The Breast Cancer/EMF connection: Melatonin, Tamoxifen, 50-60 Hertz Electromagnetic Fields and Breast Cancer

An Australian Senate discussion Paper, 27 October 1997 (published in Hansard)

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According to recent statistics, breast cancer in Australia effects one in 14 women, kills one in 27 and is increasing at a rate of 3% annually. These figures reflect a growing community concern and as a consequence, in 1995 the Federal Government allocated $3 million over a 3 year period, solely for breast cancer studies.

It is unfortunate however, that apparently no current Australian breast cancer research is examining the growing evidence that low level exposures to 50-60 hertz electromagnetic fields (EMF) may block melatonin's ability to suppress breast cancer cells and reduce the pineal gland's nocturnal production of melatonin, thereby increasing susceptibility to breast cancer. This evidence consists of both human and laboratory studies, some of which are summarised in this paper. Almost all of these studies have been conducted only within the last few years and are still awaiting the peer review process which can take years to complete. As a result, many of these studies do not yet constitute part of the body of substantiated scientific evidence, often referred to by national and international expert regulatory groups, such as the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

In drafting its own guidelines for both residential and occupational exposure to powerline frequency (50-60 Hz) EMFs, Australian authorities, such as the National Health & Medical Research Council (NH&MRC) and the Australian Radiation Laboratory (ARL) have taken their maximum exposure guidelines from overseas expert groups, mainly the ICNIRP, which are as follows, (for magnetic fields over a 24 hour exposure):

For Residential Exposures:	For Occupational Exposures:
1000 milliGauss (mG)	5000 milliGauss (mG)

This is the official position taken by Australian regulatory bodies. However it is important to note that these guidelines are only designed to avoid immediate high level hazards and do not consider prolonged low-level exposures at all. This was admitted in 1991 by Dr Keith Lokan, from the ARL in a conference paper published in Radiation Protection in Australia (Vol 9 No.4, 1991), referring to

IRPA/INIRC guidelines which were taken over by the ICNIRP in 1993 and reconfirmed at that time.

To quote: " These limits [as above] represent plausible field values, below which immediate adverse health effects are unlikely, and as such serve a useful purpose. They are NOT intended to provide protection against possible cancer induction by continued exposure at the lower field levels implicated in the studies we have been considering at this workshop." (1 - 3 mG)

So not only do the official guidelines fail to consider low level exposures but the scientific research they are based upon (substantiated evidence) was last considered in 1993, when the current ICNIRP guidelines were reconfirmed. This predates the entire body of evidence as examined in this report.

The idea that low level powerline frequency magnetic fields may reduce the pineal gland's production of melatonin and that melatonin's ability to suppress cancer cells is blocked by these fields, is called the "melatonin hypothesis". At the recent international conference, the Second World Congress for Electricity and Magnetism in Biology and Medicine , held in Bologna, Italy in June of 1997, it is mentioned in the program bulletin:

"A number of experimental studies have been conducted to test the [melatonin] hypothesis. Although the literature is still evolving and consensus is being built, it is fair to say, a) there exists credible scientific support for the hypothesis and, importantly, b) this support encompasses in vitro, in vivo, and epidemiological research. The melatonin hypothesis, thus, currently represents one of the more well documented/tested interactions in the field of bioelectromagnetics."

What is the medical fraternity to do when presented with a significant body of reputable scientific evidence that exposure to low level powerline frequency magnetic fields may well be a risk factor in breast cancer? Advice from such government bodies such as the NH&MRC and the ARL can only reflect their official position as mentioned above.

Considering the prevalence of breast cancer in Western society and the extensive body of recent evidence pointing to a connection with EMF exposure, it is the position of this report that with breast cancer patients, avoiding excessive EMF exposure should be part of the treatment, under the Precautionary Principal, which in this case could be defined as:

The precautionary principal should guide decision-makers when confronted by potential threats to human health. The lack of full scientific certainty should not be used as a reason for postponing measures to prevent exposure to these potential threats. If measures generally reducing exposure can be taken at reasonable expense and with reasonable consequences in all other respects, an effort should be made to reduce exposures to a level below that level which evidence indicates may be harmful to health

1.0: Melatonin

Both human and animal circadian rhythms are driven by the day/night cycle and are synchronized with natural geomagnetic electromagnetic fields. The major control gland over this natural cycle is the pineal gland which secretes the neurohormone melatonin. During the day, light falling on the eye's retina produces signals which are biochemically amplified to stimulate the pineal gland to reduce its melatonin output. At night the absence of light with sleep stimulates the pineal gland to produce melatonin.

The circadian production of melatonin is thought to control important processes in the eyes, including restoration of rods (for night vision) at the end of the night, and renewal of cones (for colour vision) at the end of the day. One theory on how man made EMF's may affect the pineal gland is that the pineal gland may 'sense' EMF's as light and therefore reduce melatonin production. A possible cause

for such an effect is from insoluble granular material contained within the pineal gland.

Research by Dr. Sidney Lang, an expert on piezoelectricity, which is the production of electric fields by pressure on crystalline structures, has shown that the pineal gland has piezoelectrical activity. Dr Lang hypothesizes that this activity is a function of this granular material and if so it may be responding to narrow wave lenghts. (1)

Once melatonin is produced, its ability to pass through the cell membrane allows it to pass directly into the blood stream. Once in the blood melatonin has access to every cell in the body where it passes through the cell membrane to the cell nucleus, which has receptors for it. A few cell membranes also have receptors for melatonin, which may control the 24 hour circadian rhythm of the endocrine system.

In the cell nucleus, melatonin plays a role in regulating gene expression. The ability of melatonin to enter all cells is also essential for one of the other important functions of melatonin, which is to act as a scavenger of highly toxic oxygen-based free radicals. The production of these free radicals is a consequence of the utilization of oxygen by all organisms. About 1 - 2% of inspired oxygen ends up as toxic free radicals which can damage macromolecules such as DNA, proteins and lipids. This damage is referred to as oxidative stress.

Because of its ability to eliminate free radicals, melatonin is probably the most efficient natural cell protection and oncostatic agent in our bodies. At night, melatonin production floods our bodies, eliminating the build up of free radicals that are being produced, allowing the DNA synthesis and cell division to occur with a far lower chance of damage and hence producing more healthy cells. Melatonin also dampens the release of estrogen, prolonged exposure to which may increase the risk of breast cancer. (2)

As for the role of melatonin in effective chemotherapy, researchers at the Tumor Radiation Laboratory at the University of Milan in Italy found that elevated blood levels of melatonin significantly enhanced the effectiveness of chemotherapy. The study included 42 cancer patients of both sexes, including 10 breast cancer patients, 13 lung cancer patients, and 11 colon cancer patients. It was found that 75% (12 OF 16) patients whose melatonin levels were enhanced after chemotherapy exhibited objectively measured tumor regression, whereas only 8% (2 of 26 patients) whose melatonin levels did not go up after chemotherapy exhibited tumor regression.

2.0: Tamoxifen

Tamoxifen, which is the most widely used therapy for treatment of breast cancer, has proven effective in treating breast cancer in its early stages and is also used by over one million women throughout the world who have had breast cancer, to prevent its recurrence. Although tamoxifen is not as effective as melatonin in inhibiting the growth of MCF-7 breast cancer cells in vitro , the drug has been shown to be about 100 times more effective in inhibiting breast cancer cell growth if the cells have first been pre-treated with a physio-logic concentration of melatonin.

3.0: Electromagnetic Fields (EMF)

In 1987 Stephens et al. in the paper, Electric power use and breast cancer; a hypothesis, suggested that electromagnetic fields (EMF's) reduce melatonin production by the pineal gland and that melatonin suppresses the development of breast cancer. (3)

Other researchers have also hypothesized that the possible suppression of melatonin by electromagnetic fields may provide a single mechanism for explaining how number of different types of cancer could be promoted by EMF's, however this suggestion has been hotly debated due to the

previous failure to replicate several key studies. Replication is a key step in the scientific method for it takes an unproven hypothesis to a significant conclusion which can be acted upon.

In 1993 Dr David Blask and co-workers first reported that physiological levels of melatonin reduce MCF-7 human breast cancer cell growth in vitro. (4)

Research reported in 1993 by Liburdy, et al. found that melatonin reduces the growth rate of human breast cancer cells (MCF-7) in culture, but that a 12mG 60 Hz magnetic field can block the ability of melatonin to inhibit breast cancer cell growth. (5)

Examined in this report are five in vitro studies, from three major laboratories, using human breast cancer cell cultures, with results showing that low level powerline frequency magnetic fields in the order of 12 milligauss can block melatonin and/or Tamoxifen's ability to suppress breast cancer cells.

It is this body of laboratory evidence and the three human exposure studies also mentioned herein, that have significant implications for the successful treatment of breast cancer and calls for immediate action from researchers and oncologists alike. The failure to do so, under the excuse of "more research needs to be done" is not acting in the best interests of breast cancer patients, to say the least.

In June 1996 at the 18 th. Annual Meeting of the Bioelectro-magnetics Society (BEMS), the following three studies were presented. When these three studies are added to recent research presented at the Second World Congress for Electricity and Magnetism in Biology and Medicine, held in Bologna Italy, in June of 1997, there now exists an important body of scientific research in relation to breast cancer and electromagnetic fields.

3.1: ELF INHIBITION OF MELA-TONIN AND TAMOXIFEN ACTION ON MCF-7 CELL PROLIFER-ATION; FIELD PARAMETERS.

(J.D. Harland and R.P. Liburdy. Lawrence Berkeley National Laboratory, University of California, Berkeley, California, USA.)

This study was designed to define the parameters by which a 12 milli-Gauss (mG) 60 Hz magnetic field can block the inhibitory action of melatonin and Tamoxifen, a widely used drug treatment for breast cancer. They found that a 12 mG field can significantly reduce the growth inhibitory action of melatonin and Tamoxifen on human breast cancer cells (MCF-7) in culture.

"Preliminary experiments suggest that at least three days exposure at 12mG is necessary to block the cytostatic action of Tamoxifen (from 27% growth inhibition, $p<0.0001$; to 5% growth inhibition, $p>0.5$) indicating that prolonged 12mG exposure may be required. This appears to be consistent with a "slow"interaction mechanism. This result also raises the possibility of field effects that may be cell cycle dependent, since measurable effects appear to be delayed or reversible until cell division begins. In addition, all field magnitudes of 12 mG or higher that have been tested thus far (12mG, 20mG, 1Gauss) have been effective at blocking melatonin." (6)

A lower field of 2mG did not have any significant effect, suggesting a threshold might exist between 2 and 12 mG.

3.2: INDEPENDENT REPLICATION OF THE 12-MG. MAGNETIC FIELD EFFECT ON MELATONIN AND MCF-7 CELLS IN VITRO.

C.F.Blackman, S.G. Benane, D.E. House and J.P. Blanchard. National Health & Environmental Effects Research Laboratory, U.S. Environmental Protection Agency, USA.

This study was specifically designed to attempt to replicate the previous study, with the cooperation of the originating laboratory. The results independently confirmed the previous study's findings that a) Melatonin can inhibit the growth of human breast cancer cells MCF-7 in culture, and b) A 12 mG 60 Hz magnetic field can completely block melatonin's oncostatic action.

The authors of this study believe these results are particularly significant because these findings represent the first replication of a key magnetic bioeffect, and that these two studies represents a foundation for theorists to generate "testable" hypotheses for biological mechanisms of interaction. (7)

3.3: INHIBITION OF MELATONIN'S ACTION OF MCF-7 CELL PROLIFERATION BY MAGNETIC FIELDS ASSOCIATED WITH VIDEO DISPLAY TERMINALS: A PRELIMINARY STUDY.

(S.M.J. Afzal and R.P. Liburdy. Lawrence Berkeley National Laboratory, University of California, USA.)

This study was undertaken to test the hypothesis that ELF and VLF magnetic fields associated with Video Display Terminals (VDT's) influence human breast cancer cell growth in vitro by altering melatonin's natural oncostatic activity. This hypothesis was based on the findings of the two previously mentioned studies.

The conclusions of this study appear to suggest that 12 mG VDT magnetic fields also inhibit the oncostatic action of melatonin in vitro and that the magnetic field component was the operative factor in the 12 mG 60 Hz exposures. Preliminary data from two seperate experiments indicated significant growth inhibition (33% and 22%) on day 6 in the 2 mG magnetic field conditions.(8)

A fourth study of a 12 mG effect on MCF-7 breast cancer cells was presented at San Antonio Texas in Nov.1996 by Dr Richard Luben, as follows:

3.4: REPLICATION OF 12 mG EMF EFFECTS ON MELATONIN RESPONSES OF MCF-7 BREAST CANCER CELLS IN VITRO. R.A.

(Luben, S. Saraiya and A. P. Morgan. Division of Biomedical Sciences, University of California, Riverside, California 92521, USA.)

The objective of this study was to replicate, with the cooperation of the originating laboratories, the studies conducted by Liburdy and Blackman.

They "found that exposure of breast cancer cells to 12 mG 60 Hz EMF induced a reproductable net increase (mean +28%, $p<0.001$) in the growth rate of MCF-7 cells treated with a physiological dose of melatonin. This constitutes a replication of the observations reported previously by Liburdy and Blackman, in that EMF produced a blocking of the anti-cell-growth effects of melatonin. There are some variations between our findings and theirs: Nevertheless, the net differences between (melatonin+EMF) and (melatonin-EMF) groups is both qualitatively and quantitively consistent in all the studies. . ." (9)

From the Second World Congress for Electricity and Magnetism in Biology and Medicine , held in Bologna, Italy in June of 1997:

3.5: DIFFERENTIAL INHIBITION OF TAMOXIFEN'S ONCOSTATIC FUNCTIONS IN A BREAST CANCER CELL LINE BY A 12 mG MAGNETIC FIELD.

(J.D. Harland, M.Y. Lee, G.A. Levine, R.P. Liburdy, Lawrence Berkeley National Laboratory,

University of California, USA.)

"Previously, we have reported that 12 mG (1.2 uT), 60-Hz magnetic fields reduce the inhibition of tamoxifen's cytostatic action in the human mammary tumor cell line MCF-7. tamoxifen is a nonsteroidal antiestrogen, the most frequently prescribed drug for the treatment of human estrogen-receptor (ER) positive breast cancer, and known to bind specifically to the estrogen receptor. However, tamoxifen's action is multifactorial; besides its oncostatic activities in ER+ cells, it also inhibits the growth of some ER-breast cancer cells. The later has been ascribed to tamoxifen's other cellular activities In an effort to determine a possible site of interaction of the 12 mG field with the cell, we are investigating the effect of the 12 mG field on the action of drugs known to differentially mimic one of tamoxifen's cytostatic activities in MCF-7 cells

RESULTS: We observe a blocking effect of a 12 mG magnetic field of the pure antiestrogen ICI 182,780 This blocking effect appears to be even greater than that seen for tamoxifen: from 18% inhibition at 2 mG, to 15% enhancement of growth at 12 mG However we also find that the 12 mG field has an even greater inhibition of the calmodulin antagonist W-13, from 16% inhibition at 2 mG to 28% enhancement of growth at 12 mG Future research will be directed at further characterizing the specificity of the 12 mG field interaction "(10)

4.0: Related Research

Also at the Second World Congress for Electricity and Magnetism in Biology and Medicine, held at Bologna Italy in July 1997, R.P. Liburdy from the Lawrence Berkeley National Laboratory, summed up the current state of in vitro research findings:

"Collectively, this body of in vitro research establishes that environmental-level 60-Hz magnetic fields can alter melatonin's antiprolif-erative activity in human breast cancer cells. The significance of these findings is that a replicated bioeffect involving melatonin has been identified with the potential for elucidation possible biological mechanisms. Moreover, the potential exists for translation to relevant in vivo experiments involving melatonin and environmental-level magnetic fields."

It does not necessarily mean that the above in vitro study conclusions can be directly applied to breast cancer patients. However it is important to note that some recent human exposure studies also indicate a melatonim/EMF effect, and that levels around 12 mG can be routinely encountered in daily life, for example, electric blankets can give emissions in excess of 12 mG, depending upon manufacturer and setting used.

Sleeping with an electric blanket on is a special concern, as it is at night that the pineal gland, located near the centre of the brain, produces melatonin. In the study by Liburdy and Harland, indications were that a prolonged exposure may be required, which is a further possible implication of electric blanket use while sleeping.

In a study by Yaofei Liu and Dr. Indra Chatterjee at the University of Nevada they found that with electric blankets, "The average current density (induced in the body) in the head is higher than the torso because of the smaller cross section of the head."(11)

4.1: At the June 1997 Bologna World Congress meeting, mentioned above, a paper presented by the Faculty of Medicine, University of Tokyo, specifically looked at melatonin levels and electric blanket use. This study set out to determine whether the effects of comparably long-term powerline frequency EMF (from electric blanket use) exposure on suppression of the melatonin rhythm in humans could be replicated.

The participants were 9 healthy male volunteers, 23 to 37 years of age. The results of this study

found that: "Nocturnal exposures to 50 Hz EMF generated from electric blankets was not related to melatonin production in terms of its mean values (for 8 subjects excluding one whose rhythm could not be calculated) but showed tendencies of suppressing peak value and/or delaying phase of melatonin rhythm in 7 of the 8 subjects.

The present findings may suggest a possibility that exposure to ELF-EMF by electric blankets, if magnitude and duration are sufficient, could lead to changes in melatonin production and its rhythm, at least in highly sensitive individuals.

However, a definitive conclusion could not be obtained from only the present results, since the experiments were performed under unrestricted daily lives. Experiments with major possible modifying factors for melatonin metabolism being controlled are warranted." (12)

It is important to note that the subjects of this study were healthy young male volunteers, with hopefully robust immune systems. What effect would be seen with people who's immune systems are already under stress, such as patients undergoing chemotherapy?

In a soon to be published follow up study by Dr. Henry Lai and Dr. Narendra Singh, who earlier found single and double strand DNA breaks in rats exposed to low level radiofrequency radiation (RFR) after a single two hour exposure, the treatment of either melatonin or a free radical scavenger (PBN) to the exposed rats immediately before and after RFR exposure prevented the DNA damage. (13)

This indicates the importance of melatonin in DNA repair mechanisms, and therefore in cancer suppression, but not that the RFR is effecting is the rats own pineal melatonin production. The current body of evidence examines Extremely Low Frequency (ELF) 50-60 Hz fields and its effects on melatonin. At this point in time evidence for a similar effect on the pineal gland/ melatonin from radiofrequency and microwave radiation has yet to be demonstrated. (14)

In a study by Tan et al in 1993, rats were injected with a chemical carcinogen, Safrole which damages DNA by inducing the production of large numbers of free radicals. Rats injected with Safrole were found to have extensive DNA damage after 24 hours. When melatonin was also injected, the DNA damage was reduced by 99%. (15)

4.2: A preliminary study of 60 workers at a Finnish garment factory found "a highly significant effect"of EMF's in reducing nocturnal melatonin levels. Magnetic field measurements were taken for the two types of machines used in the factory and operators were assigned to high or low exposure groups, based on the type of machine they were using, with average exposures either above of below 10 milliGauss. Unexposed non industrial workers were used as controls.

The results of this study found strong effects of both magnetic field exposure and smoking on night time levels of melatonin. No difference was found in melatonin levels on week nights and Sunday nights, indicating "that the possible suppression caused by magnetic field exposure is chronic, with little recovery during the weekend." (16) - consistent with the effect of chronic electric field exposure in the rat experiments of Wilson et al. (1986) (17)

4.3: In a study of 192 electric utility workers, Drs. John Reif and James Burch, from the Colorado State University, found that some EMF exposures are associated with lower levels of melatonin. They found a significant association between magnetic field exposures and lower daytime melatonin levels on the second and third of three days of measurement. The lack of an effect on the first day (following a weekend or equivalent) may indicate a cumulative effect of exposure.

Some studies have suggested that EMF effects on melatonin may depend on whether the field is continuous or intermittent. Reif and Burch found that magnetic fields in the home that were "temporally coherent"(less intermittent) had a very significant association with lower melatonin levels

at night. They concluded that, "The intensity and temporal characteristics of magnetic fields appear to be involved in melatonin suppression." (18)

4.4: Office workers who used computer monitors (VDU's) had a significant reduction in circulating levels of melatonin over a course of the working day, according to a study by researchers Drs. Bengt Arnetz of the Karolinska Institute, and Mats Berg of the Karolinska Hospital in Stockholn Sweden. No such change was found during days at the office with no VDU use. According to the researchers; "This suggests that there is a direct impact from the electromagnetic environment of the VDU on levels of melatonin."

Levels of a different hormone, adrenocorticotropic hormone (ACTH), went up during the working day and this showed a strong correlation with worker's subjective assessment of mental strain. Arnetz and Berg note that ACTH is "known as a classic stress hormone that reacts to mental strain." But in contrast, "occupational strain did not correlate with melatonin levels." (19)

This finding supports the Boston University breast cancer study, in which Patrica Coogan and co-workers found a 43% increase in breast cancer among women with a high potential for occupational exposures to magnetic fields, notably those working with main-frame computers. In an interview with Microwave News , Coogan said,"This study lends credence to the idea that EMF's might influence breast cancer." (20)

Not all human exposure studies found a melatonin reduction effect. A study by Dr. Charles Graham et al at the Midwest Research Laboratory in Kansas City, MO. conducted for the Electric Power Research Institute (EPRI), found that a continuous 60 Hz, 200 mG magnetic field applied to people while they slept had no effect on nocturnal melatonin levels.

In a similar study published in 1994, Graham found no overall effect for intermittent EMF exposures, however, data from that study showed that men with preexisting low levels of melatonin had even lower levels when exposed to EMF's, suggesting that a person's prior melatonin level may be an important factor. Later research by Graham failed to replicate this finding however.

Graham cautions against a conclusion that EMF's do not effect melatonin. He points out that all of the volunteers in his studies were "healthy young men", and that the types of EMF's with which people come in contact in an industrialised society are much more varied than those created in the carefully controlled MRI exposure facility. (21)

In relation to this, Dr John Reif of Colorado State University comments, "Most natural observations appear to find melatonin changes, while controlled lab studies tend not to. . . In a general way, I'm concerned that the controlled lab trials may not mimic exposures in the real world."(22)

5.0: The International Breast Cancer Intervention Study

This study, which has been running for five years now, is aimed at discovering if the drug Tamox-ifen can help prevent the disease in those who have not yet developed it but are at increased risk.

Women from the UK, Europe, New Zealand and Australia are participating in the study, which is open to women aged between 35 and 70 who have a strong family history of breast cancer.

Those aged 45 to 70 must have had a close family member diagnosed with breast cancer at the age of 50 or under, or in both breasts at any age, or must have two close blood relatives who have had breast cancer at any age. Those aged 35 to 45 must have had a close family member diagnosed with breast cancer before 40 or at least two close blood relatives who have had breast cancer before 50.

Each participant is encouraged to continue with the study for 5 years. During that time they take one tablet, which is either Tamoxifen or a placebo, each day and receive a clinical assessment every six months and a mammogram each year. If Tamoxifen is proved effective it could ultimately be provided to women at increased risk.

Considering the above mentioned studies, especially the study by Liburdy and Harland, ELF Inhibition of Melatonin and Tamoxifen Action On MCF-7 Cell Proliferation; Field Parameters, which found that a 12 mG magnetic field can significantly reduce the growth inhibitory action of melatonin and Tamoxifen, participants EMF exposures should be included in the International Breast Cancer Intervention Study as a possible confounding factor.

If EMF exposures are a possible confounding factor, the statistical model for analysis of the study should take into account this possible factor. If not, the possible EMF factor may put enough statistical noise to the study that the conclusions may well be affected as the effectiveness of Tamoxifen may be reduced in the participants with relevant EMF exposures.

If environmental EMF's, and electric blanket use are a confounding factor, this should be possible to check by questioning the subjects on their habits, maybe even taking home and workplace EMF exposure readings. If some participants are found to be exposed to prolonged EMF exposures in the order of 2 to 12 milliGauss, (there appears to be a dose-response relationship from 2 to 12 milliGauss) it may be advisable to recommend avoiding these exposures. Since the studies examined in this paper found no effect at 2 mG, this may be a safe level to aim to keep prolonged exposures under.

It may also be advisable to do actual measurements of melatonin levels in those subjects identified as being prone to breast cancer. Women with breast cancer have shown a lower nocturnal increase in melatonin levels than control women. (23)

In the September 1996 issue of Epidemiology, Susan Preston-Martin reviews much of the data on topic. She also calls for including melatonin levels in breast cancer risk assessment studies and for obtaining an ELF exposure history.

A possible avenue for research would be to determine if the use of melatonin would have a similar protective effect as Tamoxifen, as breast cancer patients may have a better prognosis if their melatonin levels are high.(24)

Professor Russell Reiter who has been researching the effects of EMF's on melatonin production has done a review paper on this subject. This review paper was prompted by a number of epidemiological studies in which an increased incidence of cancer was reported in individuals living or working in an environment of higher than normal artificial electromagnetic fields. His paper extract concludes with the following observation:

"Reduction of melatonin at night, by any means, increases cell's vulnerability to alteration by carcinogenic agents. Thus, if in fact artificial electromagnetic field exposure increases the incidence of cancer in humans, a plausible mechanism could involve a reduction in melatonin which is a consequence of such exposures."

Dr. Reiter also notes: " Epidemiologists should look for other possible changes, including psychological depression, fatigue, sleep inefficiency, chronic feelings of jet lag, endocrine disturbances and other symptoms; all these may result from a chronically low melatonin rhythm." (25)

As a result of his latest study Dr. Reiter now proposes that melatonin is "more rapidly taken up into

tissues during the exposure." He noted that if EMF's result in higher levels of free radicals, then an antioxidant like melatonin "would disappear from the blood more quickly than is normal because it would be required for the scavenging of free radicals." (26)

If Reiter's hypothesis is correct, then prolonged exposures may tax the pineal gland's ability to maintain adequate levels of melatonin to cope with the extra stress created by EMF exposure, and also Tamoxifen's ability to inhibit the growth of breast cancer cells.

6.0: World Confer-ence on Breast Cancer on the U.S. National Cancer Institute Linet Study

At The First World Conference On Breast Cancer, held at Queens University, Kingston, Ontario, Canada, from 13 to 17 July 1997, over 600 delegates from around the world met to establish a Global Action Plan to eradicate breast cancer, which currently affects one in eight women in North America. This plan will later be presented to the United Nations, the World Health Organization and other major international organizations.

As noted in the conference bulletin, the conference was "a massive and truly global undertaking, organized by grass-roots women's organizations, survivors, environmental groups, scientists and health-care professionals. For the first time ever, the voices of the women and others most affected by this disease will take centre stage, as experts from around the globe assemble to share knowledge and experience of this complex problem."

Less than two weeks before the conference, the U.S. National Cancer Institute released a study, conducted by Dr. Martha Linet and co-workers, in which it was claimed that there was no evidence that powerline electromagnetic fields increase childhood leukemia risks. This study was published on July 3rd 1997 in the New England Journal of Medicine and has widely been mis-reported in the world's media as the final word in exonerating powerline frequency EMFs from any connection with cancer. This line is also being promoted as proof that future research into EMFs and cancer should cease.

The NCI study was specifically examined at the conference and many concerns were raised on the calls for ending future EMF health effects research, based on the NCI Linet study. The following is a joint press release on the NCI study from the conference:

Dateline: 1st World Conference on Breast Cancer, Kingston, Ontario, Canada , July 15, 1997.

"The recent report in the New England Journal of Medicine by Linet and colleagues has been widely reported as showing no link between exposure to electromagnetic fields (EMF) and one type of leukemia in children.

On the basis of this new study, some scientists and some news media organisations, including the major networks, have repeated the questionable claim that the link between EMF exposure and cancer risk is no longer an issue, and further research is unnecessary.

Such statements, based on a single study, are troubling. More disturbing still, is the fact that the data presented in the Linet study do not support the assertion that no link exists. Even a cursory review of the main data set shows a 53% increase in leukemia incidence at magnetic field exposure levels above 2 mG; a 72% increase (which is statistically significant) above 3 mG; and a more than 600% increase at exposures of between 4 and 5 mG.

Above 5 mG, no link is shown, but there are too few cases in this range to yield any significant result.

Dr. Bary Wilson, who has co-authored a recent book on EMF and breast cancer, and several other speakers at the World Conference on Breast Cancer, including Dr. Kjell Hansson Mild of National Institute of Working Life in Sweden, have stated that a study which is apparently positive and limited only to leukemia should not be used to discount a possible link between EMF and cancer in its entirety.

Any statement claiming the demise of the EMF and cancer issue should be based on an analysis of all the available data and not one study, particularly one in which the reported data are apparently not reflected in the conclusions. In fact, available data on the subject, provided by many scientists over more than a decade, do not support the hypothesis that there is no link between EMF exposure and increased risk for several types of cancer.

Cindy Sage of Sage Associates and Chair of the EMF program at the conference points out that, "even a small increased risk of breast cancer due to EMF exposure has enormous public health implications given the high incidence of this disease in developed countries."

Based on the Linet, et al. study, it is clearly not justified to call for the end of research into the possible !ink between EMF and cancer. Given the growing body of evidence for a possible link between EMF and breast cancer, in particular, cessation of research funding at this time would be reckless and scientifically indefensible."

Kjell Hansson Mild, Ph.D.
Natl Inst for Working Life, Sweden

Cindy Sage
Sage Associates, USA

Bary W. Wilson, Ph.D.
Pacific Northwest National Laboratory, USA

7.0: Conclusion

The evidence as outlined in this report, quite clearly identifies commonly encountered environmental magnetic fields of 12 milligauss, with a possible dose-response relationship down to 2 milligauss, as being a probable cancer promoter.

As to the role of cancer promoters, Dr. Robert O.Becker in his book, Cross Currents states: "Cancer promoters, however, have major implications for the incidence of cancer because they increase the number of cases of cancer that become evident. We are constantly exposed to cancer-causing agents in our environment ranging from carcinogenic chemicals to cosmic rays.

As a result, we are always developing small cancers that are recognised by our immune system and destroyed. Any factor that increases the growth rate of these small cancers gives them an advantage over the immune system, as a result more people develop clinical cancers that require treatment." Therefore, it would be fair to say that in the situation of residential and occupational exposures, where cancer patients are routinely being exposed to levels in the order of 12 mG, the necessity of avoiding these exposures is paramount. Since the recent World Conference on Breast Cancer, held in Ontario Canada, there is an increasing overseas awareness that EMFs are a risk factor with breast cancer, but at present there are no figures as to the degree of risk. In relation to breast cancer patients, an important first step is to determine how many are being exposed to EMFs of the order of 2 to 12 mG?

An important initial step would be to conduct detailed surveys of groups of breast cancer patients to

build up a profile of any prolonged exposures in relation to the 12 milligauss level. If we take 2 mG as a no-effect level and 12 + mG as a definite level of effect, we could get some idea of the percentage of participants who are most likely at increased risk from this exposure. Ideally such a survey would be conducted independently in several countries, using the same criteria and results then compared.

The outcome of this would be to develop effective advice for patients to avoid exposures, which can come from many sources, such as electric blankets, electrically heated water beds, improperly grounded home wiring, in-floor electrical heating systems, older computer monitors, flourescent lighting systems, occupational exposures, etc.

Although this paper only deals with powerline EMFs, electromagnetic radiation (EMR) from radiofrequency and microwave emissions are also now being implicated in breast cancer.

Besides some epidemiological studies, such as one showing a significant increase in breast cancer for female radio operators, there is evidence that breast cancer tumors absorb significantly more EMR than other cancers, or healthy tissue. To quote from one study, conducted at Duke University, North Carolina, USA, in 1993.

"In general, at all frequencies tested [50 to 900 MHz], both conductivity and relative permittivity were greater in malignant tissue than in normal tissue of the same type. For tissues of the same type, the differences in electrical properties from normal to malignant were least for kidney (about 6% and 4% average differences over the frequency range in permittivity and conductivity, respectively), and these differences were the greatest for mammary gland (about 233% and 577% average differences in permittivity and conductivity, respectively) (27)

The ability of breast cancer tumors to absorb significantly more EMR than normal tissue should be of concern when compared to an official joint statement, made in the Information sheet, Safety of Mobile Phones and Towers - The Answers (Nov.1995) by the Australian Radiation Laboratory, Spectrum Management Agency, Austel and the Commonwealth Science and Industrial Research Organisation, (under the heading, Is Cancer an issue?)

"There is yet insufficient scientific knowledge of many aspects of health effects of radio waves. One common question is: Do radio waves frommobile phones increase the risks of cancer? The answer is that there is no experimental evidence that radio waves directly cause cancer. Laboratory studies on animals suggest that where cancer exists, radio waves may accelerate its growth."

For this reason, acting under the Precautionaly Principal as mentioned prevously, one should also consider radiofrequency and microwave exposures as a possible risk factor to be avoided.

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