

**Evidence of Neurological effects of  
Electromagnetic Radiation: Implications  
for degenerative disease and brain  
tumour from residential, occupational,  
cell site and cell phone exposures.**

**Dr Neil Cherry O.N.Z.M.  
Associate Professor of Environmental Health**

**10<sup>th</sup> September 2002**

**Neil.Cherry@ecan.govt.nz**

**© Dr Neil Cherry 2002-2005**

**Human Sciences Department  
P.O. Box 84  
Lincoln University  
Canterbury, New Zealand**

# **Evidence of Neurological effects of Electromagnetic Radiation: Implications for degenerative disease and brain tumour from residential, occupational, cell site and cell phone exposures.**

**Dr Neil Cherry, O.N.Z.M.  
Associate Professor of Environmental Health  
Lincoln University, New Zealand**

**10<sup>th</sup> September 2002**

## **Abstract**

The brain it is a really sensitive bioelectromagnetic organ. Therefore it is scientifically plausible that brain will react to and be sensitive to external electromagnetic signals. It has been shown that has very strong evidence that the brain detects and responds to the Schumann Resonance signal of  $0.1\text{pW}/\text{cm}^2$ . Since the first evidence that RF radiation damages chromosomes in 1959, many independent studies have identified broken DNA stands, chromosome aberrations and altered gene expression in animal cells, human cells and in living animals and humans from EMR exposure. Microwaves, including cell phone radiation, open the Blood Brain Barrier (BBB). Exposure to RF/MW is consistently associated with headaches, fatigue, loss of concentration and memory loss. These symptoms have been called "The Radiofrequency Sickness Syndrome" or "Microwave Syndrome". Because these are subjective symptoms they have been largely dismissed in the West. These symptoms are now shown with cell phone use in a significant dose-response manner. All of these effects are linked to electromagnetic radiation's ability to alter cellular calcium ions and GABA through cellular signal transduction processes not involving heat, to reduce melatonin and damage DNA, and enhance Apoptosis. A large and growing body of epidemiological research is revealing EMR associated neurological effects, degenerative disease and brain tumour. Cell phone radiation is involved in many of the biological effects and now shows significant increases in DNA damage and brain tumours. Residential exposures down to  $0.4\text{nW}/\text{cm}^2$ , typically a thousand times stronger than the Schumann Resonance signal, and living within the vicinity of cell sites, are shown to have a causal relationship to the melatonin reduction related sleep disturbance. Therefore they will produce a host of other genotoxic and melatonin related health effects.

Key Words: Electromagnetic radiation, calcium ion efflux, GABA, genotoxicity, melatonin reduction, neurological disease, suicide, brain cancer

## **Introduction:**

Our brains are exquisitely sensitive bioelectrochemical organs that are the seat of human creativity, memory, emotions and intelligence. We use electrical signals, including charged calcium ions, to think, remember and see, to regulate the beating of our heart, and for communication in our central nervous system and between and within our cells. Human brains were proven in the 1950's and 1960's, König (1974) and Wever (1974), to be very sensitive to and reactive to extremely small, naturally occurring Schumann Resonances. The Schumann Resonances are global low frequency signals that share the same part of the spectrum as the EEG. They are generated largely by tropical thunderstorms. They

propagate around the (at the speed of light), being ducted in the resonant cavity formed between the earth and the ionosphere. König observed highly significant alteration of human reaction times associated with the intensity of the Schumann Resonances, Figure 1. He then carried out laboratory experiments and could speed people up with 10 Hz signals and slow them down with 3 Hz signals. This work was independently confirmed by Hamer (1965, 1969). Wever (1974) carried out long-term isolation experiments and showed that isolation from sunlight resulted in significantly lengthened daily rhythms. Isolation also from all EMR extended the daily period significantly more. About 30 % of subjects were desynchronized, producing very long and erratic daily rhythms. These could be corrected by the introduction of a very low intensity 10 Hz signal, similar to the primary Schumann Resonance peak.

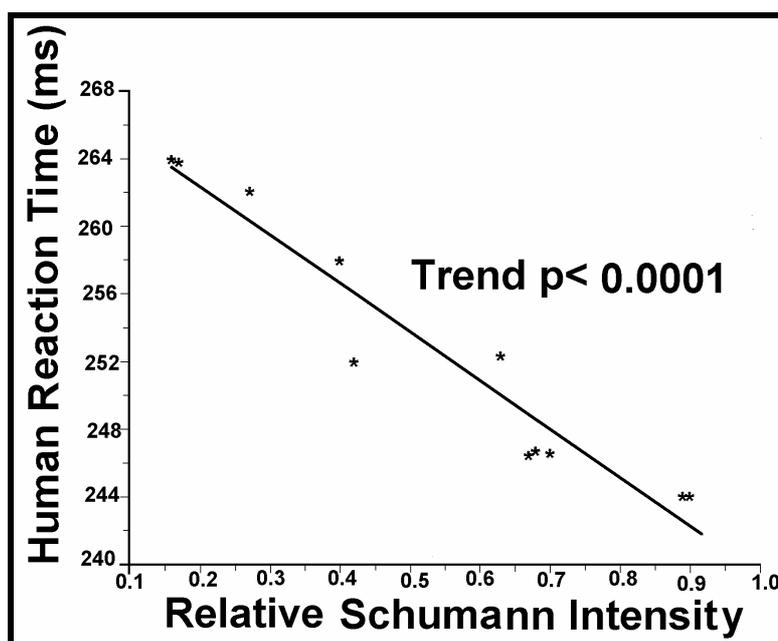


Figure 1: Human reaction times are causally correlated with natural variations in the Schumann Resonance Intensity, König (1974). The mean Schumann intensity (Relative Schumann Intensity =0.5) is 0.65mV/m or 0.1pW/cm<sup>2</sup>. The range is 0.2 to 1.2 mV/m (0.01 to 0.4pW/cm<sup>2</sup>).

The original König and Hamer experiments involved field strengths in the order of 1 V/m (0.27 $\mu$ W/cm<sup>2</sup>) but results were still statistically significant when 1mV/m (0.27pW/cm<sup>2</sup>) was used. The Schumann Resonances have a fundamental frequency of 7.8 Hz. The spectrum has other resonance peaks near 14.1, 20.3, 26.4 and 32.5 Hz. The three primary peaks between 7 and 21 Hz have a mean intensity of about 0.1pW/cm<sup>2</sup>, Polk (1982). Thus the early German research concluded that there was significant proof that human beings react to electromagnetic radiation at extremely low intensities, including that naturally produced and called the Schumann Resonances. They speculated that humans had evolved to use the Schumann Resonances to timing synchronization, that is, they are a Zeitgeber.

Cherry (2002) shows that the Schumann Resonance (SR) signal modulation by Solar/Geomagnetic Activity (S/GMA) modulates human melatonin, Figure 2, and causes modulation of human health effect including, cancer, cardiac, reproductive and neurological diseases and mortality, with a mean intensity of 0.1pW/cm<sup>2</sup>, with a magnetic field component about 1-3pT.

It is noted that cell sites produce signal intensities over  $0.1\mu\text{W}/\text{cm}^2$ , out to 500m to 1000 m, depending on the power and height of the tower. This is 1 million times higher than the natural SR signals that it is proven that our brains detect and use. The possibility of interference with the natural signals and the processes that they alter is strongly evident.

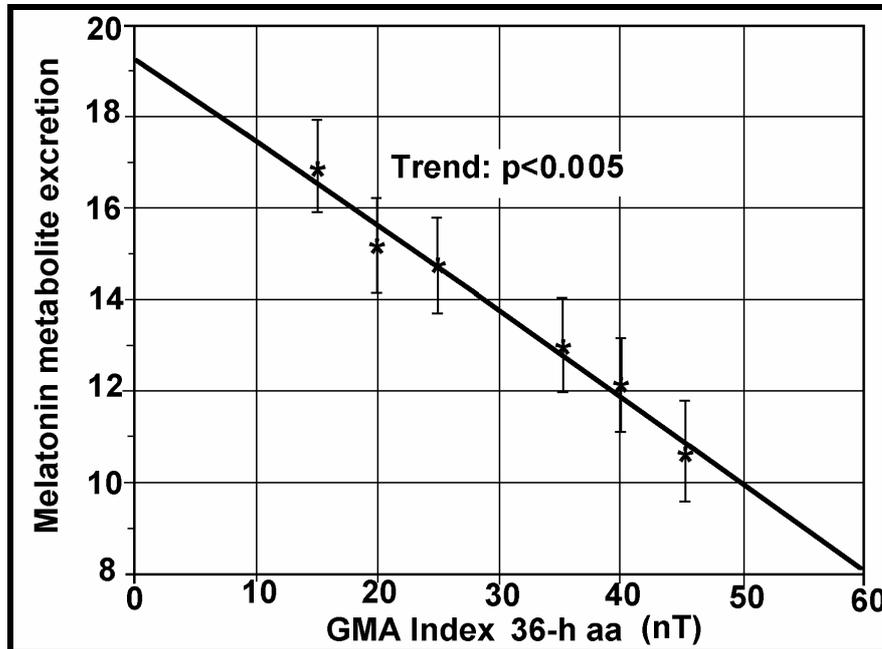


Figure 2: Reduction in the melatonin metabolite 6-OHMS in  $\mu\text{g}$  in urine from U.S. electric utility workers, as a function of the 36 hr global GMA aa-index, Burch et al. (1999b).

Figures 1 and 2 show a classically causal relationship between the Schumann Resonance signal strength, which is extremely correlated with GMA indices, with altered human reaction times and modulation of human melatonin.

A core principle of Environmental Health is understanding and appreciating the natural system before assessing the impact of human activity on people, organs and cells. The failure of authorities to appreciate this and to apply this principle, has led to massive trends in neurological illnesses from living in electric power produced ELF fields and RF/MW fields from radio and TV stations, computer screens, cordless phones, and occupational exposures of electrical workers, physiotherapists, airport staff, military, police and fire personnel, radio and TV personnel. Most recently this involves the introduction of a cellular phone network and wireless laptop systems.

Western public exposure guidelines and standards are typically in the range 0.1 to 10 billion times higher than the SR signal which is causally associated with modulation of human health effects. The evidence and conclusions of this report give a strong motivation for revising exposure standards and the development and application of safer technologies.

## **Early Evidence of Neurological Symptoms from chronic radar exposure:**

Evidence that radiofrequency/microwave (RF/MW) radiation also interacts with human brains at extremely low intensities comes from the U.S. Embassy in Moscow during the

1950s-1970s, Lilienfeld et al. (1978). Overall the mortality rate of Moscow personnel was 42% and in the comparative posts personnel it was 36% of the U.S. rate, showing the health employee effect and the healthier status of State Department staff through the selection of health staff.

The U.S. Embassy was deliberately irradiated by Soviet radar for over 20 years. It was aimed at the 5<sup>th</sup> floor of the west wall at one end of the Embassy Building. During most of this time the peak reading was  $5\mu\text{W}/\text{cm}^2$ , over the working hours. The internal exposures are much smaller, Pollard (1979). Mean daily exposures are typically in the range 0.01 to  $0.1\mu\text{W}/\text{cm}^2$ .

Several significant adverse health effects were identified. Several sickness symptoms were significantly increased with years of service in the Moscow Embassy, a dose-response relationship. They included Arthritis/Rheumatism (trend  $p=0.02$ ), Back Pain (trend  $p=0.04$ ), Ear problems (trend  $p=0.02$ ), Skin/Lymphatic (trend  $p=0.02$ ) and Vascular System (trend  $p=0.004$ )

The male staff who were chronically exposed to the radar signal showed a wide range of elevated neurological symptoms, some of which were significantly increased. These included depression ( $p=0.004$ ), irritability ( $p=0.009$ ), difficulty in concentration ( $p=0.001$ ), memory loss ( $p=0.008$ ). Dependents developed increased rates of cancer, including significant brain tumors, SMR = 20 (2.4-72.2). Children had increased mental and nervous conditions (RR = 5.0) and behavioural problems (RR= 2.06).

Baranski and Czerski (1976) give a description of a microwave exposure syndrome that was identified by Soviet researchers, e.g. Gordon (1966). Similar syndromes were reported in France by Deroche (1971) and in Israel by Moscovici et al. (1974). The Syndrome's symptoms included headaches, fatigue, irritability, nausea, vertigo, sleep disturbances and decreased libido. Johnson-Liakouris (1998) states that a literature review and the Lilienfeld study supports the Radiofrequency (RF) Sickness Syndrome as a medical entity. The headache symptoms were found with microwave exposure during "microwave hearing" experiments, Frey (1998) and in microwave exposure case studies, Forman et al. (1986).

The evidence was strong enough in 1982 for the Supreme Court of New York to award workers compensation for "Radiofrequency Sickness Syndrome" for chronic occupational microwave exposure to a technician servicing TV transmitters in the 87th floor of the Empire State Building, Yannon vs New York Telephone Co. The compensation also recognized that the chronic microwave exposure caused his death. Application for leave to appeal was declined. The primary expert witness in this case was Dr Milton Zaret.

### **Biological Mechanisms for Neurological Effects:**

Biological mechanism for these effects have been well identified, especially, reduced melatonin. Pulsed and modulated RF/MW radiation is also shown to induce efflux of calcium ions and GABA from brain cells.

GABA related neurotransmitters are changed in a dose response manner by 915 MHz microwaves, Figure 3. Altered GABA is shown to cause all of the neurological symptoms identified above. GABA (gamma-amino butyric acid) and glutamatergic synapses make up up to 60 % of the synapses in the CNS and 40 % in the brain, Kolomytkin et al. (1994). Hence induced alteration of GABA in the brain can have serious consequences. Figure 3

shows that a 5 minute exposure to pulsed microwaves have a dose-response effect on GABA related receptors.

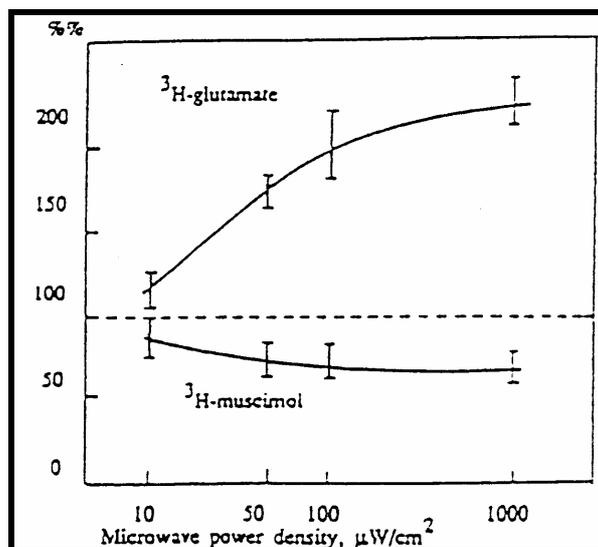


Figure 3: Exposure related alteration of GABA related molecules in rat brains exposed for 5 minutes to 915 MHz microwaves, pulsed at 16 pps. Differences from controls are still significant at  $10\mu\text{W}/\text{cm}^2$ . Kolomytkin et al. (1994)

Frey (1995) concludes that EMR affects the dopamine systems of the brain through its effects on GABA. He also notes that the dopamine-opiate systems interact with the pineal melatonin/serotonin system.

### **Altering Cellular calcium in homeostasis:**

The initial calcium ion research of Adey and Bawin was motivated by the observations that EMR altered reaction times in people, König (1974) and Hamer (1965, 1969), and monkeys, Gavalas-Medici and Day-Magdaleno (1976). Bawin, Gavalas-Medici and Adey (1973) showed alterations in cat EEGs and subsequently calcium ion efflux from cat brains under the same exposure conditions, Adey (1979). Shandala et al. (1979) show that microwaves significantly altered the EEG of animals.

Calcium ions are ubiquitous in cells throughout our bodies. The calcium ion ( $\text{Ca}^{2+}$ ) is one of the most important substances in cells.  $\text{Ca}^{2+}$  is a first, second and third signal transduction messenger, Alberts et al. (1994), Pahl (1999). Alberts et al. describes  $\text{Ca}^{2+}$  as a prominent and ubiquitous intracellular messenger. This means that factors that induce changes of cellular  $\text{Ca}^{2+}$  can cause significant changes of cells. As a signal transduction messenger  $\text{Ca}^{2+}$  initiates and regulates many cellular processes, such as melatonin production. Given that EMR induces changes in cellular calcium ions it is reasonable to investigate whether EMR induces changes in melatonin. This biological plausibility of ELF detection by the brain is significantly strengthened by the observation that mammal brains contain and use phase-locked loop circuitry to detect and react to incoming ELF signals, Ahissar et al. (1997). Hence our brains contain a highly efficient, tuned FM receiver, Motluk (1997).

Chemical substances, such as TPA, are cancer promoters. They operate by altering the calcium ions. They cause calcium ion influx, which stops a damaged cell from going into apoptosis (programmed cell death) so that the cancer cell survives. Certain electromagnetic radiation combinations cause calcium ion influx, i.e. promoting cancer,

while other causes of calcium ion efflux, promoting apoptosis. Balcer-Kubiczek (1995) describes the ways in which TPA at low concentrations are able to switch the effect of calcium ion elevation from cell death to cell proliferation, probably by the activation of protein kinase C.

Dr Carl Blackman reviewed the extensive research literature on calcium ion efflux. He was well qualified to do this since he and his group at the U.S. E.P.A. had been responsible to replicating and extending all of the research shown in other laboratories. Blackman (1990) concludes:

**"Taken together, the evidence overwhelmingly indicates that electric and magnetic fields can alter normal calcium ion homeostasis and lead to changes in the response of biological systems to their environment".**

Blackman (1990) concludes that calcium ion efflux/influx is an established biological effect of EMR exposure and it changes the biological response of cells. Because modulation frequencies are critically involved, and low intensity exposures are observed under some circumstances to produce greater effects than some higher exposure conditions, resonant interactive processes are indicated and heating is definitely not involved except to establish a homeostatic range.

Blackman's group confirmed and significantly extended the "windows" concept of  $\text{Ca}^{2+}$  efflux, as well as aspects of homeostasis, involving tissue temperature for example.  $\text{Ca}^{2+}$  efflux is a function of modulation frequencies. Frequencies out to 510 Hz produce significant  $\text{Ca}^{2+}$  efflux at some frequencies, but not at other frequencies on either side, Blackman et al. (1988). Power-Density windows are also identified, Bawin and Adey (1976), Blackman et al. (1989). The lowest intensity that has been published showing significant  $\text{Ca}^{2+}$  efflux is 0.00015 W/kg, Schwartz et al. (1990). This involved a 16 Hz modulation carried on a 240 MHz carrier. This is equivalent to  $0.08\mu\text{W}/\text{cm}^2$ .

Blackman et al. (1990a) showed the importance of the local static magnetic field. Blackman et al. (1991) showed that  $\text{Ca}^{2+}$  efflux occurred for tissue temperatures of  $36^\circ\text{C}$  and  $37^\circ\text{C}$  and not at  $35^\circ\text{C}$  and  $38^\circ\text{C}$ .  $\text{Ca}^{2+}$  efflux is demonstrably not a thermal effect. It occurs at extremely low non-thermal levels and is a function of frequency, modulation frequency and it occurs in exposure windows. This appears to be a form of resonant interaction.

In some quarters the RF-Thermal View still dominates. This has been challenged many times since the Second World War. For example, Dr Adey gave the introductory paper to a 1974 conference, Adey (1975), on the effects of EMR on the nervous system. In this paper he states:

**"Even a recent review body of the World Health Organization decided after discussion to dismiss from its concerns possible biological effects that might occur in the absence of significant heating. It has become clear, however, that interactions with the mammalian central nervous system can be reliably produced by oscillating electric and electromagnetic fields without significant heating of tissues."**

Blackman et al. (1991) comment that the windowing aspects of  $\text{Ca}^{2+}$  efflux could be very good reasons why experimental outcomes have been difficult to confirm in some laboratories. Everything may appear to be the same but the local magnetic field is

different and completely changes the results. High exposure levels that raise the temperature outside the homeostatic range will produce no effects. Hence only non-thermal exposures produce these effects. Thus people are moving through constantly changing fields at home, at work and in the environment. They pass through windows of effect and no effect all the time. The cumulative effect of the 'effect' windows produces dose-response increases in health effects associated with extremely low mean exposures. The calcium ion effects are shown in brain tissue and heart muscle tissue, implicating neurological and cardiac effects.  $\text{Ca}^{2+}$  efflux from pinealocytes (cell in the pineal gland) is likely to reduce melatonin production. This has implications for many kinds of sickness, cancer, miscarriage, neurological disease etc... because melatonin is a very potent free radical scavenger and

### **EMR Reduces Melatonin in Animals and People**

DNA strand breaks, Chromosome Aberrations, impaired immune system competence and many other biological and health effects, are caused by reduced melatonin, Reiter and Robinson (1995). Light-at-night and electromagnetic radiation, are proven to reduce melatonin and hence pose significant adverse health effects.

Light-at-night and electromagnetic radiation, are proven to reduce melatonin and hence pose significant adverse health effects. The evidence for EMR is summarized here. Rosen, Barber and Lyle (1998) state that seven different laboratories have reported suppression of nighttime rise in pineal melatonin production in laboratory animals. They show that a 50  $\mu\text{T}$ , 60 Hz field with a 0.06 $\mu\text{T}$  DC field, over 10 experiments, averages a 46% reduction in melatonin production from pinealocytes. Yaga et al. (1993) showed that rat pineal response to ELF pulsed magnetic fields varied significantly during the light-dark-cycle. They found that the rate-limiting enzyme in melatonin synthesis, N-acetyltransferase (NAT) activity showed that magnetic field exposure significantly suppressed NAT during the mid- to late dark phase.

Seventeen studies from show that ELF and RF/MW exposure reduces melatonin and enhances serotonin in people. Evidence that EMR reduced melatonin in human beings commenced with Wang (1989) who found that workers who were more highly exposed to RF/MW had a dose-response increase in serotonin, and hence indicates a dose-response reduction in melatonin. Sixteen studies have observed significant EMR associated melatonin reduction in humans. They involve a wide range of exposure situations. This includes 16.7 Hz fields, Pfluger et al. (1996); 50/60 Hz fields, Wilson et al. (1990), Graham et al. (1994), Wood et al. (1998), Karasek et al. (1998), Burch et al. (1997, 1998, 1999a, 2000), Juutilainen et al. (2000) and Graham et al. (2000); combination of 60 Hz fields and cell phone use, Burch et al. (1997, 1999a); VDTs ELF/RF exposures, Arnetz et al. (1996), and a combination of occupational 60Hz exposure and increased geomagnetic activity around 30nT, Burch et al. (1999b). Two recent studies recorded significant melatonin reduction in women in EMF residential exposure situations, Davis et al. (2002) and Levallois et al. (2002).

The eighteenth human melatonin reduction study is from 6.1-21.8 MHz SW RF exposure as reported during the shutting down process of the Schwarzenburg shortwave radio tower, Professor Theo Abelin (seminar and pers.comm.). Urinary melatonin levels were monitored prior to and following the closing down of the Schwarzenburg short wave radio transmitter. This showed a significant rise in melatonin after the signal was turned off.

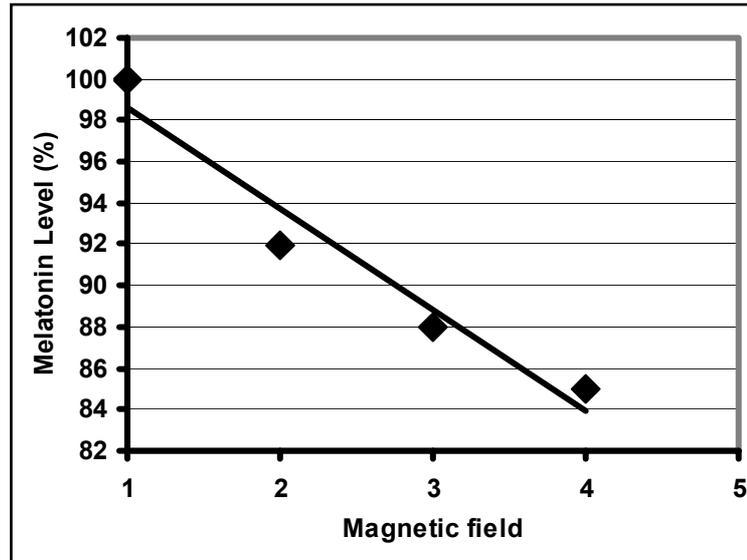


Figure 4: Human melatonin reduction from residential field exposures, the horizontal graph scale is in multiples from the lowest exposure (1), Davis (1997).

### Schwarzenburg Study:

The Swiss research, Altpeter et al. (1995, 1997) - The Schwarzenburg Study) found a causal relationship between sleep disturbance and subsequent chronic fatigue, and short-wave radio exposures at extremely low mean levels. A wide range of symptoms were significantly elevated in a dose response manner, especially for those aged more than 45 years. In a multivariate analysis only the RF exposure was independently significantly associated with sleep disturbance,  $p < 0.01$ .

The causal relationship between RF radiation exposure and deterioration in sleep quality is identified through a significant dose response relationship ( $p < 0.001$ ), Figures 5 and 6, improvements in sleep quality which changing the direction of the beams and turning the transmitter off, and reduced melatonin as the biological mechanism.

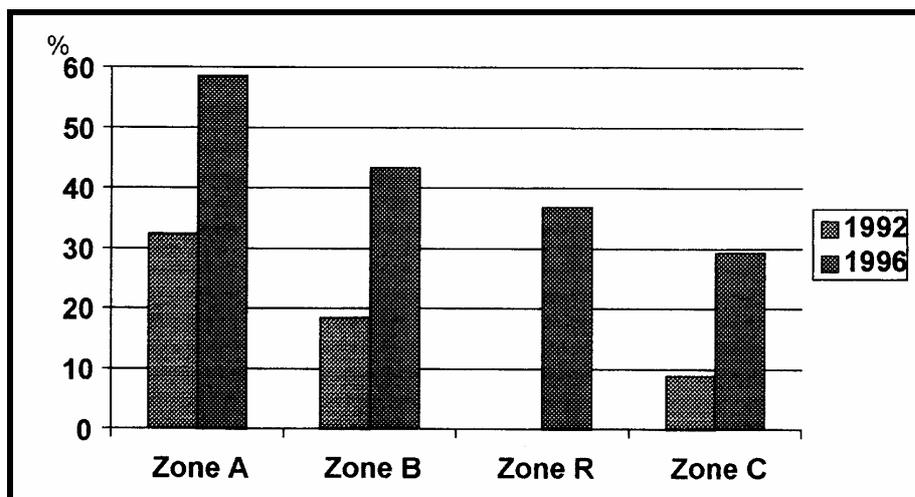


Figure 5: Adult Sleep Disturbance with RF exposure at Schwarzenburg, Switzerland, Altpeter et al. (1997).

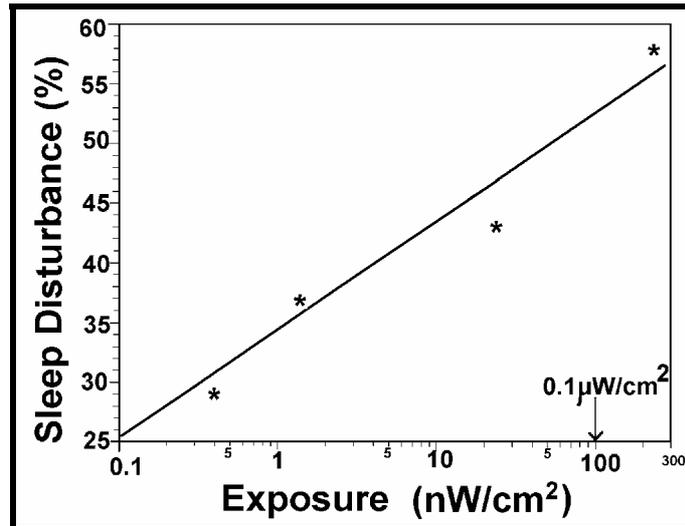


Figure 6: Dose-response relationship for Sleep Disturbance at Schwarzenburg with exposure in nW/cm<sup>2</sup>. Note: 1nW/cm<sup>2</sup>= 0.001μW/cm<sup>2</sup>

Groups B, R and C are all exposed to a mean RF signal of less than 0.1μW/cm<sup>2</sup> and they experienced highly significant sleep disturbance and reduced melatonin. Since sleep disturbance and melatonin reduction has been observed with cell phone exposure, Mann and Roschke (1995) and Burch et al. (1997), these observations also apply to cell sites. Assuming a normal sleep disturbance of 10 %, the approximate exposure level threshold for zero additional effect is near 1 pW/cm<sup>2</sup>, near the natural level for the Schumann Resonances.

As an experiment, the transmitter was secretly turned off for three days. Sleep quality improved in all three groups being studied. Figure 7 shows Groups A and C.

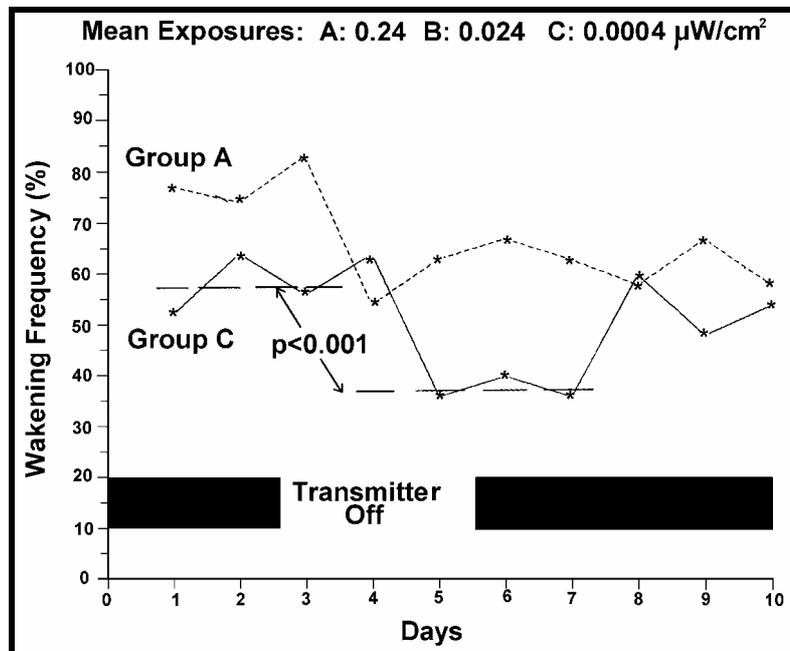


Figure 7: Sleep disturbance in people exposed to a short-wave radio stations which was turned off for three days, Altpeter et al. (1995), showing the highest exposed Group A, and lowest exposed Group C.

Both Groups show a delayed improvement in sleep of one to two days. The reduced wakening averaged over days 4 to 6 compared with days 1 to 3, for group A, and days 5

to 7 compared with days 1 to 4 for group C, are highly significantly reduced,  $p < 0.001$ . Thus a significant ( $p < 0.001$ ) improvement in sleep quality is associated with a measured 24 hour mean and median exposure of  $0.1 \text{ mA/m}$  ( $0.4 \text{ nW/cm}^2$ ).

Human melatonin was sampled from urine in the morning. This is relatively ineffective because the important measure is the nocturnal peak. Altpeter et al. note that "Persons reporting sleep disorders, however, tend to have lower melatonin levels." When the decision was made to close down the transmitter permanently, melatonin readings were taken from a large group of residents before and after the closure. This showed a significant increase in melatonin following the closure, Professor Theo Abelin pers. Comm - seminar).

Two herds of 5 cows each, had salival melatonin sampled several times a day, including night-time. The "exposed" herd as at 500 m from the tower with a mean exposure of  $0.095 \mu\text{W/cm}^2$ . Their mean melatonin levels were  $17.7 \text{ pg/ml}$  compared with  $19.0 \text{ pg/ml}$  for the "unexposed" cows whose measured mean exposure as  $0.00022 \mu\text{W/cm}^2$ . Figure 8 shows the melatonin for these two herds during the experiment involving turning the tower off.

The small number of cows makes it difficult to show a significant difference. There is a persistent phase shift in the nocturnal melatonin peak with the exposed cows showing a delay. This reduced when the transmitter was off but returned when it was turned on. The exposed cows have lower mean melatonin prior to the off period. It rises progressively while the transmitter is off and is significantly higher on the third night. It then drops significantly when the transmitter is turned on again. This shows the "classic" effect of EMR reduction of melatonin. The "low" exposure cow's melatonin drops when the transmitter is turned on.

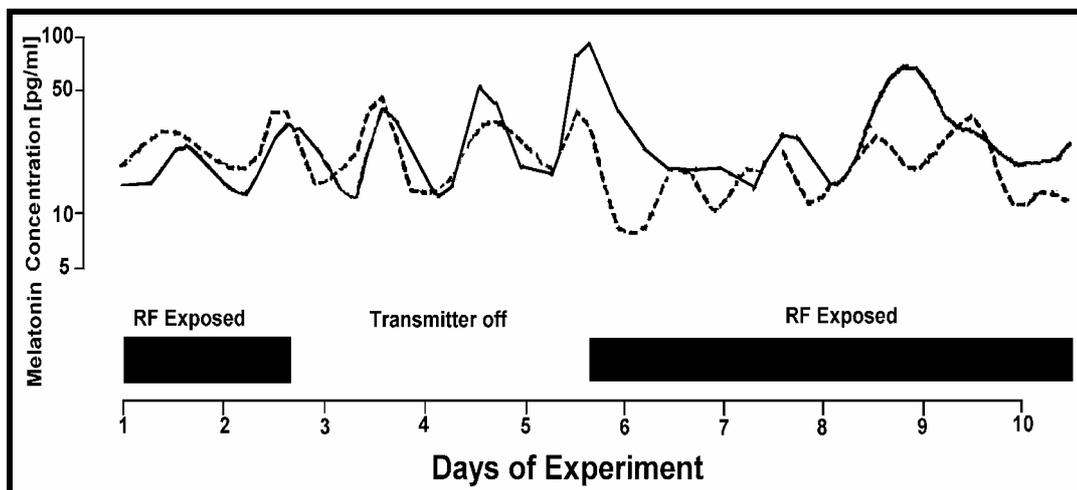


Figure 8: Salivary melatonin from two herds of 5 cows, one exposed at 500 m,  $0.095 \mu\text{W/cm}^2$ , (solid line) and one "unexposed" at 4000 m,  $0.00022 \mu\text{W/cm}^2$ , (dashed line).

The causal relationship with human sleep disturbance is strong evidence of a significant neurological effect of RF radiation on people, associated with mean exposures down to less than  $0.4 \text{ nW/cm}^2$ . Hence, it is highly likely that cell phone users, with brain exposures many millions of times higher than the Schwarzenburg exposure levels, will experience significant neurological effects. The significant bovine behavioural effects of extremely low RF exposure is confirmed by Löscher and Käs (1998).

Table 1: Odd's ratios for an increase in 24-hour average exposure from 1 to 10 mA/m (0.04 to 3.8 $\mu$ W/cm<sup>2</sup>) adjusted for age, sex, attribution and duration of time lived at the same place

Symptoms	OR	95% Confidence Intervals
Nervosity (Anxiety)	2.77	1.62 - 4.74
Diff. in falling asleep	3.35	1.86 - 6.03
Diff. in maintaining sleep	3.19	1.84 - 5.52
Joint pain	2.46	1.37 - 4.43
Limb pain	2.51	1.15 - 5.50
Cough and sputum	2.80	1.18 - 6.64

All of the symptoms in Table 1 are consistent with reduced melatonin, Reiter and Robinson (1995). When the symptoms are ranked by exposure zone they form a dose-response relationship, Table 2. All of the symptoms in Table 1, except for cough and sputum, show very highly significant dose-response trends. Significant trends are also seen for Psychovegetative Index, Feeling Body excitement and Constipation. Non-significant trends are seen for Disturbed Concentration, Stomach pain and Neck and Shoulder pain. It is a common experience that lack of sleep, anxiety and depression lead to many other illnesses and symptoms.

Table 2: Complaints by Zones for all ages, showing the p-value for the trend.

Symptoms	Zone A(%)	Zone B (%)	Zone C (%)	Trend p-value
Nervousness (Anxiety)	25.0	18.0	7.0	<0.001
Difficulty in falling asleep	22.9	17.6	6.7	<0.001
Difficulty in maintaining sleep	32.4	18.5	8.9	<0.001
General weakness and tiredness	22.0	13.0	6.0	<0.001
Limb pain	14.3	6.7	3.3	0.003
Joint pain	22.9	10.1	10.0	0.004
Psychovegetative Index	12.5	5.2	3.4	0.010
Feeling body excitement	7.6	5.9	1.1	0.018
Constipation	7.6	6.7	1.7	0.034
Disturbed concentration	7.6	2.5	2.8	0.083
Stomach pains	9.5	5.9	3.9	0.152
Neck and shoulder pain	17.1	15.1	10.0	0.182

### Other Neurological Effects:

Since it is now established that EMR alters calcium ions, GABA and melatonin, including overwhelming evidence for melatonin reduction in people, it is expected that EMR exposure will produce observable neurological effects, especially those that are known to be related to calcium ions, GABA or melatonin reduction.

### Recent Research results from cell phone radiation exposure:

In recent years research into the biological effects of cell phones have revealed many significant effects, especially neurological effects, Table 3.

**Table 3: Biological effects shown by mainly government and industry funded research that associates cell phone radiation with the following symptoms:**

- Alters brain activity including EEG, Von Klitzing (1995), Mann and Roschkle (1996)
- Disturbs sleep. Mann and Roschkle (1996), Bordely et al. (1999)
- Alters human reaction times, Preece et al. (1999), Induced potentials, Eulitz et al. (1998), slow brain potentials, Freude et al. (1998), Response and speed of switching attention (need for car driving) significantly worse, Hladky et al. (1999). Altered reaction times and working memory function (positive), Koivisto et al. (2000).
- Causes memory loss, concentration difficulties, fatigue, and headache, in a dose response manner, (Mild et al. (1998)). Headache, discomfort, nausea, Hocking (1998).

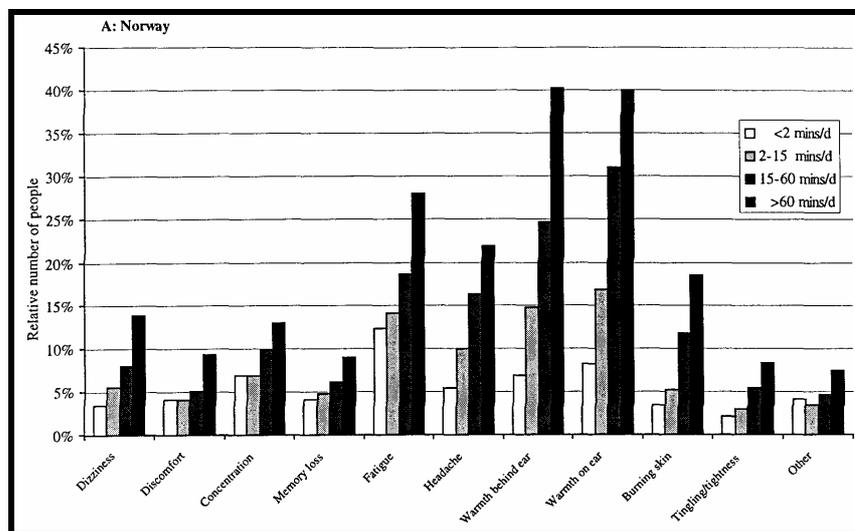


Figure 9: Prevalence of symptoms for Norwegian mobile phone users, mainly analogue, with various categories of length of calling time per day, Mild et al. (1998).

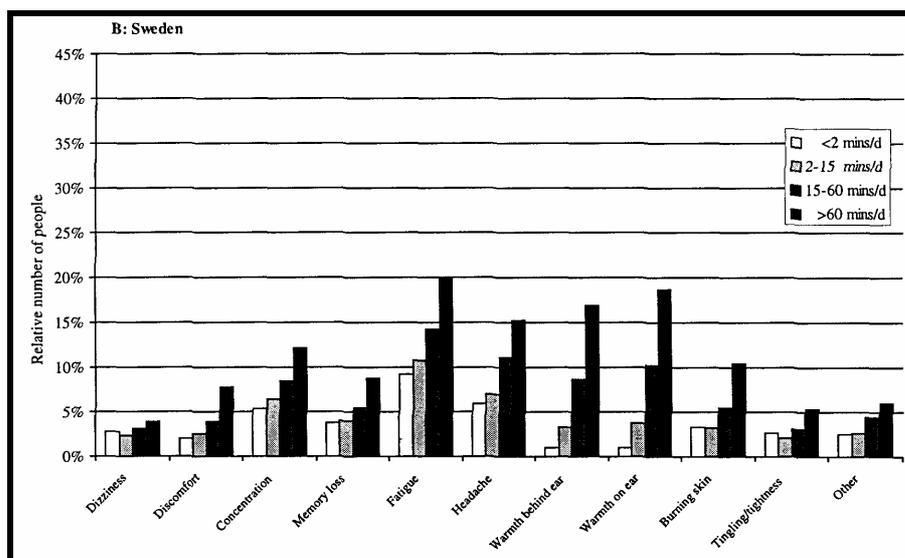


Figure 10: Prevalence of symptoms for Swedish mobile phone users, mainly digital, with various categories of length of calling time per day, Mild et al. (1998).

These are the same symptoms that have frequently been reported as "Microwave Sickness Syndrome" or "Radiofrequency Sickness Syndrome", Baranski and Czerski (1976) and Johnson-Liakouris (1998).

- A Fifteen minute exposure, increased auditory brainstem response and hearing deficiency in 2 kHz to 10 kHz range, Kellenyi et al. (1999).
- Highly significant Increased permeability of the blood brain barrier for 915 MHz radiation at SAR =0.016-0.1 ( $p=0.015$ ) and SAR = 0.1-0.4 ( $p=0.002$ ); Salford et al. (1994).
- Significant changes in local temperature, and in physiologic parameters of the CNS and cardiovascular system, Khdnisskii, Moshkarev and Fomenko (1999).
- Reduces the pituitary production of Thyrotropin (Thyroid Stimulating Hormone, TSH):

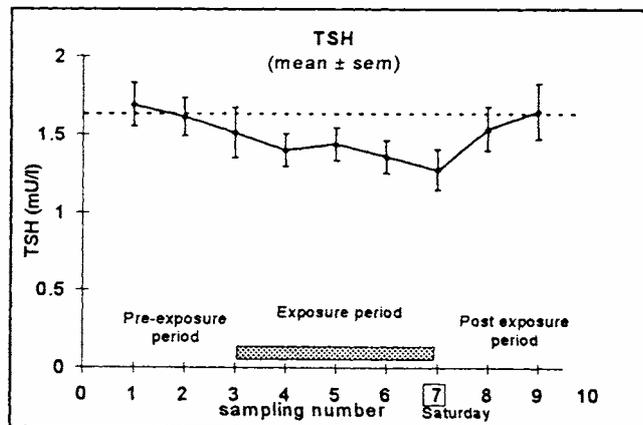


Figure 11: A significant reduction in Thyrotropin (Thyroid Stimulating Hormone) during cell phone use, de Seze et al. (1998).

- Decreases in sperm counts and smaller tube development in testes, Dasdag et al. (1999).
- Increases embryonic mortality of chickens, Youbicier-Simo, Lebecq and Bastide (1998).
- Increases blood pressure, Braune et al. (1998).
- Reduces melatonin, Burch et al. (1997).
- Breaks DNA strands (Verschaeve et al. (1994), Maes et al. (1997), Phillips et al. (1998)).
- Produces an up to three-fold increase in chromosome aberrations in a dose response manner from all cell phones tested, Tice, Hook and McRee, reported in Microwave News, April/May 1999.
- Doubles c-fos gene activity (a proto oncogene) for analogue phones and increases it by 41 % for digital phones, Goswami et al. (1999), altered c-jun gene, Ivaschuk et al. (1997), Increased hsp70 messenger RNA, Fritiz et al. (1997).

- Increase Tumour Necrosis Factor (TNF), Fesenko et al. (1999)
- DNA synthesis and cell proliferation increased after 4 days of 20 min for 3 times/day exposure. Calcium ions were significantly altered, French, Donnellan and Mc Kenzie (1997). Decreased cell proliferation, Kwee and Raskmark (1997), Velizarov, Raskmark and Kwee (1999)
- Doubles the cancer in mice, Repacholi et al. (1997).
- Increases human brain tumor rate by 2.5 times (Hardell et al. (1999)). Associated with an angiosarcoma (case study), Hardell (1999), significant increases in Brain Cancer, Hardell et al. (2000, 2002) and for Astrocytoma Hardell et al. (2002a).

An objective and independent scientific assessment would clearly state, cell phones are a strong risk factor for all of the adverse health effects identified for EMR. Hence, although a specific study is yet to be carried out, there is extremely strong evidence to conclude that cell phones are a risk factor for breast cancer. The biological mechanisms involving hormone change and altered cellular function and damage, and neurological effects, strongly supports the hypothesis that neurological effects found in association with EMR exposures are highly likely to be seen from chronic use of cell phones.

### **Alzheimer's disease:**

Sobel et al. (1995) analysed three independent studies about AD and EMR exposure. All three studies had a consistent OR (2.9, 3.1, and 3.0). The combined results were very highly significant, OR = 3.0, 95%CI: 1.6-5.4,  $p < 0.001$ , and for women OR = 3.8, 95%CI: 1.7-8.6,  $p < 0.001$ . They concluded that the most obvious possibly etiological relevant exposure is that of electromagnetic fields.

Sobel et al. (1996) found that workers in industries with likely electromagnetic field exposure have a very significant ( $p = 0.006$ ) increase in incidence of Alzheimer's disease, OR = 3.93, 95% CI: 1.5-10.6. For males the adjusted odds ratio was 4.9, 95% CI: 1.3-7.9,  $p = 0.01$ , and for females, OR = 3.40, 95% CI: 0.8-16.0,  $p = 0.01$ . They note that:

**“These results are consistent with previous findings regarding the hypothesis that electromagnetic field exposure is etiologically associated with the occurrence of AD.”**

Sobel and Davanipour (1996) outline the etiological process they hypothesize by which EMR produces Alzheimer's disease.

- The first step involves EMR exposure upsetting the cellular calcium ion homeostasis through calcium ion efflux from cells increasing the intracellular calcium ion concentrations. This cleaves the amyloid precursor protein to produce soluble amyloid beta (sA $\beta$ ).
- sA $\beta$  is quickly secreted from cells after production, increasing the levels of sA $\beta$  in the blood stream. sA $\beta$  then binds to Apolipoprotein E and apolipoprotein J to be transported to and across the Blood Brain Barrier.

- Over time, when sufficient  $sA\beta$  have been transported to the brain, a cascade of further events lead to the formation of insoluble neurotoxic beta pleated sheets of amyloid fibril, senile plaques, and eventually AD.

The biological mechanism for EMR to cause Alzheimer's disease is well advanced and entirely plausible, commencing with calcium ion efflux.

### Multiple Sclerosis in Danish Electric Utility Workers:

A study of 26,124 men working in Danish utility companies were studied for their incidence of multiple sclerosis (MS) in relation to average work-related exposure to electromagnetic fields. A small group of 15 men were shown to have a dose-response incidence of MS as a function of EMF exposure, Figure 12.

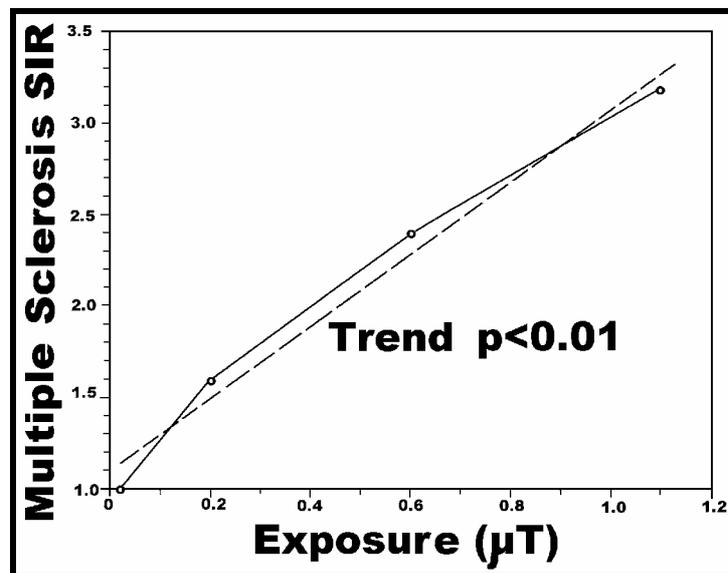


Figure 12: Dose response relationship of Multiple Sclerosis for a small group (N=15) of men occupationally exposed to typical peak magnetic fields in a Danish utility company, Johansen et al. (1999).

The authors conclude that they find no support for the hypothesis. In fact, despite the small sample size, their data shows very strong support for the hypothesis that EMR is associated with adverse neurological effects at extremely low mean exposure levels.

### Suicide in U.S. Electric Utility Workers:

A very large study of men working in U.S. electric utility companies included monitoring time weighted average ELF exposures of 2842 people and the identification of 536 deaths from suicide and 5348 controls. For recent exposure and 1 to 5 years of recent exposure there were significant dose-response relationships with cumulative exposure to electromagnetic fields. The recent exposure result is shown in Figure 13.

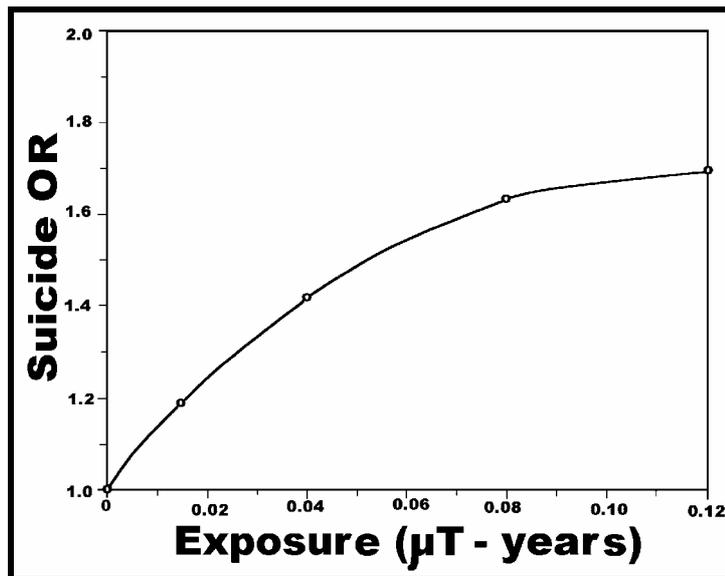


Figure 13: Dose response relationship of Suicide after recent monitored exposure to cumulative 50 Hz magnetic fields for men <50 years, adjusted for work, class, location and exposure to sunlight and solvents, Wijngaarden et al. (2000).

This confirms the results of Perry et al. (1981) who found a highly significant association between suicide and the exposure to magnetic fields from High Voltage Powerlines. Baris and Armstrong (1990) also found RF exposure shows a significant 53% increase in suicide or British Radio and Radar Mechanics, and 156 % increase for Telegraph radio operators. EMR is significantly associated with Clinical Depression, Verkasalo et al. (1997); Psychological symptoms, Beale et al. (1997); and ALS, Savitz et al. (1998a,b). Beale et al. found significant dose-response relationships for several symptoms including depression and anxiety

Non-linear response for neurological effects at extremely low exposure levels are evident in the three studies presented here for sleep disturbance, multiple sclerosis and suicide

#### **MND/ALS, Parkinson's and Alzheimer's Disease:**

Welders are occupationally exposed to a combination of lead and strong ELF/RF/MW fields. Welders have increased incidence of MND, OR = 5.3 and for electric plating OR = 8.0, 95%CI: 0.9-72, Strickland et al. (1996).

Electric utility workers are frequently exposed to elevated electric and magnetic fields and sometimes to electric shocks that send high currents through their bodies, including the Motor Neuron part of their central nervous system (CNS). Overall reported electromagnetic field exposures gave for MND/ALS, OR = 3.8, 95%CI: 1.4-13.0. For electric shocks producing unconsciousness, OR = 2.8, 95%CI: 1.2-9.9.

Parkinson's disease was also significantly elevated from ELF exposure, OR = 2.7, 95%CI: 1.1-7.6, Deapen and Henderson (1986). An independent study by Davanipour et al. (1997) compared MND/ALS rates between non-electrical and electrical occupations. They found that the higher the exposure the higher the rate of MND, Figure 14. Savitz, Loomis and Tse (1998) researched neurodegenerative disease and electrical occupations and found elevated Alzheimer's Disease (AD), Parkinson's Disease (PD) and Amyotrophic

Lateral Sclerosis (ALS/MND). The highest rates were found in a very highly exposed group, the power plant operators:

**For AD, Adj OR = 2.6, 95%CI: 1.3-5.1.**

**For PD Adj OR = 2.1, 95%CI: 0.9-4.7.**

**For MND Adj OR = 4.8, 95%CI: 1.9-12.4.**

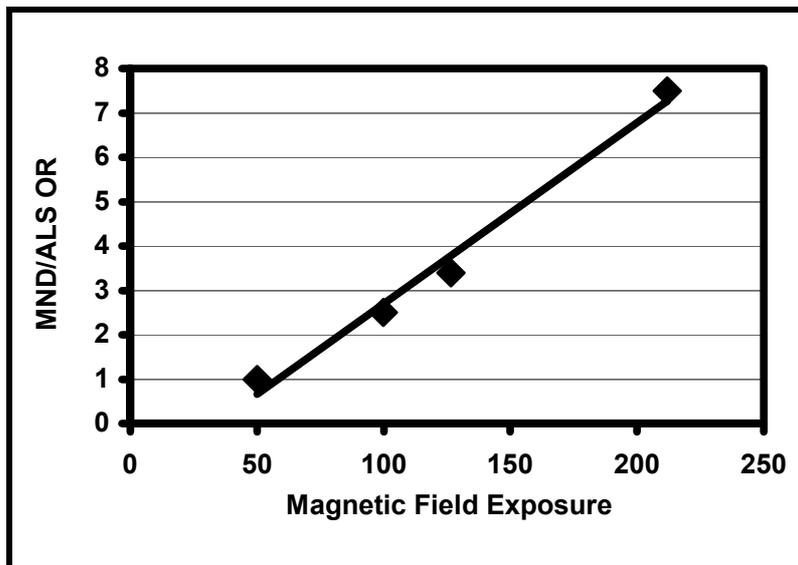


Figure 14: Dose-response increase in MND/ALS from chronic magnetic field exposures in electric utility workers,  $p < 0.02$ , Davanipour et al. (1997)

A follow-up study, Savitz, Checkoway and Loomis (1998) also found a positive association with duration of electric occupational work and MND (ALS), RR = 2.0, 95%CI: 0.7-6.0. They also found that the longer you worked in these electromagnetic fields the higher the MND rate rose, Figure 15.

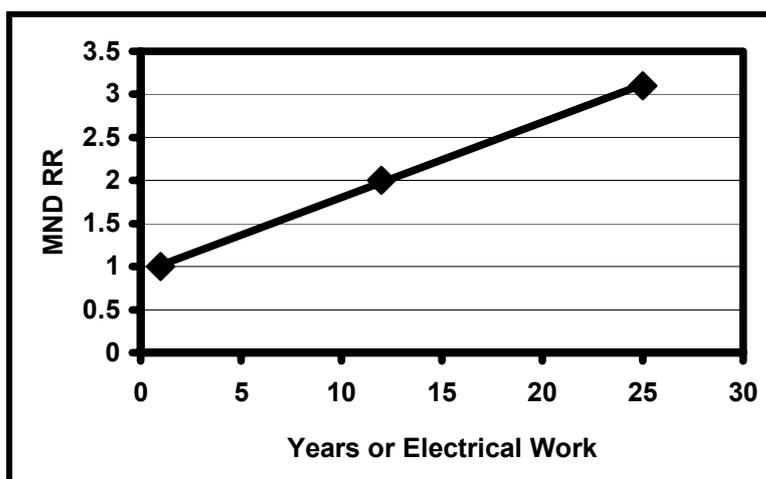


Figure 15: A significant dose-response relationship ( $p < 0.001$ ) between years of electrical work and MND (ALS), Savitz, Checkoway and Loomis (1998).

Electric utility workers in Denmark have the same risk factor for MND as U.S. utility workers, Figure 16. These three dose-response studies of EMF exposure show a causal link between chronic exposure to EMF and Motor Neuron Disease.

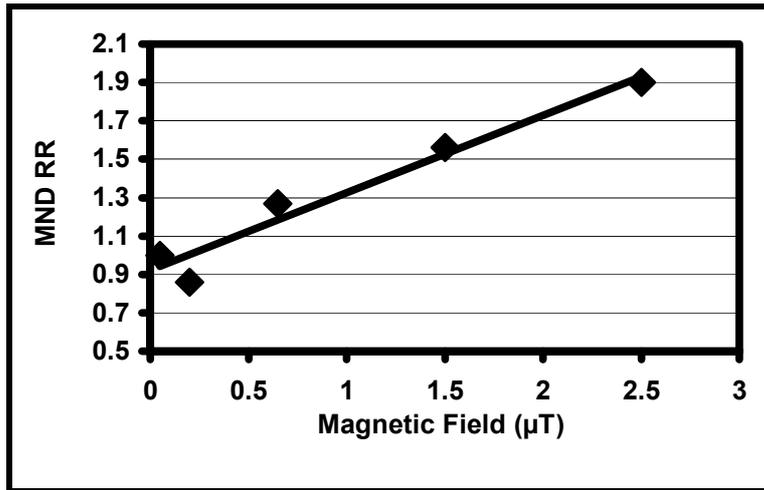


Figure 16: A significant dose-response ( $p < 0.0001$ ) increase in MND correlated with long-term mean ELF magnetic field exposures in electric utility occupations, Johansen (2000).

A recent review of Neurodegenerative Diseases in relation to EMF, Ahlbom (2001), identified 7 studies involving MND/ALS and electrical workers. When they were appropriately grouped, each group shows a significantly elevated MND rate, Table 4.

Table 4: Pooling across groups of studies on EMF and ALS, Ahlbom (2001).

Pooled studies	Number of studies	RR	95% C.I.
All	7	1.5	1.2-1.7
Clinically and ALS society based studies	3	3.3	1.7-6.7
Mortality registry and census based studies	2	1.3	1.1-1.6
Utility cohorts studies	2	2.7	1.4-5.0

This review confirms that EMF exposure in various situations significantly increases the incidence and mortality of MND/ALS.

#### Epidemiology of Brain Tumour:

Eminent academic epidemiologist Dr John Goldsmith reviewed the research of RF/MW health effects. He concludes, Goldsmith (1995):

**“There are strong political and economic reasons for wanting there to be no health effect of RF/MW exposure, just as there are strong public health reasons for more accurately portraying the risks. Those of us who intend to speak for public health must be ready for opposition that is nominally but not truly, scientific. At present there seems to be little interest in or understanding of epidemiologic information among regulatory bodies that should provide protection.”**

Goldsmith (1997):

**“Available data suggest that RF radiation be considered a carcinogenic risk, a position already taken in an internal U.S. E.P.A. document in 1990 when there was much less evidence of the potential harmfulness of RF radiation.”**

The evidence in this report confirms Dr Goldsmith's conclusions.

## **Early evidence of brain tumor associated with EMR exposure**

Our strong attraction to the evident benefits of electronic technology easily masks the very strong evidence of the adverse health effects in our brains and bodies which radiation from this technology causes. This situation was described very clearly by Zaret (1977):

**“As we are all well aware, many special societal benefits have been derived from the electronic revolution. What has not yet been established are the risks associated with exposure to stray radiation. In this context, my purpose in writing is to call attention to one largely over-looked possibility, that nonionizing radiation as an atmospheric pollutant may be carcinogenic.”**

**“Despite the paucity of published information a number of clusters, each by definition consisting of 2 or more cases, are known to exist.”**

**“Regarding the clusters of our immediate concern, one instance of brain tumors (2 cases with astrocytoma) appeared in a small group of workers (about 18) servicing microwave communication equipment.”**

**“Space limitations do not permit my developing a rationale nor citing the large number of supportive references already at hand, beginning with Heller and Teixeira-Pinto in 1959, which demonstrate that nonionizing radiation can induce mutagenesis.”**

Zaret (1977) identifies 2 cases of astrocytoma (the most common primary brain tumour) in a group of 18 microwave exposed workers. Age standardized astrocytoma rates in the 1970's were about 6 per 100,000 p-yrs. Assuming a period of 25 years for these workers' exposures, this gives  $RR = 74.1$ ,  $95\%CI: 15.0-367$ ,  $p < 0.0001$ , which is extremely significant. Heller and Teixeira-Pinto (1959) showed that pulsed RF radiation significantly increased chromosome damage.

### **Brain Tumour with VDT exposure:**

Beall et al. (1997) found significant increases in brain tumour, especially glioma, among long-term workers using computers who are exposed to a mix of ELF and RF radiation from the VDTs. For long-term computer users, Engineering/technical users show a non-significant dose response, but computer programmers show a significant dose-response relationship, Figure 17.

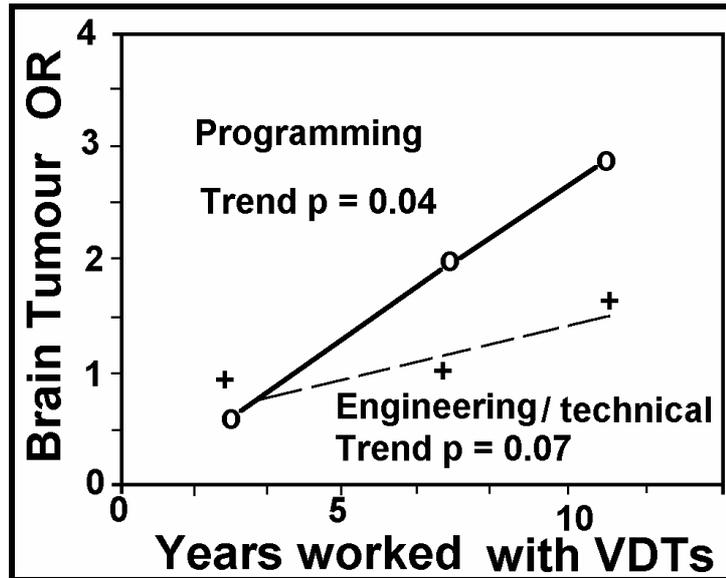


Figure 17 Dose-response increases in brain tumour from years of working with computers, Beall et al. (1997).

A search of the epidemiological literature, with the assistance of MEDLINE, and medical school libraries, reveals 96 studies covering over 420 separately exposed groups, that reveal that brain tumour incidence or mortality is increased with EMR exposure across the spectrum. Table 6 lists 28 studies showing dose response or significant dose response increases in brain tumour incidence with EMR exposure.

**Table 5: Summary table of studies and groups showing elevated brain cancer from exposure to electromagnetic radiation across the EMR spectrum.**

<b>Total studies showing elevated brain cancer:</b>	<b>96</b>
<b>Total groups showing elevated brain cancer:</b>	<b>423</b>
<b>Total studies showing at least one significantly elevated brain cancer</b>	<b>43</b>
<b>Total groups showing significantly elevated brain cancer:</b>	<b>153</b>
<b>Total studies showing at least one dose response relationship</b>	<b>28</b>
<b>Total groups showing dose-response trends of brain cancer:</b>	<b>78</b>
<b>Total groups showing significant dose-response trends <math>p \leq 0.1</math></b>	<b>64</b>
<b>Total groups showing significant dose-response trends <math>p \leq 0.05</math></b>	<b>48</b>

The studies showing dose-response relationships for EMF/EMR exposures are summarized in Table 6. Since the degrees of freedom ( $n-2$ ) are very small for dose-response trends it is appropriate to use a threshold of  $p \leq 0.1$ . Despite this the number of trends have  $p \leq 0.05$  and many have  $p < 0.01$ .

**Table 6: Studies showing dose-response relationships for EMR exposure and brain tumor:**

- Denver, United States, residential fields. Wertheimer and Leeper (1979)  
 Childhood ) Brain cancer is near 26% of all cancer.  
 All cancer) Dose related for children living at same address,  $p < 0.008$ .
- Electrical Occupations in Maryland, U.S. Lin et al. (1985)

	Glioma/Astrocytoma	Other Brain Tumors
Definite Exposure	2.15 (1.10-4.06)* n = 27	1.54 (0.68-3.38) n = 15
Probable exposure	1.95 (0.94-3.91) n = 21	1.30 (0.60-2.78) n = 19
Possible exposure	1.44 (1.00-1.95)* n = 128	0.94 (0.68-1.31) n = 87
No exposure	1.0 n = 323	1.0 n = 286
	Trend $p < 0.01$	Trend $p < 0.05$
- Eastern U.S. Electronic Industries Thomas et al. (1987)  
 Astrocytic brain tumours RR=4.9 (1.9-13.2)\*

	RR	Unexposed	Duration Employed (yr)		
			<5	5-19	$\geq 20$
		1.0	3.3	7.6	10.4
Solder fume adjusted	RR	1.0	1.65	3.8	5.2

(trend  $p < 0.05$ )
- United States, Meta Analysis Kheifets et al. (1995)  
 Electrical Occupations

Pooled Dose-Response, Reference	RR = 1.0
Low	RR = 1.23 (1.06-1.42)
Middle	RR = 1.36 (1.11-1.68)
High	RR = 1.61 (1.28-2.04) Trend $p = 0.006$
- East Texas, Males Glioma Speers, Dobbins and Miller (1988)  
 n=202  
 Electricity or electromagnetic fields OR = 3.94 (1.52-10.20)\* Trend:  $p < 0.01$
- Los Angeles County, Occupational exposure Preston-Martin et al. (1989)  
 High exposure to electric and magnetic fields n=272

Glioma 0 years	OR = 1.0	
Glioma 0-5 years	OR = 1.4 (0.7-3.1)	
Glioma >5 years	OR = 1.8 (0.8-4.3)	Trend $p = 0.05$
Astrocytoma, >5 years empl.	OR = 4.3* (1.2-15.6)	Trend $p = 0.008$
- U.S., prenatal domestic appliances Savitz, John and Kleckner (1990)  
 Electric Blanket usage:

Night duration use <8 hrs	OR = 1.5 (0.4-5.7)	n=3
Night Duration use = 8 hrs	OR = 3.1 (1.2-8.5)*	n=7
Night Duration use >8 hrs	OR = 4.5 (0.5-39.0)	n=1
(Assuming 4, 6, 8, 10 hours)	Trend $p = 0.019$	

- United States, 16 States (Mortality) adjusted for age & race Loomis and Savitz (1990)

Dose-response relationship:

Exposure	Crude	Adjusted (age & race)
Possible only (Adj)	OR = 1.8* (1.4-2.3)	OR = 1.5* (1.1-1.9)
Unlikely (low) exposure (Adj)	OR = 1.3* (1.0-1.6)	OR = 1.2 (0.9-1.5)
Reference Control	OR = 1.0	OR = 1.0
- Los Angeles County, electrical industry Mack et al. (1991)

Stratification from years worked in exposed situations:  
Exposure Index 1, from Thomas et al. (1987)

Type of brain tumor	0	>0-5	>5-10	>10	Trend-p
All brain tumors	1.0	1.1 (0.6-2.0)	0.5 (0.1-2.0)	1.3 (0.3-3.0)	0.67
Glioma	1.0	1.1 (0.5-2.1)	0.4 (0.1-2.1)	1.7 (0.7-4.4)	0.21
Astrocytoma	1.0	1.1 (0.5-2.9)	0.4 (0.1-2.1)	10.3 (1.3-80.8)*	0.01**

Exposure Index 2, from Milham (1985)

Type of brain tumor	0	>0-5	>5-10	>10	Trend-p
All brain tumors	1.0	1.1 (0.6-2.2)	0.4 (0.1-1.7)	1.2 (0.5-2.8)	0.70
Glioma	1.0	1.2 (0.6-2.4)	0.4 (0.1-2.1)	1.4 (0.6-3.5)	0.32
Astrocytoma	1.0	1.3 (0.5-3.1)	0.4 (0.1-2.1)	4.6 (1.0-21.4)*	0.02*
- Sweden, Occupational exposure Floderus et al. (1993)

Time Above 0.2mT,	<16%	17-23%	24-28%	≥29%	≥39%	Trend p
All brain tumors	1.0	1.3 (0.9-2.0)	1.3 (0.9-1.9)	1.5 (1.0-2.2)*	1.9 (1.2-3.1)*	0.005**
Astrocytoma III-IV	1.0	1.6 (1.0-2.6)*	1.6 (1.0-2.5)*	1.7 (1.1-2.8)*	2.1 (1.2-3.8)*	0.011*

Median Exposure	<0.11μT	0.12-0.16μT	≥0.17μT	≥0.20μT	
Astrocytoma I-II<40	1.0	0.9 (0.3-2.9)	2.7 (1.1-6.8)*	5.7 (1.9-16.7)*	0.035*
Adjusted for Benzene	1.0	1.0 (0.7-1.5)	1.4 (1.0-2.0)*	1.6 (1.0-2.5)*	0.051
Possible solvents	1.0	0.9 (0.5-1.9)	1.4 (0.9-2.2)	1.9 (0.8-4.5)	0.066

Median Exposure	≤0.15μT	0.20-0.28μT	≥0.29μT	≥0.41μT	
Study participants	1.0	1.1 (0.8-1.5)	1.2 (0.9-1.7)	1.4 (0.9-3.3)	0.003**
Study and Nonrespondents	1.0	1.0 (0.8-1.4)	1.2 (0.9-1.6)	1.3 (0.9-2.0)	0.05*

Age Specific ≤40

Study participants	1.0	0.8 (0.4-1.8)	1.4 (0.7-3.0)	2.7 (1.0-7.8)*	0.094
Study and Nonrespondents	1.0	0.9 (0.5-1.9)	1.6 (0.8-3.3)	2.9 (1.1-7.7)	0.065
- Canada, Provincial Residential Electric Consumption (REC) Childhood brain cancer significantly increases with REC in a significant dose-response manner. Kraut et al. (1994)
- Ontario, Quebec and France Theriault et al. (1994)

Dose-response for the median, 90<sup>th</sup> %ile, with a strongly skewed distribution, using exposure weights of 15, 25 and 92.

Ontario Hydro: Malignant Brain Cancer:

Trend p-value

Median: OR = 1.85 (0.53-6.49) >90<sup>th</sup> OR = 5.45 (0.59-50.59) p=0.036\*

All Companies: Malignant Brain Cancer:

0-20 yrs Median: OR = 1.05 (0.20-5.35) >90<sup>th</sup> OR = 5.90 (0.37-94.91) p=0.065

All Median: OR = 1.95 (0.98-3.86) >90<sup>th</sup> OR = 2.14 (0.80-5.72) p=0.44

All Companies: Astrocytoma:

0-20 yrs Median: OR = 3.99 (0.72-22.0) >90<sup>th</sup> OR = 11.1\*(1.44-85.6) p=0.10

All Median: OR = 3.69 (0.61-22.2) >90<sup>th</sup> OR = 28.48\*(1.76-461) p=0.02\*

Cumulative exposure groups

Astrocytoma

Trend OR = 9.41\* (1.07-82.79)

- U.S. Electrical Workers, 1950-1988

Savitiz and Loomis (1995)

Measured field assessment and confounders.

Cumulative exposures and duration windows:

Total Exposure (RR)

0-<0.6	0.6-<1.2	1.2-<2	2-<4.3	≥4.3	Trend p
1.0	1.61 0.99-2.63	1.47 0.84-2.56	1.65 0.92-2.95	2.29*1.15-4.56	0.033*

Past 2-10yrs

0	0-<0.2	0.2-<0.4	0.4-<0.7	≥0.7	Trend p
1.0	1.17 0.66-2.08	1.39 0.75-2.58	1.46 0.76-2.84	2.56*1.35-4.86	0.009**

Past 10-20 yrs

0	0-<0.3	0.3-<0.5	0.5-<0.9	≥0.9	Trend p
1.0	1.76*1.07-2.91	1.26 0.69-2.29	1.47 0.76-2.84	1.63 0.92-2.90	0.44

Past >20

0	0-<0.4	0.4-<1.1	1.1-<2.0	≥2.0	Trend p
1.0	0.76 0.45-1.27	0.89 0.51-1.56	1.12 0.59-2.14	1.26 0.64-2.48	0.074

Mortality

Dose-response rates

RR per μT-yr

95%CI

Total Exposure	1.07*	1.01-1.14
Past 2-10 years	1.94*	1.34-2.81
Past 10-20 years	1.35*	1.01-1.79
Past>20 years	1.06	0.97-1.16

- U.S. electronics industry workers

Beall et al. (1996)

Dose-response relationships:

Computer Programmers (>10 yrs)	OR = 2.8 (1.1-7.0)*	Trend p = 0.04
Engineering/Technical (>10 yrs)	OR = 1.7 (1.0-3.0)*	Trend p = 0.07
Glioma, All subjects, 5yr progrm.	OR = 3.9 (1.2-12.4)*	Trend p = 0.08

- United States, office workers

Milham (1996)

Transformer fields

SIR = 389 (156-801)\*

N=410

Exposure trend p=0.0034

Employment period trend p<0.05

- Ontario Hydro male employees (Adjusted ORs) Miller et al. (1996)

Brain Tumour	Mod. Field	OR = 1.27 (0.32-5.41)	Both show trends.
	High Field	OR = 1.33 (0.52 -10.8)	
Benign Brain Tumour	Mod. Field	OR = 5.38 (0.42-69.3)	
	High Field	OR = 5.64 (0.3-105)	

- France, electrical utility workers, ELF exposures Guenel et al. (1996)

Crude and adjusted on Magnetic Fields (MF), Socioeconomic Status (SES) and solvent exposures (SOL), given with exposure percentiles:

Percentiles:	Cases	OR Adj SES	OR Adj MF+SES	OR Adj. SES+SOL
<50	29	1.0	1.0	1.0
50-<75	22	2.47 (0.99-6.16)	2.51 (1.00-6.34)*	2.29 (0.89-5.94)
>75-90	8	1.43 (0.46-4.45)	1.43 (0.45-4.48)	1.43 (0.45-4.57)
>90	10	3.08 (1.08-8.74)*	2.83 (0.97-8.28)	2.97 (1.00-8.80)*

Adjusting for a 5-year latency gives the highest Odds ratios:

Cumulative Exposure V/m-years	Cases	OR	95%CI
<202	22	1.00	
202-274	20	3.43*	1.25-9.40
275-342	9	2.40	0.73-7.90
≥343	9	3.69*	1.10-12.43

Adjusting for 10-year latency gives a linear dose-response:

Cumulative Exposure V/m-years	Cases	OR	95%CI
<166	22	1.00	
166-229	14	1.67	0.67-4.19
230-294	9	1.79	0.60-5.36
≥295	7	2.15	0.63-7.26

Trend p = 0.013

- Children in Los Angeles (1996b) Preston-Martin et al.

Dose-response relationship:

All years Reference <1mG	OR = 1.0	
>2mG	OR = 1.2 (0.5-2.8)	n=16
>2.5mG	OR = 1.4 (0.5-3.8)	n=13
>3mG	OR = 1.7 (0.6-5.0)	n=12
	Trend p = 0.036	

- Norway Tynes and Haldorsen (1997)

Children	<0.05μT	0.05-<0.14μT	>0.14μT	n=10
RR =	1.0	2.6 (0.5-12.0)	2.3 (0.8-6.6)	p=0.07

- Sweden, Electrical Occupations Rodvall et al. (1998)

Dose-response for groups with >10 cases:

Estimated daily Mean:	<0.2μT	0.2-0.4μT	>0.4μT	>0.4μT for ≥5yrs
Glioma (Mean)	1.0	1.1 (0.4-2.7)	1.9 (0.8-5.0)	1.8 (0.7-5.1)

Estimated daily Median: Glioma (Median)	<0.12 $\mu$ T 1.0	0.12-0.19 $\mu$ T 1.1 (0.5-2.6)	>0.19 $\mu$ T 1.4 (0.5-3.6)	>0.19 $\mu$ T for $\geq$ 5yrs 1.5 (0.6-4.1)
--	----------------------	------------------------------------	--------------------------------	--

Dose-response

Estimated daily Mean: Glioma (Mean)	<0.2 $\mu$ T 1.0	0.2-0.4 $\mu$ T 1.3 (0.07-2.4)	>0.4 $\mu$ T 1.3 (0.5-3.2)
Estimated daily Median: Glioma (Median)	<0.12 $\mu$ T 1.0	0.12-0.19 $\mu$ T 1.9 (1.0-3.5)	>0.19 $\mu$ T 1.1 (0.5-2.6)

- United States Utility Workers  
5 studies combined  
RR per 10  $\mu$ T-years

Kheifets et al. (1999)

RR = 1.12 (0.98-1.28)
- Swedish cohort study of ELF exposures  
Occupational Exposure of Males:

1971-1977 Astrocytoma III-IV	Middle Exp 0.084-0.115 $\mu$ T RR = 1.1 (0.9-1.4)	High Exp $\geq$ 0.116 $\mu$ T RR = 1.2 (1.0-1.5)*
1971-1984 Astrocytoma III-IV	Middle Exp 0.084-0.115 $\mu$ T RR = 1.2 (1.1-1.4)*	High Exp $\geq$ 0.116 $\mu$ T RR = 1.3 (1.2-1.5)*

Floderus, Stenlund and Persson (1999)
- United States Electric Utility Workers

Reference	OR = 1.0
Cumulative exposure	OR = 1.8 (0.7-4.7)
Average exposure	OR = 2.5 (1.0-6.3)*

Savitz et al. (2000)

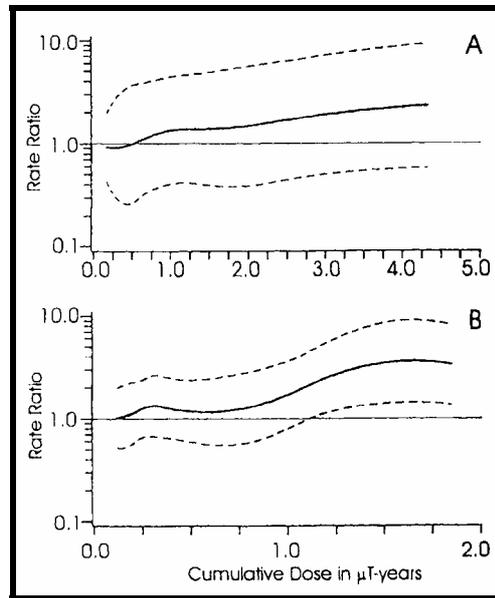


Figure 18: Brain cancer increases from refined case-cohort job-exposure matrix in the US Utility Worker Mortality Study 1950-1988, Savitz et al. (2000). Cumulative exposure over entire career with A: a 2-year lag; B: 2-10 years in the past.

- Cell phone users in Denmark

Duration of digital subscription	<1 yr	1-2yrs	$\geq$ 3 yrs	
Relative to reference group	SIR	0.7	0.9	1.2
Relative to <1 yr group	RR	1.0	1.29	1.71

Johansen et al. (2001)

- San Francisco, Sutra Tower (FM/TV) Cherry (2002)  
Children < 21 yrs Brain Cancer

Ring (km)	RR	95%CI	
0.1-1	15.5	3.14-76.8	
1-2	7.8	2.1-30.9	
2-3	3.3	0.84-13.4	
3-4	3.2	0.85-12.1	
4-5	3.07	0.81-11.6	Trend p-valuep=0.03
>5	1.00		Log/Lin Trendp<0.001

- Canadian Electrical Workers Villeneuve et al.(2002)

	Highest average exposure <0.3µT	≥0.3µT	≥0.6µT
All Brain Cancer OR(adj)	1.0	1.12 (0.83-1.51)	1.33 (0.75-2.36)
Glioblastoma multiforme	1.0	1.48 (0.89-2.47)	5.36 (1.16-24.78)
Other Brain Cancers	1.0	1.10 (0.58-2.09)	1.58 (0.56-4.50)
	Average exposure <0.3µT	≥0.3µT-<0.6µT	≥0.6µT
All Brain Cancer OR(adj)	1.0	1.13 (0.72-1.79)	1.50 (0.69-3.28)
Glioblastoma multiforme	1.0	1.99 (0.83-4.81)	12.59 (1.50-105.6)

- Cell phone users in Finland Auvinen et al. (2002)  
Significantly elevated brain cancer and salivary gland cancers from analogue phone usage.

Trends of OR for years of usage are:

All Brain Cancers,	Analogue Phones	1.2* (1.0-1.3)
	Total Phones	1.1* (1.0-1.3)
Glioma	Analogue Phones	1.2* (1.1-1.5)
	Total Phones	1.2* (1.0-1.4)
Other Brain cancers	Analogue Phones	1.1 (0.8-1.4)
	Total Phones	1.1 (0.8-1.4)
Salivary gland cancers	Analogue Phones	1.3 (0.7-2.5)
	Digital Phones	1.5 (0.2-11.9)
	Total Phones	1.3 (0.7-2.6)

### Summary of Brain Cancer studies:

The epidemiological studies on EMR associated brain cancer include 96 studies of over 400 separate groups with elevated brain cancer from EMR exposure from across the spectrum. Of the 423 groups, 153 show significant increases, 78 show dose response relationships and 48 of these are statistically significant. From acknowledged RF/MW exposure there are 35 groups, 19 with significant increases, 8 with dose responses, of which 6 are significant. This is strongly backed by evidence of genotoxicity. This evidence is more than sufficient, using the Bradford-Hill guidance, Hill (1965), to conclude that there is a causal relationship between EMR exposure across the spectrum and brain tumour incidence and mortality

Significant increases in brain cancer incidence or mortality are shown in welders, equipment repairers, microwave repairers, utility workers, telephone industry workers, amateur radio operators, military personnel exposed to radio and radar, commercial and

air force pilots and aircrew, computer users, children living near broadcast towers and high voltage powerlines and cell phone users.

### **Cell phones and Brain tumours:**

Analogue cell phones use FM radio signals while digital cell phones use pulsed microwaves that are very similar to radar. The analogue phones expose the user's head to much higher intensities of microwaves than the more modern digital phones. The way the information is encoded in the pulsed differs but it is the pulsing action that is likely to enhance the biological effects. Since FM exposed populations show significant increases and significant dose-response increases in brain tumour at very low exposure levels, Cherry (2002a), and since cell phone produce far high mean exposures and the same neurological effects in a dose response manner, Mild et al. (1998), then analogue cell phones are highly likely to produced significant increases in brain cancer and degenerative neurological diseases.

Dr Andrew Davidson, an Oncologist in Western Australia, Davidson (1998), has noted a parallel increase in diagnosed brain tumours with the rising use of mobile phones. In a comment Dr Bruce Hocking refers to Rothman et al. (1996) who compared the mortality rates during 1994 of portable (hand-held) phone users and mobile (Bag) phone users. Dr Hocking quotes the results of RR = 0.86 to show that mobile phone users have a lower mortality rate. Actually Rothman et al. have deliberately reversed the ratio so that people will take the conclusion that Dr Hocking has drawn by reporting the rate of portable phone use over mobile phone use. When it is corrected, and mobile phone use is compared with portable phone use, for all users and for male users, mobile phone users have significantly higher mortality rates than portable phone users.

Table 7: Comparative mortality rates between mobile (Bag) phone users and portable (hand-held) phone users in the United States for 1994, Rothman et al. (1996).

Group	RR	95%CI	p-value
For Men	1.40	1.06 - 1.86	0.017
For Women	1.52	0.78 - 2.95	0.31
All People	1.38	1.07 - 1.79	0.013

Hardell et al. (1999) found no overall increase in brain cancer risk for mobile phone users compared with the general population. However they did find a marginally insignificant increase in a particular type of tumour at the position and side of the head that received the highest exposure from the mobile phone, based on 209 cases and 425 controls. Left side OR = 2.4, 95%CI: 0.52-10.9 and Right Side OR = 2.45, 95%CI: 0.78 - 7.76. They found a slightly higher rate for the digital GSM phones compared with the analogue NMT phones.

Dr George Carlo, former chairman of Wireless Technology Research (WTR), the industry funded research body in the U.S., reported that the studies they had funded had reported similar results to those in Sweden,

Digital phones are like radar and radar exposure has been shown to significantly increase brain tumour, Szmigielski (1996). Tice et al. (1999) reported that every cell phone tested in their U.S. laboratory caused chromosome aberrations in a dose response manner up to a 3-fold increase. Phillips et al. (1998), Maes and Verschaeve and Maes (1998) observed

significant DNA damage from a range of digital cell phone signals. Phillips et al. used exposures of 1.2 and 13 $\mu$ W/cm<sup>2</sup>.

The largest and most careful case-control cell phone usage and brain cancer studies have been carried out in Sweden, Hardell et al. (1999, 2000, 2001, 2002a,b). Initially small case samples (n=270) showed elevated brain cancer from using an analogue mobile phone. When the results included more cases and adjusted the results for Xray and therapy exposures, the incidence of Brain Cancer on the side of the head that was exposed was significantly elevated, OR = 2.62 (1.02-6.71). The study group was significantly expanded to include 1429 cases. Using a cell phone for longer than a year raised the risk of Brain Cancer, OR = 1.26 (1.02-1.56). For longer latency periods, > 5 years gave OR = 1.35 (1.03-1.77) and > 10 years OR = 1.77 (1.09-2.86). For the side of the head the phone exposed OR = 2.50 (1.2-4.88).

For Acoustic Neuromas among analogue phone users OR =3.27 (1.67-6.43). The final study involved only patients with Astrocytomas (n=414). For analogue phone use OR = 1.29 (0.87-1.90) and digital phone use OR = 1.1 (0.81-1.53). When the side of the head where the phone was used was considered, for Analogue phone OR = 1.85 (1.12-3.39) for all Brain Cancers and OR = 1.95 (1.12-3.39) for Astrocytomas. For digital and cordless phones, the risk of side of head astrocytomas was OR= 1.59 (0.98-2.58) and OR= 1.70 (1.06-2.74) respectively, Hardell et al. (2002a). For astrocytomas in the temporal or occipital areas, OR=9.00 (1.14-71.0) based on 12 cases and 5 controls, Hardell et al. (2002b).

### **Summary and Conclusions:**

Has a very sensitive electromagnetic organ. Since the published research shows that electromagnetic fields and radiation significantly enhance neurological responses by the brain acute exposure to mobile telephones. And there's a large body of evidence showing that people who live and work in electromagnetic fields have a significantly higher rate of neurological disorders, including Motor Neuron Disease, Alzheimer's disease, Parkinson's disease, and enhance epileptic fits. There is also robust evidence that there is a causal relationship between sleep disturbance, depression, suicide and brain cancer from chronic exposure to electromagnetic fields and radiation. The symptoms of radiofrequency or microwave syndrome must not be dismissed as simply subjective reactions. They are real and biologically sensible responses of an electromagnetic organ to electromagnetic interference.

All of these symptoms and disease rates are being enhanced by electromagnetic fields of homes, radiofrequency fields and radio and TV towers and the extensive installation of cell sites and the use of cellular telephones.

The causal association of neurological diseases and mortality from residential exposures to electromagnetic fields for about one million times higher than the Schumann Resonance signal, and cell phone exposures of one billion times higher than Schumann Resonance signal, there is highly scientifically sensible and well-established by multiple independent epidemiological studies.

Therefore public health protection standards should be set at 10nW/cm<sup>2</sup> to significantly reduce the risk rate in the public from the well identified and serious neurological symptoms, diseases and mortality rates.

**References:**

- Ahlbom, A., 2001: "Neurodegenerative diseases, suicide and depressive symptoms in relation to EMF". *Bioelectromagnetics Supplement 5*: S132-S143.
- Adey, W.R., 1975: "Introduction: Effects of electromagnetic radiation on the nervous system". *Annals N.Y. Acad. Sci.* 247: 15-20.
- Adey, W.R., 1979: "Neurophysiologic effects of Radiofrequency and Microwave Radiation". *Bull NY Acad Med* 55(11): 1079-93.
- Adey, W.R., 1980: "Frequency and Power windowing in tissue interactions with weak electromagnetic fields". *Proc. IEEE*, 68:119-125.
- Adey, W.R., 1980: "Tissue Interactions with nonionizing electromagnetic fields". *Physiological Reviews* 61(2): 435-514.
- Adey, W.R., 1993: "Electromagnetics in Biology and Medicine". In *Modern Radio Science* (Hiroshi Matsumoto ed). Oxford, England, Oxford University Press, 227-245.
- Ahissar, E., Haidarliu, S. and Zacksenhouse, M., 1997: "Decoding temporally encoded sensory input by cortical oscillations and thalamic phase comparators". *Proc Nat Acad Sci USA* 94:11633-11638.
- Ahuja YR, Bhargava A, Sircar S, Rizwani W, Lima S, Devadas AH, Bhargava SC. "Comet assay to evaluate DNA damage caused by magnetic fields. In: *Proceedings of the International Conference on Electromagnetic Interference and Compatibility, India Hyderabad, December 1997*: 272-276.
- Alberts B, Bray D, Lewis J, Raff M, Roberts K, Watson JD. *Molecular Biology of the cell*, 3rd edition, New York, Garland Publishing, 1994.
- Altpeter ES, Krebs Th, Pfluger DH, von Kanel J, Blattmann R, Emmenegger D, Cloetta B, Rogger U, Gerber H, Manz B, Coray R, Bauman R, Staerk K, Griot Ch, Abelin Th. *Study of health effects of Short-wave Transmitter Station of Schwarzenburg, Berne, Switzerland. University of Berne, Institute for Social and Preventative Medicine, August (1995).*
- Altpeter ES, Sprenger K, Madarasz K, Abelin Th., 1997: "Do radiofrequency electromagnetic fields cause sleep disorders?" In: *Proceedings of the IAE meeting, Munster, Germany, Abst. No. 351.*
- Armstrong B, Theriault G, Guenel P, Deadman J, Goldberg M, Heroux P. *Am J Epidemiol* 140(9):805-820 (1994).
- Arnetz, B.B. and Berg, M., 1996: "Melatonin and Andrenocorticotrophic Hormone levels in video display unit workers during work and leisure. *J Occup Med* 38(11): 1108-1110.
- Auvinen, A., Hietanen, M., Luukkonen, R. and Koskela, R-S, 2002: "Brain Tumours and Salivary Gland Cancers among cellular telephone users". *Epidemiology* 13: 356-359.
- Band PR, Le ND, Fang R, Deschamps R, Coldman A, Gallagher RP, Moody J. *Cohort study of Air Canada pilots: mortality incidence and leukaemia risk. Am J Epidemiol* 143(2):137-143 (1996).
- Band PR, Spinelli JJ, Ng VT, Moody J, Gallagher RP. *Mortality and cancer incidence in a cohort of commercial airline pilots. Aviat Space Environ Med* 61(4):299-302 (1990).

- Balcer-Kubiczek EK. Experimental studies of electromagnetic field-induced carcinogenesis in cultured mammalian cells. In: *On the nature of electromagnetic field interactions with biological systems* (Allan H Frey ed). Austin Texas, R.G. Landes Co. (1995)
- Baranski S, Czerski P. *Biological effects of microwaves*. Stroudsburg, Pennsylvania: Dowden, Hutchinson and Ross Inc, 1976.
- Bawin, S.M. and Adey, W.R., 1976: "Sensitivity of calcium binding in cerebral tissue to weak electric fields oscillating at low frequency". *Proc. Natl. Acad. Sci. USA*, 73: 1999-2003.
- Bawin SM, Gavalas-Medici R, Adey WR., 1973: "Effects of modulated very high frequency fields on specific brain rhythms in cats". *Brain Res* 58: 365-384.
- Bawin SM, Kaczmarek LK, Adey WR. Effects of modulated VHF fields on the central nervous system. *Ann NY Acad Sci* 247:74-81 (1975).
- Beale IL, Pearce NE, Conroy DM, Hemming MA, Murrell KA. Psychological effects of chronic exposure to 50 Hz magnetic fields in human living near extra-high-voltage transmission lines. *Bioelectromagnetics* 18(8):584-594 (1997).
- Beall C, Delzell E, Cole P, Brill I. Brain Tumors among electronics Industry Workers. *Epidemiology* 7(2): 125-130 (1996).
- Blackman, C.F., Benane, S.G., Elliott, D.J., and Pollock, M.M., 1988: "Influence of Electromagnetic Fields on the Efflux of Calcium Ions from Brain Tissue in Vitro: A Three-Model Analysis Consistent with the Frequency Response up to 510 Hz". *Bioelectromagnetics*, 9:215-227.
- Blackman, C.F., Kinney, L.S., House, D.E., and Joines, W.T., 1989: "Multiple power-density windows and their possible origin". *Bioelectromagnetics*, 10: 115-128.
- Blackman, C.F., 1990: "ELF effects on calcium homeostasis". In "Extremely low frequency electromagnetic fields: The question of cancer", BW Wilson, RG Stevens, LE Anderson Eds, Publ. Battelle Press Columbus: 1990; 187-208.
- Blackman, C.F., Benane, S.G., and House, D.E., 1991: "The influence of temperature during electric- and magnetic-field induced alteration of calcium-ion release from in vitro brain tissue". *Bioelectromagnetics*, 12: 173-182.
- Blackman CF, Benane SG, Elliott DJ, Pollock MM. Influence of Electromagnetic Fields on the Efflux of Calcium Ions from Brain Tissue in Vitro: A Three-Model Analysis Consistent with the Frequency Response up to 510 Hz. *Bioelectromagnetics* 9:215-227 (1988).
- Blackman CF, Kinney LS, House DE, Joines WT. Multiple power-density windows and their possible origin. *Bioelectromagnetics* 10: 115-128 (1989).
- Blackman CF. ELF effects on calcium homeostasis. In *Extremely low frequency electromagnetic fields: The question of cancer* (BW Wilson, RG Stevens, LE Anderson eds) Columbus, Battelle Press: 1990; 187-208.
- Borbely, AA, Huber, R, Graf, T, Fuchs, B, Gallmann, E, Achermann, P, 1999: Pulsed high-frequency electromagnetic field affects human sleep and sleep electroencephalogram. *Neurosci Lett* 275(3):207-210.
- Burch JB, Reif JS, Pittratt CA, Keefe TJ, Yost MG. Cellular telephone use and excretion of a urinary melatonin metabolite. In: *Annual review of Research in Biological Effects of*

- electric and magnetic fields from the generation, delivery and use of electricity, San Diego, CA, Nov. 9-13, 1997: P-52.
- Braune S, Wrocklage C, Raczek J, Gailus T, Lucking CH. Resting blood pressure increase during exposure to a radio-frequency electromagnetic field. *Lancet* 351:1857-1858 (1998).
- Breve R, Feldmane G, Heisele O, Volrate A, Balodis V. Several immune system functions of the residents from territories exposed to pulse radio-frequency radiation. Presented to the Annual Conference of the ISEE and ISEA, Boston Massachusetts July 1998.
- Burch, J.B., Reif, J.S., Pittrat, C.A., Keefe, T.J. and Yost, M.G., 1997: "Cellular telephone use and excretion of a urinary melatonin metabolite". In: Annual review of Research in Biological Effects of electric and magnetic fields from the generation, delivery and use of electricity, San Diego, CA, Nov. 9-13, P-52.
- Burch, J.B., Reif, J.S., Yost, M.G., Keefe, T.J. and Pittrat, C.A., 1998: "Nocturnal excretion of urinary melatonin metabolite among utility workers". *Scand J Work Environ Health* 24(3): 183-189.
- Burch, J.B., Reif, J.S., Yost, M.G., Keefe, T.J. and Pittrat, C.A., 1999a: "Reduced excretion of a melatonin metabolite among workers exposed to 60 Hz magnetic fields" *Am J Epidemiology* 150(1): 27-36.
- Burch, J.B., Reif, J.S. and Yost, M.G., 1999b: "Geomagnetic disturbances are associated with reduced nocturnal excretion of melatonin metabolite in humans". *Neurosci Lett* 266(3):209-212.
- Burch, J.B., Reif, J.S., Noonan, C.W. and Yost, M.G., 2000: "Melatonin metabolite levels in workers exposed to 60-Hz magnetic fields: work in substations and with 3-phase conductors". *J of Occupational and Environmental Medicine*, 42(2): 136-142.
- Burch JB, Reif JS, Yost MG, Keefe TJ, Pittrat CA. Nocturnal excretion of urinary melatonin metabolite among utility workers. *Scand J Work Environ Health* 24(3): 183-189 (1998).
- Burch JB, Reif JS, Yost MG. Geomagnetic disturbances are associated with reduced nocturnal excretion of melatonin metabolite in humans. *Neurosci Lett* 266(3):209-212 (1999).
- Cherry, N.J., 2002: "Schumann Resonances, a plausible biophysical mechanism for the human health effects of Solar/Geomagnetic Activity". *Natural Hazards* 56: 279-331.
- Cocco P, Heineman EF, Docemeci M. Occupational risk factors for cancer of the central nervous system (CNS) among US women. *Am J Ind Med* 36(1):70-74 (1999).
- Dasdag, S, Ketani, MA, Akdag, Z, Ersay, AR, Sar,i I, Demirtas ,OC, Celik, MS, 1999: Whole-body microwave exposure emitted by cellular phones and testicular function of rats. *Urol Res* 27(3):219-223.
- Davanipour Z, Sobel E, Bowman JD, Qian Z, Will AD. Amyotrophic Lateral Sclerosis and occupational exposure to electromagnetic fields. *Bioelectromagnetics* 18: 28-35 (1997).
- Davidson, J.A., 1998: "Brain tumour and mobile phones?". *Medical Journal of Australia* 12(1):48.
- Davis, S., 1997: "Weak residential Magnetic Fields affect Melatonin in Humans", *Microwave News*, Nov/Dec 1997.
- Davis, S., Mirick, D.K. and Stevens, R.G., 2002: "Residential magnetic fields and the risk of breast

- cancer". *Am J Epidemiology* 155(5): 446-454.
- Deapen DM, Henderson BE. A case-control study of Amyotrophic Lateral Sclerosis. *Am. J. Epidemiol* 123(5): 790-799 (1986).
- Deroche m. Etude de perturbations biologiques chez les techniciens O.R.T.F. dans certains champs electromagnetiques de haute frequence. *Arch Mal Prof* 32:679-683 (1971).
- de Seze R, Fabbro-Peray P, Miro L. GSM radiocellular telephones do not disturb the secretion of antipituitary hormones in humans. *Bioelectromagnetics* 19(5): 271-278 (1999).
- Dockerty JD, Elwood JM, Skegg DC, Herbison GP. Electromagnetic field exposures and childhood cancers in New Zealand. *Cancer Causes and Control* 9(3):299-309 (1998).
- 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).
- Dolk H, Elliott P, Shaddick G, Walls P, Grundy C, Thakrar B. Cancer incidence near radio and television transmitters in Great Britain, II All high power transmitters. *Am J Epidemiol* 145(1):10-17 (1997).
- Donnellan M, McKenzie DR, French PW, 1997: Effects of exposure to electromagnetic radiation at 835 MHz on growth, morphology and secretory characteristics of a mast cell analogue, RBL-2H3. *Cell Biol Int* 21:427-439.
- Dosemeci M, Blair A. Occupational Cancer Mortality Among Women Employed in the Telephone Industry. *J Occup Med* 36 (11):1204-1209 (1994).
- Eulitz, C, Ullsperger, P, Freude, G, Elbert ,T, 1998: Mobile phones modulate response patterns of human brain activity. *Neuroreport* 9(14):3229-3232.
- Fanelli C, Coppola S, Barone R, Colussi C, Gualandi G, Volpe P, Ghibelli L. Magnetic fields increase cell survival by inhibiting apoptosis via modulation of Ca<sup>2+</sup> influx. *FASEB Journal* 13(1): 95-102 (1999).
- Fear NT, Roman E, Carpenter LM, Newton R, Bull D. Cancer in electrical workers: an analysis of cancer registrations in England, 1981-1987. *Br J Cancer* 73(7): 935-939 (1996).
- Fesenko, EE, Makar, VR, Novoselova, EG, Sadovnikov, VB, 1999: 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.
- Feychting M, Pedersen NL, Svedberg P, Floderus B, Gatz M. Dementia and occupational exposure to magnetic fields. *Scand J Work Environ Health* 24(1): 46-53 (1998).
- Feychting M, Ahlbom A. Magnetic fields and cancer in children residing near Swedish High-voltage power lines. *Am J Epidemiol* 138 (7):467-481 (1993).
- Feychting M, Forssen U, Floderus B. Occupational and residential magnetic field exposure and leukemia and central nervous system tumors. *Epidemiology* 8(4):384-389 (1997).
- Feychting M, Schulgen G, Olsen JH, Ahlbom A. Magnetic fields and childhood cancer- pooled analysis of two Scandinavian studies. *Europ J Cancer* 31A (12): 2035-2039 (1995).

- Floderus B, Persson T, Stenlund C, Wennberg A, Ost A, Knave B Occupational exposure to electromagnetic fields in relation to leukemia and brain tumors: a case-control study in Sweden. *Cancer Causes Control* 4(5):465-76 (1993).
- Forman, S.A., Holmes, C.K., McManamon, T.V., and Wedding, W.R., 1982: "Physiological Symptoms and Intermittent Hypertension following acute microwave exposure". *J. of Occup. Med.* 24(11): 932-934.
- Fraumeni JF, Devesa SS, Hoover RN, Kinlen LJ. Epidemiology of cancer. In: *Cancer: Principles and Practice of Oncology*, 4th edition, (Vincent T De Vita, Jr, Samuel Hellman, Steven A Rosenberg, ed), Philadelphia, J.B. Lippincott Co., 1993; 150-181.
- Freude, G, Ullsperger, P, Eggert ,S, Ruppe, I, 1998: Effects of microwaves emitted by cellular phones on human slow brain potentials. *Bioelectromagnetics* 19(6):384-387.
- French PW, Donnellan M, McKenzie DR, 1997: Electromagnetic radiation at 835 MHz changes the morphology and inhibits proliferation of a human astrocytoma cell line. *Bioelectrochem Bioenerg* 43:13-18.
- Freude, G, Ullsperger, P, Eggert, S, Ruppe, I, 2000: Microwaves emitted by cellular telephones affect human slow brain potentials. *Eur J Appl Physiol* 81(1-2):18-27.
- Frey, A.H., 1995: "An integration of the data on mechanisms with particular reference to cancer", Chapter 2 in "On the Nature of electromagnetic Field Interactions with Biological Systems", Ed A.H. Frey, Publ. R.G. Landes Co. Medical Intelligence Unit, Austin, Texas.
- Frey AH. Headaches from cellular telephones: are they real and what are the impacts. *Environ Health Perspect* 106(3):101-103 (1998).
- Fritze K, Wiessner C, Kuster N, Sommer C, Gass P, Hermann DM, Kiessling M, Hossmann KA, 1997: Effect of global system for mobile communication microwave exposure on the genomic response of the rat brain. *Neuroscience* 81(3):627-639.
- Gavalas-Medici R, Day-Magdaleno SR. Extremely low frequency weak electric fields affect schedule-controlled behaviour of monkeys. *Nature* 261:256-258 (1976)
- Goswami PC, Albee LD, Parsian AJ, Baty JD, Moros EG, Pickard WF, Roti Roti JL, Hunt CR. Proto-oncogene mRNA levels and activities of multiple transcription factors in C3H 10T 1/2 murine embryonic fibroblasts exposed to 835.62 and 847.74 MHz cellular telephone communication frequency radiation. *Radiat Res* 151(3): 300-309 (1999).
- Goldsmith JR. Incorporation of epidemiological findings into radiation protection standards. *Public Health Rev* 19:19-34 (1991/92).
- Goldsmith, JR. Epidemiological Evidence of Radiofrequency Radiation (Microwave) Effects on Health in Military, Broadcasting, and Occupational Studies. *Int J Occup Environ Health* 1: 47-57 (1995).
- Goldsmith JR. Epidemiologic evidence relevant to radar (Microwave) effects. *Environ Health Perspect* 105 (Suppl 6): 1579-1587 (1997).
- Gordon, ZV. Problems of industrial hygien and the biological effects of electromagnetic superhigh frequency fields. [In Russian], Moscow Medicina. (1966). English Translation in NASA Rep. TT-F-633, 1976.
- Graham C, Cook MR. Human sleep in 60 Hz magnetic fields. *Bioelectromagnetics* 20: 277-283 (1999).

- Graham, C., Cook, M.R., Cohen, H.D. and Gerkovich, M.M., 1994: "A dose response study of human exposure to 60Hz electric and magnetic fields". *Bioelectromagnetics* 15: 447-463.
- Graham, C., Cook, M.R., Sastre, A., Riffle, D.W. and Gerkovich, M.M., 2000: "Multi-night exposure to 60 Hz magnetic fields: effects on melatonin and its enzymatic metabolite". *J Pineal Res* 28(1): 1-8.
- Grayson JK. Radiation Exposure, Socioeconomic Status, and Brain Tumour Risk in the US Air Force: A nested Case-Control Study. *Am J Epidemiol* 143 (5), 480-486 (1996).
- Grayson JK, Lyons TJ. Cancer incidence in the United States Air Force. *Aviat Space Environ Med* 67(2):101-104 (1996).
- Green LM, Miller AB, Agnew DA, Greenberg ML, Li J, Villeneuve PJ, Tibshirani R. Childhood leukaemia and personal monitoring of residential exposures to electric and magnetic fields in Ontario, Canada. *Cancer Causes Control* 10(3):233-243 (1999).
- Guberan E, Usel M, Tissot R, Sweetnam PM. Disability, mortality and incidence of cancer among Geneva painters and electricians: a historical prospective study. *Br J Ind Med* 46:16-23 (1989).
- Guenel P, Nicolau J, Imbernon E, Chevalier A, Goldberg M. Exposure to electric field and incidence of leukemia, brain tumors, and other cancers among French electric utility workers. *Am J Epidemiol* 144(12):1107-1121(1996).
- Hamer, J.R., 1965: Biological entrainment of the human brain by low frequency radiation". NSL 65-199, Northrop Space Labs.
- Hamer, J.R., 1969: "Effects of low level, low frequency electric fields on time judgement". Fifth Intern. Biometeorological Congress, Montreaux, Switzerland.
- Hammett and Edison Inc. Engineering analysis of radio frequency exposure conditions with addition of digital TV channels. Prepared for Sutra Tower Inc., San Francisco, California, January 3, 1997.
- Hardell L, Nasman A, Pahlson A, Hallquist A, Hansson Mild K, Use of cellular telephones and the risk of brain tumours: A case-control study. *Int J Oncology*, 15(1): 113-116 (1999).
- Hardell, L, Reizenstein, J, Johansson, B, Gertzen, H, Mild, KH, 1999: Angiosarcoma of the scalp and use of a cordless (portable) telephone. *Epidemiology* 10(6):785-786.
- Hardell, L, Nasman, A, Hallquist, A, 2000: "Case-control study of radiology work, medical X-ray investigations and use of cellular telephones as risk factors". *J of General Medicine* [www.medscape.com/Medscape/GeneralMedicine/journal/2000/v02.n03/](http://www.medscape.com/Medscape/GeneralMedicine/journal/2000/v02.n03/)>
- Hardell, L. Hansson Mild, K.,H., Hallquist, A., Carlberg, M., Pahlson, A., Lilja, A. and Larsson, I., 2001: "Swedish study on use of cellular and cordless telephones and the risk for brain tumours". Conference Mobile Telephones and Health – The Latest Developments, London June 6-7, 2001
- Hardell, L., Hallquist, A., Hansson Mild, K., Carlberg, M., Pahlson, A. and Lilja A., 2002a: "Cellular and Cordless Telephones and the Risk for Brain Tumors". *European Journal of Cancer Prevention*. 11(4): 377-386.

- Hardell, L., Hansson Mild. K., and Carlberg, M., 2002b: "Use of Cellular Telephones and the Risk for Astrocytomas" unpublished manuscript, In Press, October 2002, International Journal of Radiation Biology.
- Heineman EF, Gao YT, Dosemeci M, McLaughlin JK. Occupational risk factors for brain tumors among women in Shanghai, China. *J Occup Environ Med* 37(3): 288-293 (1995).
- Heller JH, Teixeira-Pinto AA. A new physical method of creating chromosome aberrations. *Nature*, 183 (4665): 905-906 (1959).
- Hill A.B., 1965: "The environment and disease: Association or causation?". *Proc Royal Soc Med* 58: 295-300.
- Hladky, A, Musil, J, Roth, Z, Urban, P, Blazkova, V, 1999: Acute effects of using a mobile phone on CNS functions. *Cent Eur J Public Health* 7(4):165-167.
- Hocking B, Preliminary report: Symptoms associated with mobile phone use. *Occup Med* 48(6): 357-360 (1998).
- Hocking B, Gordon IR, Grain HL, Hatfield GE. Cancer incidence and mortality and proximity to TV towers. *Med J Australia* 165: 601-605 (1996).
- Irvine D, Davies DM. The mortality of British Airways pilots, 1966-1989: a proportional mortality study. *Aviat Space Environ Med* 63(4):276-279 (1992).
- Ivaschuk OI, Jones RA, Ishida-Jones T, Haggren Q, Adey WR and 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).
- Jacobson, C.B., 1969: Progress report on SCC 31732, (Cytogenic analysis of blood from the staff at the U.S. Embassy in Moscow), George Washington University, Reproductive Genetics Unit, Dept. of Obstetrics and Gynecology, February 4, 1969.
- Johansen C, Olsen JH. Risk of cancer among Danish utility workers - a nationwide cohort study. *Am J Epidemiol* 147(6):548-555(1998).
- Johansen C, Koch-Hendriksen N, Rasmussen S, Jørgen OH. Multiple Sclerosis among utility workers. *Neurology* 52(6): 1279-1282 (1999).
- Johansen, C., 2000: "Exposure to electromagnetic fields and risk of central nervous system disease in utility workers". *Epidemiology* 11(5): 539-543.
- Johansen, C., Boice, J.D., McLaughlin, J.K., and Olsen, J., 2001: "Cellular telephones and cancer - a nationwide cohort study in Denmark". *J Nat Cancer Inst* 93(3): 203-207.
- Johnson-Liakouris AJ. Radiofrequency (RF) Sickness in the Lilienfeld Study: an effect of modulated microwaves. *Arch Environ Health* 53(3):236-238 (1998).
- Jones IF. A study of the propagation of wavelengths between three and eight meters. *Proc Inst Radio Eng* 21(3): 349-386 (1933).
- Juutilainen, J., Stevens, R.G., Anderson, L.E., Hansen, N.H., Kilpelainen, M., Laitinen, J.T., Sobel, E. and Wilson, B.W., 2000: "Nocturnal 6-hydroxymelatonin sulphate excretion in female workers exposed to magnetic fields". *J Pineal Res* 28(2): 97-104.

- Juutilainen J, Laara E, Pukkala E. Incidence of leukaemia and brain tumours in Finnish workers exposed to ELF magnetic fields. *Intl Arch Occup Environ Health* 62(4):289-293 (1990).
- Kaczmarek LK, Adey WR. The efflux of  $^{45}\text{Ca}^{2+}$  and (3H)gamma-aminobutyric acid from cats cerebral cortex. *Brain Res* 63:331-42 (1973).
- Karasek, M., Woldanska-Okonska, M., Czernicki, J., Zylinska, K. and Swietoslowski, J., 1998: "Chronic exposure to 2.9 mT, 40 Hz magnetic field reduces melatonin concentrations in humans". *J Pineal Research* 25(4): 240-244.
- Kellenyi, L, Thuroczy, G, Faludy, B, Lenard, L, 1999: Effects of mobile GSM radiotelephone exposure on the auditory brainstem response (ABR). *Neurobiology* 7:79-81.
- Kheifets LI, Afifi AA, Buffler, Zhang ZW. Occupational electric and magnetic field exposure and brain cancer: a meta-analysis. *J Occup Environ Med* 37(12):1327-1341 (1995).
- Kheifets LI, Gilbert ES, Sussman SS, Guenel P, Sahl JD, Savitz DA, Theriault G. Comparative analyses of the studies of magnetic fields and cancer in electric utility workers: studies from France, Canada and the United States. *Occup Environ Med* 56(8):567-574 (1999).
- Khudnitskii, SS, Moshkarev, EA, Fomenko, TV, 1999: [On the evaluation of the influence of cellular phones on their users]. [Article in Russian] *Med Tr Prom Ekol* (9):20-24.
- Koivisto, M, Revonsuo, A, Krause, C, Haarala, C, Sillanmaki, L, Laine, M, Hamalainen, H, 2000: Effects of 902 MHz electromagnetic field emitted by cellular telephones on response times in humans. *Neuroreport* 11(2):413-415.
- Kolomytkin O, Kuznetsov V, Yurinska M, Zharikova A, Zharikov S. Response of brain receptor systems to microwave energy exposure. In *On the nature of electromagnetic field interactions with biological systems* (Allan H Frey ed) 1994; 195-206.
- König HL, Behavioural changes in human subjects associated with ELF electric fields. In: *ELF and VLF electromagnetic field effects* (Persinger MA ed), New York, Plenum Press, 1974; 81-99.
- Kraut A, Tate R, Tran NM. Residential electric consumption and childhood cancer in Canada (1971-1986). *Arch Environ Health* 49(3):156-159 (1994).
- Kwee, S, Raskmark, P, 1997: Radiofrequency electromagnetic fields and cell proliferation. Presented at the Second World Congress for Electricity and Magnetism in Biology and Medicine, Bologna, Italy, June.
- Levallois, P., Dumont, M., Touitou, Y., Gingras, S., Masse, B., Gauvinm, D., Kroger, E., Bourdages, M. and Douville, P., 2002: "Effects of electric and magnetic fields from high-power lines on female urinary excretion of 6-sulfatoxymelatonin". *Am J Epidemiol.* 154(7): 601-609.
- Lilienfeld AM, Tonascia J, Tonascia S, Libauer CA, Cauthen GM, Foreign Service health status study - evaluation of health status of foreign service and other employees from selected eastern European posts. Final Report (Contract number 6025-619073) to the U.S. Department of State, July 31, 1978, 429pp.
- Lin RS, Dischinger PC, Conde J, Farrel KP. Report on the relationship between the incidence of brain tumors and occupational electromagnetic exposure. *J Occup Med* 27:413-419 (1985).

- Loomis DP, Savitz DA. Mortality from brain cancer and leukaemia among electrical workers. *Br J Ind Med* 47(9):633-638 (1990).
- Löscher, W. and Käs, G., 1998: "Conspicuous behavioural abnormalities in a dairy cow herd near a TV and radio transmitting antenna". *Prakt. Tierarzt* 79(5): 437-444 [In German]. [Practical Veterinary Surgeon 79(5): 437-444.]
- Mack W, Preston-Martin S, Peters JM. Astrocytoma risk related to job exposure to electric and magnetic fields. *Bioelectromagnetics* 12(1):57-66 (1991).
- Maes A, Collier M, Van Gorp U, Vandoninck S, Verschaeve L, 1997: Cytogenetic effects of 935.2-MHz (GSM) microwaves alone and in combination with mitomycin C. *Mutat Res* 393(1-2): 151-156.
- Mallin K, Rubin M, Joo E. Occupational cancer mortality in Illinois white and black males, 1979-1984, for seven cancer sites. *Am. J. Ind. Med* 15(6): 699-717 (1989).
- Mann K, Roschke J. Effects of pulsed high-frequency electromagnetic fields on human sleep. *Neuropsychobiology* 33: 41-47 (1996).
- Matanoski GM, Elliot EA, Breyse PN, Lynberg MC. Leukemia in telephone linemen. *Am J Epidemiol* 137(6):609-619 (1993).
- Mattos IE, Koifman S. Cancer mortality among electricity utility workers in the state of Sao Paulo, Brazil. *Rev Saude Publica* 30(6):564-575 (1996).
- Meinert R, Michaelis J. Meta-Analysis of studies on the association between electromagnetic fields and childhood cancer. *Radiat Environ Biophys* 35(1):11-18 (1996).
- Meltz ML. Biological effects versus health effects: an investigation of the genotoxicity of microwave radiation. In: *Radiofrequency Radiation Standards, NATO ASI Series* (B.J. Klauberg Ed). New York, Plenum Press, 1995: 235-241.
- Mild H.K., Oftedak G, Sandstrom M, Wilen J, Tynes T, Haugsdal B, Hauger E. Comparison of symptoms experienced by users of analogue and digital mobile phones - a Swedish-Norwegian epidemiological study Rpt No 1998:23. National Institute for Working Life, Umea, Sweden (1998).
- Milham S Jr. Increased incidence of cancer in a cohort of office workers exposed to strong magnetic fields. *Am J Ind Med* 30(5):702-704 (1996).
- Milham S. Mortality in workers exposed to electromagnetic fields. *Environ Health Perspectives* 62:297-300(1985).
- Milham S. Increased mortality in amateur radio operators due to lymphatic and hematopoietic malignancies. *Am J Epidemiol* 127(1):50-54 (1988).
- Miller, RD, Neuberger JS, Gerald KB. *Epidemiologic Reviews* 19(2):273-293.
- Miller AB, To T, Agnew DA, Wall C, Green LM. Leukemia following occupational exposure to 60-Hz electric and magnetic fields among Ontario electric utility workers. *Am J Epidemiol* 144(2):150-160(1996).
- Moscovici B, Lavyel A, Ben-Itzhac D. Exposure to electromagnetic radiation among workers. *Fam Physician* 3(3):121 (1974).

- Motluk, A., 1997: "Radio head: The brain has its own FM receiver". *New Scientist*, 25 October 1997, p17.
- Nicholas JS, Lackland DT, Butler GC, Mohr LC Jr, Dunbar JB, Kraune WT, Grosche B, Hoel DG. Cosmic radiation and magnetic field exposure to airline flight crews. *Am J Ind Med* 34(6):574-580 (1998).
- Nicholas JS, Lackland DT, Dosemeci M, Mohr LC Jr, Dunbar JB, Grosche B, Hoel DG. Mortality among US commercial pilots and navigators. *J Occup Environ Med* 40(11):980-985 (1998).
- Olsen JH, Jensen JK, Nielsen A, Schulgen G. Electromagnetic fields from high-voltage transmissions and cancer in childhood. *Ugeskr Laeger* 156(17):2579-2584 (1994).
- Olsen JH, Nielson A, Schulgen G. Residence near high voltage facilities and risk of cancer in children. *BMJ* 307:891-895 (1993).
- Pahl, H.L., 1999: "Signal transduction from the endoplasmic reticulum to the cell nucleus". *Physiological Reviews*, 79(3): 683-701.
- Park RM, Silverstein MA, Green MA, Mirer FE. Brain cancer mortality at a manufacture of aerospace electrochemical systems. *Am J Ind Med* 17(5):537-552 (1990).
- Pearce N, Reif J, Fraser J. Case-control studies of cancer in New Zealand electrical workers. *Int J Epidemiol* 18(1): 55-59 (1989).
- Perry FS, Reichmanis M, Marino A, Becker RO. Environmental power-frequency magnetic fields and suicide. *Health Phys* 41(2):267-277 (1981).
- Pflugger, D.M. and Minder, C.E., 1996: "Effects of 16.7 Hz magnetic fields on urinary 6-hydroxymelatonin sulfate excretion of Swiss railway workers". *J Pineal Research* 21(2): 91-100.
- Phillips, J.L., Ivaschuk, O., Ishida-Jones, T., Jones, R.A., Campbell-Beachler, M. and Haggren, W., 1998: "DNA damage in molt-4 T-lymphoblastoid cells exposed to cellular telephone radiofrequency fields in vitro". *Bioelectrochem Bioenerg* 45: 103-110.
- Polk C, 1982: "Schumann Resonances". In: *CRC Handbook of Atmospheric*, 2 (Hans Volland ed). Boca Raton, Florida: CRC Press, 111-177.
- Pollack, H., 1979: "Epidemiologic data on American personnel in the Moscow Embassy", *Bull. N.Y. Acad. Med*, 55(11): 1182-1186.
- Pollack H. The Microwave Syndrome. *Bull NY Acad Med* 55: 1240-1243 (1979).
- Preece AW, Iwi G, Davies-Smith A, Wesnes K, Butler S, Lim E, Varey A., Effect of a 915-MHz simulated mobile phone signal on cognitive function in man. *Int J Radiat Biol* 75(4): 447-456 (1999).
- Preston-Martin S, Navidi W, Thomas D, Lee PJ, Bowman J, Pogoda J. Los Angeles study of residential magnetic fields and childhood brain tumors. *Am J Epidemiol* 143:105-119 (1996).
- Preston-Martin S, Lewis S, Winkelmann R, Borman B, Auld J, Pearce N. Descriptive epidemiology of primary cancer of the brain, cranial nerves, and cranial meninges in New Zealand, 1948-88. *Cancer Causes and Control* 4(6):529-538 (1993).

- Preston-Martin S, Mack W, Henderson BE. Risk factors for gliomas and meningiomas in males Los Angeles County. *Cancer Research* 49:6137 (1989).
- Reiter, R.J., and Robinson, J. *Melatonin: your body's natural wonder drug*. New York: Bantam Books, 1995.
- Reiter RJ. Melatonin biosynthesis, regulation and effects. In: *The Melatonin Hypothesis: breast cancer and electric power* (Richard Stevens, Barry Wilson and Larry Anderson eds). Richland, Battelle Press, 1997; 25-48.
- Reiter, R.J., 1994: "Melatonin suppression by static and extremely low frequency electromagnetic fields: relationship to the reported increased incidence of cancer". *Reviews on Environmental Health*. 10(3-4): 171-86, 1994.
- Reiter, R.J. and Robinson, J, 1995: "Melatonin: Your body's natural wonder drug". Publ. Bantam Books, New York.
- Repacholi MH, Basten A, Gebiski V, Noonan D, Finnie JH, Harris AW. Lymphomas in  $E\mu$ -*Pim1* Transgenic Mice Exposed to Pulsed 900 MHz Electromagnetic Fields. *Radiation Research* 147:631-640 (1997).
- Robinette CD, Silverman C, Jablon S. Effects upon health of occupational exposure to microwave radiation (radar). *Am J Epid* 112(1):39-53 (1980).
- Rodvall Y, Ahlbom A, Stenlund C, Preston-Martin S, Lindh T, Spannare B. Occupational exposure to magnetic fields and brain tumors in central Sweden. *Eur J Epidemiol* 14(6):563-569 (1998).
- Rosen, L.A., Barber, I. and Lyle D.B., 1998: "A 0.5 G, 60 HZ magnetic field suppresses melatonin production in pinealocytes". *Bioelectromagnetics* 19: 123-127.
- Rothman KJ, Loughlin JE, Funch DP, Dreyer NA. Overall mortality of cellular telephone customers. *Epidemiology* 7(3): 303-305 (1996).
- Salford, L.G., Brun, A., Stureson, K., Eberhardt, J.L. and Persson, B.R.R., 1994: Permeability of the Blood-Brain Barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50 and 200 Hz.
- Salisbury DA, Band PR, Threlfall WJ, Gallagher RP. Mortality among British Columbia pilots. *Aviat Space Environ Med* 62(4):351-352 (1991).
- Santana VS, Silva M, Loomis D. Brain neoplasms among naval military men. *Int J Occup Environ Health* 5(2):88-94(1999).
- Savitz DA, Loomis DP. Magnetic field exposure in relation to leukemia and brain cancer mortality among electric utility workers. *Am J Epidemiol* 141(2):123-34 1995.
- Savitz DA, Kaune WT. Childhood cancer in relation to a modified residential wire code. *Environ Health Perspect* 101(1): 76-80 (1993).
- Savitz DA, John EM, Kleckner RC. Magnetic field exposure from electric appliances and childhood cancer. *Am J Epidemiol* 131(5):763-773 (1990).
- Savitz DA, Wachtel H, Barnes FA, John EM, Tvrdik JG. Case-control study of childhood cancer and exposure to 60-Hz magnetic fields. *Am J Epidemiol* 128(1):21-38 (1988)

- Savitz DA, Checkoway H, Loomis DP. Magnetic field exposure and neurodegenerative disease mortality among electric utility workers. *Epidemiology* 9(4):398-404 (1998).
- Savitz DA, Loomis DP, Tse CK. Electrical occupations and neurodegenerative disease: analysis of U.S. mortality data. *Arch Environ Health* 53(1):71-74 (1998).
- Schirmacher, A, Bahr, A, Kullnick, U, Stoegbauer, F, 1999: Electromagnetic fields (1.75 GHz) influence the permeability of the blood-brain barrier in cell culture model. Presented at the Twentieth Annual Meeting of the Bioelectromagnetics Society, St. Pete Beach, FL, June.
- Schlehofer B, Kunze S, Sachsenheimer W, Blettner M, Niehoff D, Wahrendorf J. Occupational risk factors for brain tumors: results from a population-based case-control study in Germany. *Cancer Causes and Control* 1(3):209-215 (1990).
- Schreiber GH, Swaen GM, Meijers JM, Slangen JJ, Sturmans F. Cancer mortality and residence near electricity transmission equipment: a retrospective cohort study. *Int J Epidemiol* 22(1):9-15 (1993).
- Schwan HP, Foster KR. RF-field interactions with biological systems: electrical properties and biophysical mechanisms. *Proc IEEE* 68(1): 104-113 (1980).
- Schwartz JL, House DE, Mealing AR. Exposure of frog hearts to CW or amplitude modulated VHF fields: selective efflux of calcium ions at 16 Hz. *Bioelectromagnetics* 11: 349-358 (1990).
- Selvin S, Schulman J, Merrill DW. Distance and risk measurements for the analysis of spatial data: a case study of childhood cancers. *Soc Sc. Med* 34(7):769-777 (1992).
- Shandala MG, Dumanski UD, Rudnev MI, Ershova LK, Los IP. Study of nonionizing microwave radiation effects on the central nervous system and behavior reactions. *Environ Health Perspect* 30:115-121 (1979)
- Sobel E, Davanipour DVM. Electromagnetic field exposure may cause increased production of amyloid beta and eventually lead to Alzheimer's disease. *Neurology* 47(12):1594-1600 (1996).
- Sobel E, Davanipour Z, Sulkava R, Erkinjuntti T, Wikstrom J, Henderson VW, Bucjwalter G, Bowman D, Lee P-J. Occupations with exposure to electromagnetic fields: a possible risk factor for Alzheimer's Disease. *Am J Epidemiol* 142(5): 515-524 (1995).
- Sobel E, Dunn M, Davanipour DVM, Qian MS, Chui MD. Elevated risk of Alzheimer's disease among workers with likely electromagnetic field exposure. *Neurology* 47(12): 1477-1481 (1996).
- Speers MA, Dobbins JG, Miller VS. Occupational exposures and brain cancer mortality: a preliminary study of East Texas Residents. *Am J Ind Med* 13:629-638 (1988).
- Stark, K.D.C., Krebs, T., Altpeter, E., Manz, B., Griol, C. and Abelin, T., 1997: "Absence of chronic effect of exposure to short-wave radio broadcast signal on salivary melatonin concentrations in dairy cattle". *J Pineal Research* 22: 171-176.
- Strickland, D., Smith, S.A., Dolliff, G., Goldman, L. and Roelofs, R.I., 1996: "Amyotrophic lateral sclerosis and occupational history. A pilot case-control study". *Arch Neurol* 53(8): 730-733.
- Szmigielski S, Bielec M, Lipski S, Sokolska G. Immunological and cancer-related aspects of exposure to low level microwave and radiofrequency fields. In: *Modern Bioelectricity* (Marino A ed). New York, Marcel Bekker, 1988:861-925.

- Szmigielski S. Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. *Sci Total Env* 180:9-17 (1996).
- Theriault G, Goldberg M, Miller AB, Armstrong B, Guenel P, Deadman J, Imbernon E, To T, Chevalier A, Cyr D, et.al. Cancer risks associated with occupational exposure to magnetic fields among electric utility workers in Ontario and Quebec, Canada, and France: 1970-1989. *Am J Epidemiol* 139(6): 550-572 (1994).
- Theriault G. Electromagnetic fields and cancer risks. *Rev Epidemiol Sante Publique* 40(Suppl 1):S55-62 (1992).
- Thomas TL, Stolley PD, Stemhagen A, Fontham ETH, Bleecker ML, Stewart PA, Hoover RN. Brain tumor mortality risk among men with electrical and electronic jobs: A case-control study. *J Natl Cancer Inst* 79(2):233-238 (1987).
- Tice R, Hook G, McRee DI. Chromosome aberrations from exposure to cell phone radiation. *Microwave News*, Jul/Aug (1999) p7
- Tomenius L. 50-Hz electromagnetic environment and the incidence of childhood tumors in Stockholm County. *Bioelectromagnetics* 7(2):191-207 (1986).
- Tornqvist S, Norell S, Ahlbom A, Knave B. Cancer in the electric power industry. *Br J Ind Med* 43(3):212-213 (1986).
- Tornqvist S, Knave B, Ahlbom A, Persson T. Incidence of leukaemia and brain tumours in some 'electrical occupations. *Br J Ind Med* 48: 597-603 (1991).
- Tynes T, Haldorsen T. Electromagnetic fields and cancer in children residing near Norwegian high-voltage power lines. *Am J Epidemiol* 145(3):219-226(1997).
- Tynes T, Anderson A, Langmark F. Incidence of cancer in Norwegian workers potentially exposed to electromagnetic fields. *Am J Epidemiol* 136(1):81-88 (1992).
- Vanecek, J., 1998: "Cellular Mechanisms of Melatonin Action". *Physiol. Rev.* 78: 687-721.
- Velizarov, S, Raskmark, P, Kwee, S, 1999: The effects of radiofrequency fields on cell proliferation are non-thermal. *Bioelectrochem Bioenerg* 48(1):177-180.
- Verkasalo PK, Haprio J, Varjonen J, Romanov K, Heikkila K, Koskenvuo M. Magnetic fields of transmission lines and depression. *Am J Epidemiol* 146(12):1037-1045 (1997).
- Verkasola PK, Pukkala E, Hongisto MY, Valjus JE, Jarvinen PJ, Heikkila, KV, Koskenvuo M. Risk of cancer in Finnish children living close to power lines. *BMJ* 307(6909):895-899 (1993).
- Verschaeve, L., Slaets, D., Van Gorp, U., Maes, A. and Vanderkom, J., 1994: "In vitro and in vivo genetic effects of microwaves from mobile phone frequencies in human and rat peripheral blood lymphocytes". *Proceedings of Cost 244 Meetings on Mobile Communication and Extremely Low Frequency field: Instrumentation and measurements in Bioelectromagnetics Research*. Ed. D, Simunic, pp 74-83.
- Vignati M, Giuliani L. Radiofrequency exposure near high-voltage lines. *Environ Health Perspect* 105 (Suppl 6): 1569-1573 (1997).

- Vijayalaxmi BZ, Frei MR, Dusch SJ, Guel V, Meltz ML, Jauchem JR. Frequency of micronuclei in the peripheral blood and bone marrow of cancer-prone mice chronically exposed to 2450 MHz radiofrequency radiation. *Radiat Res* 147: 495-500 (1997).
- Von Klitzing L. Low frequency pulsed electromagnetic fields influence EEG of man. *Physica Medica* 11(2): 77-80 (1995).
- Wang SG. 5-HT contents change in peripheral blood of workers exposed to microwave and high frequency radiation. *Chung Hua Yu Fang I Hsueh Tsa Chih* 23(4): 207-210 (1989).
- Wang, S.G. 1989: "5-HT contents change in peripheral blood of workers exposed to microwave and high frequency radiation". *Chung Hua Yu Fang I Hsueh Tsa Chih* 23(4): 207-210.
- Washburn EP, Orza MJ, Berlin JA, Nicholson WJ, Todd AC, Frumkin H, Chalmers TC. Residential proximity to electric transmission and distribution equipment and risk of childhood leukaemia, childhood lymphoma and childhood nervous system tumors: systematic review, evaluation and meta-analysis. *Cancer Causes and Control* 5(4):299-309 (1994).
- Wertheimer, N, Leeper E. Electrical wiring configurations and childhood cancer. *Am J Epidemiol* 109(3):272-284 (1979)
- Wilson, B.W., Wright, C.W., Morris, J.E., Buschbom, R.L., Brown, D.P., Miller, D.L., Sommers-Flannigan, R. and Anderson, L.E., 1990: "Evidence of an effect of ELF electromagnetic fields on human pineal gland function". *J Pineal Research* 9(4): 259-269.
- Wood, A.W., Armstrong, S.M., Sait, M.L., Devine, L. and Martin, M.J., 1998: "Changes in human plasma melatonin profiles in response to 50 Hz magnetic field exposure". *J Pineal Research* 25(2): 116-127.
- Wever R, ELF-effects on Human Circadian Rhythms. In: *ELF and VLF Electromagnetic Field Effects*, (Persinger MA ed). New York, Plenum Press; 1974; 101-144.
- Wilson BW, Wright CW, Morris JE, Buschbom RL, Brown DP, Miller DL, Sommers-Flannigan R, Anderson LE. 1990: Evidence of an effect of ELF electromagnetic fields on human pineal gland function. *J Pineal Research* 9(4): 259-269 (1990).
- Wood AW, Armstrong SM, Sait ML, Devine L, Martin MJ. Changes in human plasma melatonin profiles in response to 50 Hz magnetic field exposure. *J Pineal Research* 25(2): 116-127 (1998).
- Yaga, K, Reiter, R.J., Manchester, L.C., Nieves, H., Sun, J.H. and Chen, L.D., 1993: "Pineal sensitivity to pulsed magnetic fields changes during the photoperiod. *Brain Res Bulletin*, 30 (1-2): 153-156.
- Youbicier-Simo, BJ, Lebecq, JC, Bastide, M, 1998: Mortality of chicken embryos exposed to EMFs from mobile phones. Presented at the Twentieth Annual Meeting of the Bioelectromagnetics Society, St. Pete Beach, FL, June.
- Zaret MM. Potential hazards of hertzian radiation and tumors. *NY State J Med* 146-147 (1977).