have shown an increase in malignancies when exposed to mobile telephone radiation.
3. Studies on mobile telephone users have shown significant levels of discomfort in certain individuals following extensive use or even, in some cases, following regular short-term use.
4. The current safe levels for exposure to microwave radiation were determined based solely on the thermal effects of this radiation. There is now a large body of evidence that clearly shows that this is not appropriate, as many of the effects of this type of radiation are not related to these thermal effects.

The Irish Doctors' Environmental Association believes that the Irish Government should urgently review the information currently available internationally on the topic of the thermal and non-thermal effects of exposure to electro-magnetic radiation with a view to immediately initiating appropriate research into the adverse health effects of exposure to all forms of non-ionizing radiation in this country, and into the forms of treatment available elsewhere. Before the results of this research are available, an epidemiological database should be initiated of individuals suffering from symptoms thought to be related to exposure to non-ionizing radiation. Those claiming to be suffering from the effects of exposure to electro-magnetic radiation should have their claims investigated in a sensitive and thorough way, and appropriate treatment provided by the State. The strictest possible safety regulations should be established for the installation of masts and transmitters, and for the acceptable levels of potential exposure of individuals to electro-magnetic radiation, in line with the standards observed in New Zealand.

Appendix 9

BENEVENTO RESOLUTION September 2006

The International Commission for Electromagnetic Safety (ICEMS) held an international conference entitled "The Precautionary EMF Approach: Rationale, Legislation and Implementation", hosted by the City of Benevento, Italy, on February 22, 23 & 24, 2006. The meeting was dedicated to W. Ross Adey, M.D. (1922-2004). The scientists at the conference endorsed and extended the 2002 Catania Resolution (4) and resolved that:

1. More evidence has accumulated suggesting that there are adverse health effects from occupational and public exposures to electric, magnetic and electromagnetic fields, or EMF¹⁰, at current exposure levels. What is needed, but not yet realized, is a comprehensive, independent and transparent examination of the evidence pointing to this emerging, potential public health issue.
2. Resources for such an assessment are grossly inadequate despite the explosive growth of technologies for wireless communications as well as the huge ongoing investment in power transmission.
3. There is evidence that present sources of funding bias the analysis and interpretation of research findings towards rejection of evidence of possible public health risks.
4. Arguments that weak (low intensity) EMF cannot affect biological systems do not represent the current spectrum of scientific opinion.
5. Based on our review of the science, biological effects can occur from exposures to both extremely low frequency fields (ELF EMF) and radiation frequency fields (RF EMF). Epidemiological and *in vivo* as well as *in vitro* experimental evidence demonstrates that exposure to some ELF EMF can increase cancer risk in children and induce other health problems in both children and adults. Further, there is accumulating epidemiological evidence indicating an increased brain tumor risk from long term use of mobile phones, the first RF EMF that has started to be comprehensively studied. Epidemiological and laboratory studies that show increased risks for cancers and other diseases from occupational exposures to EMF cannot be ignored. Laboratory studies on cancers and other diseases have reported that hypersensitivity to EMF may be due in part to a genetic predisposition.
6. We encourage governments to adopt a framework of guidelines for public and occupational EMF exposure that reflect the Precautionary Principle¹¹ -- as some nations

¹⁰ EMF, in this resolution, refers to zero to 300 GHz.

¹¹ The Precautionary Principle states when there are indications of possible adverse effects, though they remain uncertain, the risks from doing nothing may be far greater than the risks of taking action to control these exposures. The Precautionary Principle shifts the burden of proof from those suspecting a risk to those who discount it.

have already done. Precautionary strategies should be based on design and performance standards and may not necessarily define numerical thresholds because such thresholds may erroneously be interpreted as levels below which no adverse effect can occur. These strategies should include:

- 6.1. Promote alternatives to wireless communication systems, e.g., use of fiber optics and coaxial cables; design cellular phones that meet safer performance specifications, including radiating away from the head; preserve existing land line phone networks; place power lines underground in the vicinity of populated areas, only siting them in residential neighborhoods as a last resort;
- 6.2. Inform the population of the potential risks of cell phone and cordless phone use. Advise consumers to limit wireless calls and use a land line for long conversations.
- 6.3. Limit cell phone and cordless phone use by young children and teenagers to the lowest possible level and urgently ban telecom companies from marketing to them.
- 6.4. Require manufacturers to supply hands-free kits (via speaker phones or ear phones), with each cell phone and cordless phone.
- 6.5. Protect workers from EMF generating equipment, through access restrictions and EMF shielding of both individuals and physical structures.
- 6.6. Plan communications antenna and tower locations to minimize human exposure. Register mobile phone base stations with local planning agencies and use computer mapping technology to inform the public on possible exposures. Proposals for city-wide wireless access systems (e.g. Wi-Fi, WiMAX, broadband over cable or power-line or equivalent technologies) should require public review of potential EMF exposure and, if installed, municipalities should ensure this information is available to all and updated on a timely basis.
- 6.7. Designate wireless-free zones in cities, in public buildings (schools, hospitals, residential areas) and, on public transit, to permit access by persons who are hypersensitive to EMF.
7. ICEMS¹² is willing to assist authorities in the development of an EMF research agenda. ICEMS encourages the development of clinical and epidemiological protocols for investigations of geographical clusters of persons with reported allergic reactions and other diseases or sensitivities to EMF, and document the effectiveness of preventive interventions. ICEMS encourages scientific collaboration and reviews of research findings.

We, the undersigned scientists, agree to assist in the promotion of EMF research and the development of strategies to protect public health through the wise application of the precautionary principle.

¹² International Commission For Electromagnetic Safety. For information, link to www.icems.eu.

Signed:

Fiorella Belpoggi, European Foundation for Oncology & Environmental Sciences, B. Ramazzini, Bologna, Italy
Carl F. Blackman, President, Bioelectromagnetics Society (1990-91), Raleigh, NC, USA
Martin Blank, Department of Physiology, Columbia University, New York, USA
Natalia Bobkova, Institute of Cell Biophysics, Pushchino, Moscow Region
Francesco Boella, National Inst. Prevention & Worker Safety, Venice, Italy
Zhaojin Cao, National Institute Environmental Health, Chinese Center for Disease Control, China
Sandro DiAlessandro, Physician, Mayor of Benevento, Italy, (2001-2006)
Enrico DiEmilia, National Institute for Prevention and Worker Safety, Monteporzio, Italy
Emilio Del Giudice, National Institute for Nuclear Physics, Milan, Italy
Antonella De Ninno, Italian National Agency For Energy, Environment & Technology, Frascati, Italy
Alvaro A. De Sallas, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil
Livio Giuliani, East Veneto & South Triol, National Inst. Prevention & Worker Safety, Camerino University
Yury Grigoryev, Institute of Biophysics; Chairman, Russian National Committee NIERP
Settimo Grimaldi, Inst. Neurobiology & Molecular Medicine, National Research, Rome, Italy
Lennart Hardell, Department of Oncology, University Hospital, Orebro, Sweden
Magda Havas, Environmental & Resource Studies, Trent University, Ontario, Canada
Gerard Hyland, Warwick University, UK; International Inst. Biophysics, Germany; EM Radiation Trust, UK
Olle Johansson, Experimental Dermatology Unit, Neuroscience Department, Karolinska Institute, Sweden
Michael Kundi, Head, Institute Environmental Health, Medical University of Vienna, Austria
Henry C. Lai, Department of Bioengineering, University of Washington, Seattle, USA
Mario Ledda, Inst. Neurobiology & Molecular Medicine, National Council for Research, Rome, Italy
Yi-Ping Lin, Center of Health Risk Assessment & Policy, National Taiwan University, Taiwan
Antonella Lisi, Inst. Neurobiology & Molecular Medicine, National Research Council, Rome, Italy
Fiorenzo Marinelli, Institute of Immunocytology, National Research Council, Bologna, Italy
Elihu Richter, Head, Occupational & Environmental Medicine, Hebrew University-Hadassah, Israel
Emanuela Rosola, Inst. Neurobiology & Molecular Medicine, National Research Council, Rome, Italy
Leif Salford, Chairman, Department of Neurosurgery, Lund University, Sweden
Nesrin Seyhan, Head, Department of Biophysics; Director, Gazi NIRP Center, Ankara, Turkey
Morando Soffritti, Scientific Director, European Foundation for Oncology & Environmental Sciences, B. Ramazzini, Bologna, Italy
Stanislaw Szmigielski, Military Institute of Hygiene and Epidemiology, Warsaw, Poland
Mikhail Zhadin, Institute of Cell Biophysics, Pushchino, Moscow Region

Date of Release: September 19, 2006. For more information, contact Elizabeth Kelley, Managing Secretariat, International Commission For Electromagnetic Safety (ICEMS), Montepulciano, Italy. Email: info@icems.eu
Website: www.icems.eu