The Biological Effects of Weak Electromagnetic Fields

Problems and solutions

Andrew Goldsworthy March 2012

Foreword

Dr Andrew Goldsworthy is a retired lecturer from Imperial College London, which is among the top three UK universities after Oxford and Cambridge and is renowned for its expertise in electrical engineering and health matters. Dr Goldsworthy spent many years studying calcium metabolism in living cells and also how cells, tissues and organisms are affected by electrical and electromagnetic fields. You may find much of what he says both surprising and worrying.

In this article, he explains how weak electromagnetic fields from cell phones, cordless phones and WiFi can have serious effects on our health. These include damage to glands resulting in obesity and related disorders, chronic fatigue, autism, increases in allergies and multiple chemical sensitivities, early dementia, DNA damage, loss of fertility and cancer.

All this happens at levels of radiation that our governments and the cell phone companies tell us are safe because the radiation is too weak to cause significant heating. **This is the only criterion that they use to assess safety.** In fact, the direct electrical effect on our cells, organs and tissues do far more damage to us at energy levels that may be hundreds or thousands of times lower than those that cause significant heating. These are termed non-thermal effects and **our governments are doing nothing to protect us from them.**

Abstract

Many of the reported biological effects of non-ionising electromagnetic fields occur at levels too low to cause significant heating; i.e. they are non thermal. Most of them can be accounted for by electrical effects on living cells and their membranes. The alternating fields generate alternating electric currents that flow through cells and tissues and remove structurally-important calcium ions from cell membranes, which then makes them leak.

Electromagnetically treated water (as generated by electronic water conditioners used to remove lime scale from plumbing) has similar effects, implying that the effects of the fields can also be carried in the bloodstream. Virtually all of the non-thermal effects of electromagnetic radiation can be accounted for by the leakage of cell membranes.

Most of them involve the inward leakage of free calcium ions down an enormous electrochemical gradient to affect calcium-sensitive enzyme systems. This is the normal mechanism by which cells sense mechanical membrane damage. They normally respond by triggering mechanisms that stimulate growth and repair, including the MAP-kinase cascades, which amplify the signal.

If the damage is not too severe or prolonged, we see a stimulation of growth and the effect seems beneficial, but if the exposure is prolonged, these mechanisms are overcome and the result is ultimately harmful. This phenomenon occurs with both ionising and non-ionising radiation and is called radiation hormesis. Gland cells are a good example of this, since

short term exposures stimulate their activity but long term exposures cause visible damage and a loss of function. Damage to the thyroid gland from living within 100 metres of a cell phone base station caused hypothyroidism and may be partially responsible for our current outbreak of obesity and chronic fatigue.

Secondary effects of obesity include diabetes, gangrene, cardiac problems, renal failure and cancer. Cell phone base station radiation also affects the adrenal glands and stimulates the production of adrenalin and cortisol. Excess adrenalin causes headaches, cardiac arrhythmia, high blood pressure, tremors and an inability to sleep, all of which have been reported by people living close to base stations. The production of cortisol weakens the immune system and could make people living near base stations more susceptible to disease and cancer.

Inward calcium leakage in the neurons of the brain stimulates hyperactivity and makes it less able to concentrate on tasks, resulting in attention deficit hyperactivity disorder (ADHD). When this happens in the brains of unborn babies and young children, it reduces their ability to concentrate on learning social skills and can cause autism. Leakage of the cells of the peripheral nervous system in adults makes them send false signals to the brain, which results in the symptoms of electromagnetic intolerance (aka electromagnetic hypersensitivity). Some forms of electromagnetic intolerance may be due to cell phone damage to the parathyroid gland, which controls the calcium level in the blood and makes cell membranes more inclined to leak. Further exposure could then tip them over the edge into full symptoms of electromagnetic intolerance.

Cell phone radiation damages DNA indirectly, either by the leakage of digestive enzymes from lysosomes or the production of reactive oxygen species (ROS) from damaged mitochondrial and plasma membranes. The results are similar to those from exposure to gamma rays from a radioactive isotope.

Effects of DNA damage include an increased risk of cancer and a loss of fertility, both of which have been found in epidemiological studies. The effects of cell phone and WiFi radiation have also been determined experimentally using ejaculated semen. The results showed the production of ROS, and a loss of sperm quality and, in some cases, DNA fragmentation.

The inward leakage of calcium ions from electromagnetic fields also opens the various tight junction barriers in our bodies that normally protect us from allergens and toxins in the environment and prevent toxic materials in the bloodstream from entering sensitive parts of the body such as the brain. The opening of the blood-brain barrier has been shown to cause the death of neurons and can be expected to result in early dementia and Alzheimer's disease. The opening of the barrier in our respiratory epithelia by electromagnetic fields has been shown to increase the risk of asthma in children and the opening of the blood-liver barrier may be partially responsible for the current outbreak of liver disease. The opening of other barriers, such as the gut barrier allows foreign materials from the gut to enter the bloodstream, which may also promote allergies and has been linked autoimmune diseases.

Cell membranes also act as electrical insulators for the natural DC electric currents that they use to transmit power. Mitochondrial membranes use the flow of hydrogen ions to couple the oxidation of food to the production of ATP. The outer cell membrane uses the flow of sodium ions to couple the ATP produced to the uptake of nutrients. If either of these leak, or are permanently damaged, both of these processes will be compromised leading to a loss of available energy, which some people believe to be a contributory factor to chronic fatigue syndrome.

The mechanism underlying electromagnetically-induced membrane leakage is that weak ELF currents flowing through tissues preferentially remove structurally important calcium ions, but they have been shown to do so only within certain amplitude windows, above and below which there is little or no effect. This means that there is no simple dose-response curve, which many people find confusing, but a plausible theoretical model is described. The mechanism also explains why certain frequencies especially 16Hz is particularly effective.

Living cells have evolved defence mechanisms against non-ionising radiation. These include pumping out surplus calcium that has leaked into the cytosol, the closure of gap junctions to isolate the damaged cell, the production of ornithine decarboxylase to stabilize DNA and the production of heat-shock proteins, which act as chaperones to protect important enzymes. However, this is expensive in energy and resources and leads to a loss of cellular efficiency. If the exposure to the radiation is prolonged or frequently repeated, any stimulation of growth caused by the initial ingress of calcium runs out of resources and growth and repair becomes inhibited. If the repairs fail, the cell may die or become permanently damaged.

To some degree, we can make our own electromagnetic environment safer by avoiding ELF electrical and magnetic fields and radio waves that have been pulsed or amplitude modulated at ELF frequencies. The ELF frequencies that give damaging biological effects, as measured by calcium release from brain slices and ornithine decarboxylase production in tissue cultures, lie between 6Hz and 600Hz. It is unfortunate that virtually all digital mobile telecommunications systems use pulses within this range. The Industry clearly did not do its homework before letting these technologies loose on the general public and this omission may already have cost many lives.

Even now, it may be possible reverse their effects by burying the pulses in random magnetic noise, as proposed by Litovitz in the 1990s or by cancelling out the pulses using balanced signal technology but, at present, the Industry does not seem to be interested in either of these.

Until the mobile telecommunications industry makes its products more biologically friendly, we have little alternative but to reduce our personal exposure as far as possible by using cell phones only in emergencies, avoiding DECT cordless phones and substituting WiFi with Ethernet . The only DECT phones that are even remotely acceptable are those that automatically switch off the base station between calls; e.g. the Siemens Gigaset C595 operating in Eco Plus mode. If you are highly electromagnetically intolerant, you may need to screen your home or at the very least your bed from incoming microwave radiation and sleep as far away as possible from known sources of ELF.

INTRODUCTION

There have been many instances of harmful effects of electromagnetic fields from cell phones (aka mobile phones), DECT phones (aka cordless phones), WiFi, power lines and domestic wiring. They include an increased risk of cancer, loss of fertility, effects on the brain and symptoms of electromagnetic intolerance. Many people still believe that, because the energy of the fields is too low to give significant heating, they cannot have any biological effect. However, the evidence that alternating electromagnetic fields *can* have non-thermal biological effects is now overwhelming. See www.bioinitiative.org and www.neilcherry.com . The explanation is that it is not a heating effect, but mainly an electrical effect on the fine structure of the electrically-charged cell membranes upon which all living cells depend.

Alternating electromagnetic fields can induce *alternating currents* to flow through living cells and tissues. These can interfere with the normal *direct currents* and voltages that are essential for the metabolism of all cells. Virtually every living cell is a seething mass of electric currents and electrical and biochemical amplifiers that are essential for their normal

function. Some have tremendous amplifying capacity; e.g. it is claimed that a dark adapted human eye can detect a single photon (the smallest possible unit of light) and the human ear can hear sounds with energies as low as a billionth of a watt. We should therefore not be too surprised to find that our cells can detect and respond to electromagnetic fields that are orders of magnitude below the strength needed to generate significant heat.

My main objective here is to show how most of the adverse health effects of electromagnetic fields can be attributed to a single cause; that being that they remove structurally-important calcium ions (electrically-charged calcium atoms) from cell membranes, which then makes these membranes leak. I will explain the scientific evidence leading to this conclusion and also how we can put matters right, but still keep on using cell phones and other wireless communications. I have included key references that should enable the more inquisitive reader to delve deeper. In many cases, you should be able to find the abstract of the paper in question by copying into Google its entry in the list of references.

Electromagnetic fields affect many but not all people

Many of the experiments on the biological effects of alternating electromagnetic fields appear to give inconsistent results. There are many reasons for this, including differences in the genetic make-up, physiological condition and the history of the test material. In humans, reported effects include an increased risk of cancer, effects on brain function, loss of fertility, metabolic changes, fatigue, disruption of the immune system, and various symptoms of electromagnetic intolerance.

Not everyone is affected in the same way and some may not be affected at all. However, there is increasing evidence that the situation is getting worse. Our electromagnetic exposure is rapidly increasing and previously healthy people are now becoming sensitised to it. In this study, I am concentrating on the cases where there have been definite effects; since this is the most efficient way in which we can find out what is going wrong and what can be done to prevent it.

The frequency of the fields is important

The fields that give the most trouble are in the extremely low frequency range (ELF) and also radio frequencies that are pulsed or amplitude modulated by ELF. (Amplitude modulation is where the strength of a *carrier wave* transmits information by rising and falling in time with a lower frequency that carries the information.).

Why microwaves are particularly damaging

The frequency of the carrier wave is also important. Higher frequencies such as the microwaves used in cell phones, WiFi and DECT phones, are the most damaging. Our present exposure to man-made microwaves is about a million billion billion (one followed by eighteen zeros) times greater than our natural exposure to these frequencies. We did not evolve in this environment and we should not be too surprised to find that at least some people may not be genetically adapted to it. As with most populations faced with an environmental change, those members that are not adapted either become ill, die prematurely or fail to reproduce adequately. Ironically, those who are electromagnetically intolerant may be better equipped to survive since they are driven to do whatever they can to avoid the radiation.

The main reason why microwaves are especially damaging is probably because of the ease with which the currents that they generate penetrate cell membranes. Cell membranes have a very high resistance to direct currents but, because they are so thin

(about 10nm), they behave like capacitors so that alternating currents pass through them easily. Since the effective resistance of a capacitor to alternating current (its *reactance*) is inversely proportional to its frequency, microwave currents pass through the membranes of cells and tissues more easily than radio waves of lower frequencies and can therefore do more damage to the cell contents.

Calcium loss from cell membranes explains most of the adverse health effects

I became interested in this topic when I was working on the biological effects of physically (magnetically) conditioned water, which is widely used to remove lime scale from boilers and plumbing. It is made by allowing tap water to flow rapidly between the poles of a powerful magnet or by exposing it to a weak pulsed electromagnetic field from an electronic water conditioner. Water treated in this way can remove calcium ions (electrically charged calcium atoms) from surfaces, and the effect on the water can last for several days. I was following up some Russian and Israeli work that had shown that magnetically conditioned water could increase the growth of crops, but it turned out to be far more important than that. The underlying principle was also to explain the mechanisms by which weak electromagnetic fields can damage living cells and also what can be done to stop it.

Magnetically conditioned water and electromagnetic fields have similar effects

Probably, our most important discovery was that when tap water was conditioned by weak electromagnetic fields, the treated water gave similar effects in yeast to those from exposing the yeast itself, amongst which was an increased permeability of their cell membranes to poisons (Goldsworthy *et al.* 1999). Since it had been known since the work of Bawin *et al.* (1975) that weak electromagnetic fields could remove calcium ions from the surfaces of brain cells, it seemed likely that both the conditioned water and the electromagnetic fields were working in the same way; i.e. **by removing structurally-important calcium ions from cell membranes, which then made them leak.** We now know that membrane leakage of this kind can explain most of the biological effects of both conditioned water and of direct exposure to electromagnetic fields.

The effects on growth depend on the length of the conditioning treatment

We also showed that the effects of conditioned water on the growth of yeast cultures depended on the length of the conditioning process. Less than 30 seconds of conditioning stimulated growth but more than this inhibited growth. It was as if the conditioning process was steadily generating one or more chemical agents in the water. A low dose from the shorter conditioning period stimulated growth, but longer conditioning periods gave higher doses, which were inhibitory. This toxic effect of heavily conditioned water, where the water is recycled continuously through the conditioner, has now been exploited commercially to poison blanket weed in ornamental ponds (www.lifescience.co.uk/domestic_blanketweed.htm). By the same token, blood continually circulating for prolonged periods under the pulsating fields from a cell phone or similar device could become toxic to the rest of the body. This means that no part of the body, from the brain to the liver and gonads, can be considered to be safe from the toxic effects of pulsed electromagnetic fields.

Radiation hormesis

Many people have shown similar dual effects with direct exposure to both *ionising and non-ionising radiation*. Small doses of otherwise harmful radiation often stimulate growth and appear to be beneficial (a phenomenon known as *radiation hormesis*) but larger doses are harmful. It also explains why small doses of pulsed magnetic fields are effective in

treating some medical conditions such as broken bones (Bassett *et al.* 1974) but prolonged exposure (as we will see later) is harmful.

It also explains some of the apparent inconsistencies found when comparing different experiments and why meta-analysis of the data should be treated with caution. Clear positive and clear negative results (depending on the dose and the condition of the material) when taken together could be mistaken for no effect, but with a high degree of variability.

Cells have tremendous powers to amplify and respond to weak signals

We now know that electromagnetic growth stimulation is almost certainly due to electrochemical amplification followed by the activation of the MAP kinase cascades by free calcium ions leaking into the cytosol (the main part of the cell). The inward leakage of calcium ions is the normal mechanism by which a cell senses that it has been damaged and triggers the necessary repair mechanisms. This involves huge amplification processes so that even minor leakage (e.g. due to membrane perforation or weak electromagnetic fields) can give rapid and often massive responses.

The first stage in the amplification is due to the calcium gradient itself. There is an enormous (over a thousand fold) concentration difference for free calcium between the inside and outside of living cells. In addition, there is a voltage difference of many tens of mV acting in the same direction. This means that even a slight change in the leakiness of the cell membrane can permit a very large inflow of calcium ions. It's like a transistor, where a slight change in the charge in the base can allow a massive current to flow through it under the influence of a high voltage gradient between the emitter and collector.

The next stage in the amplification is due to the extremely low calcium concentration in the cytosol so that even a small ingress of calcium ions makes a big *percentage* difference, to which many enzymes within the cell are sensitive.

Even more amplification comes from the MAP-kinase cascades. These are biochemical amplifiers that enable tiny amounts of growth factors or hormones (perhaps even a single molecule) to give very large effects. They consist of chains of enzymes acting in sequence so that the first enzyme activates many molecules of the second enzyme, which in turn activates still more of the third enzyme etc. The final stage then activates the protein synthesising machinery needed for cell growth and repair.

At least some of these cascades need calcium ions to work (Cho *et al.* 1992) so the inward leakage of calcium through damaged cell membranes will increase the rate of these processes to stimulate growth and repair. However, these repairs can make deep inroads into the cell's energy and resources, and its ability to make good the damage will depend on its physiological and nutritional condition. This means that, if the damage is prolonged or persistent, sooner or later it runs out of resources and gives up, which is when we see the inhibitory phase, perhaps followed by apoptosis (cell death) or the loss of some of the cell's normal functions. We are now seeing this loss of function increasingly after prolonged human exposure to cell phone base station radiation; e.g. the loss of thyroid gland function after six years of exposure (Eskander *et al.* 2012).

Effects on Glands

Gland cells are particularly sensitive to radiation

Gland cells may be particularly sensitive to radiation because their secretions are normally produced in internal membrane systems, which can also be damaged. Their secretions are usually released in vesicles (bubbles of membrane) that fuse with the external

cell membrane and disgorge their contents to the outside (exocytosis). The vesicle membrane then becomes part of the external membrane. The resulting excess external membrane is counterbalanced by the reverse process (endocytosis) in which the external membrane buds off vesicles to the inside of the cell, which then fuse with the internal membranes. In this way, an active gland cell may internalise the equivalent of its entire surface membrane about once every half an hour. This means that if the surface membrane is damaged directly by the fields, or by electromagnetically conditioned blood, the damaged membrane rapidly becomes part of the internal membrane system, upon which its normal activity depends. If the damage is too severe, the whole gland may lose its normal function.

Electromagnetic effects on the endocrine system and obesity

Although electromagnetic fields frequently stimulate glandular activity in the short term, long term exposure is often harmful in that the gland ceases to work properly. This is particularly serious for the glands of the endocrine system (those that coordinate our bodily functions) since it can affect many aspects of metabolism and throw the whole body out of kilter. For example it may be responsible, at least in part, for the current outbreak of obesity and the many other illnesses that stem from it.

An good example of this is the thyroid gland, which is in an exposed position in the front of the neck. Rajkovic *et al.* (2003) showed that after three months exposure to power line frequencies, the thyroid glands of rats showed visible signs of deterioration. They also lost their ability to produce the thyroid hormones, which they did not recover even after the fields were switched off. Esmekaya *et al.* (2010) found a similar visible deterioration of the thyroid gland in rats exposed to simulated 2G cell phone radiation for 20 minutes a day for three weeks. Eskander *et al.* (2012) found that people living for six years within 100 metres of a cell phone base station showed a significant reduction in the release into the blood of a number of hormones, including ACTH from the pituitary gland, cortisol from the adrenal glands, and prolactin and testosterone from organs elsewhere. However, the most highly significant loss was in their ability to produce the thyroid hormones. The expected consequence of this is hypothyroidism, the most frequent symptoms of which are **fatigue** and **obesity**. It may not be a coincidence that about a quarter of a million UK citizens are now suffering from what is being diagnosed as chronic fatigue syndrome, and about eight out of ten are either overweight or clinically obese.

The incidence of obesity may be exacerbated by effects on the release of the appetite regulating hormones ghrelin and peptide YY. Ghrelin is synthesised in the stomach wall and makes us feel hungry, whereas peptide YY is made in the intestine wall and makes us feel full. In normal people the level of ghrelin in the blood is high before a meal and goes down afterwards whereas peptide YY goes up, so we go from feeling hungry to feeling full, which stops us overeating.

However, in obese people the level of both hormones stays roughly the same throughout so that they never feel completely full and eat in an unregulated manner (Le Roux *et al.* 2005, Le Roux *et al.* 2006). If prolonged exposure to electromagnetic fields limits the release of these hormones in the same way as they affect the release of ACTH, cortisol, prolactin, testosterone and the thyroid hormones, it may explain why so many people find it difficult to stop eating and end up being clinically obese.

If you are affected in this way, you may be forced to go on a life-long diet, undergo gastric bypass surgery to drastically reduce the size of your stomach or risk the many serious diseases that stem from obesity **AND IT MAY NOT HAVE BEEN YOUR FAULT**. Think twice before you use a cell phone or install a cordless phone or WiFi. The consequences are only now becoming apparent; neither the Government nor the telecommunications industry will tell you what they are, but they are not good.

Obesity can trigger many other illnesses

The consequences of obesity include **diabetes, gangrene, high blood pressure, cardiac problems, renal failure and cancer**. Between them, they cause a great deal of human suffering and cost the nation's economy a great deal of money. The annual cost of obesity and related illnesses to the UK economy has been estimated as being around £6.6 – 7.4 billion (McCormick *et al.* 2007).

The annual cost of chronic fatigue syndrome is about $20000 per affected person in the USA (Reynolds *et al.* http://www.resource-allocation.com/content/2/1/4) and about £14000 in the UK (McCrone *et al.* 2003) so a fair estimate of the total annual cost of chronic fatigue syndrome to the UK economy would be somewhere in the region £3.5 billion. The total annual cost of both conditions together is about£10 billion. If part of this is due to microwave telecommunications, measures need to be taken to minimise their effects, and it would be only fair to ask the Industry to pay for this.

Electromagnetic effects on the adrenal gland

Cortisol: - Augner *et al.* (2010) in a double blind study (where neither the subject nor the person recording the results knows whether the radiation is switched on or off) showed that short-term exposure to the radiation from a 2G (GSM) cell phone base station increased the cortisol level in the saliva of human volunteers. Cortisol is a stress hormone that is normally produced in the cortex of the adrenal glands and is controlled by the calcium level in its cells (Davies et al. 1985) so electromagnetically- induced membrane leakage letting more calcium into the cytosol should also have this effect.

Cortisol is part of a mechanism that puts the body into a "fight or flight" mode, in which more sugar is released into the blood, sensitivity to pain is reduced and the immune system is suppressed. In fact, cortisol and its relatives are used medicinally to relieve pain and also to suppress the immune system after transplant surgery. However, when exposure to base station radiation does it, it is not good news since the suppression of the immune system will also increase the risk of infection and of developing tumours from precancerous cells that might otherwise have been destroyed.

Adrenalin: - Buchner and Eger (2011) studied the effect of a newly installed 2G cell phone base station on villagers in Bavaria and found that it caused a long-lived increase in the production of adrenalin. This is an important neurotransmitter which acts on adrenergic receptors to increase the calcium concentration in the cytosol. It is also synthesised in the adrenal medulla in response to signals from the sympathetic nervous system. Adrenalin too puts the body into fight or flight mode by diverting resources from the smooth muscles of the gut to the heart muscle and the skeletal muscles needed for flight or combat. It addition, it stimulates the production of cortisol by the adrenal cortex, and indirectly reduces the activity of the immune system, resistance to disease and increases the risk of getting cancer.

Some people get pleasure from the "adrenalin rush" caused by doing energetic or dangerous things, and this could be a contributory factor to the addictive nature of cell phones. However, on the down side, known effects of excess adrenalin include, headaches, cardiac arrhythmia, high blood pressure, tremors, anxiety and inability to sleep. These results confirm and explain some of the findings of Abdel-Rassoul *et al.* (2007) who found that people living near cell towers (masts) had significantly increases in headaches, memory loss, dizziness, tremors and poor sleep.

Effects on the Brain

Calcium leakage and brain function

Normal brain function depends on the orderly transmission of signals through a mass of about 100 billion *neurons*. Neurons are typically highly branched nerve cells. They usually have one long branch (*the axon*), which carries electrical signals as *action potentials* (nerve impulses) to or from other parts of the body or between relatively distant parts of the brain (a nerve contains many axons bundled together). The shorter branches communicate with other neurons where their ends are adjacent at *synapses.* They transmit information across the synapses using a range of *neurotransmitters,* which are chemicals secreted by one neuron and detected by the other.

Calcium ions play an essential role in brain function because a small amount of calcium must enter the cytosol of the neuron before it can release its neurotransmitters (Alberts *et al.* 2002). Electromagnetically-induced membrane leakage would increase the background level of calcium in the neurons so that they release their neurotransmitters sooner. This improves our reaction time to simple stimuli but it can also trigger the spontaneous release of neurotransmitters to send spurious signals that have no right to be there, which makes the brain hyperactive and less able to concentrate.

Autism

Possibly, the greatest damage to the brain from microwaves is when it is first developing in the foetus and the very young child, where it can lead to autism. Dr Dietrich Klinghardt has shown a relationship between microwaves and autism; a summary of his work can be found at http://electromagnetichealth.org/media-stories/#Autism .

What is autism?

Autism is a group of life-long disorders (autistic spectrum disorders or ASD) caused by brain malfunctions and is associated with subtle changes in brain anatomy (see Amaral *et al.* 2008 for a review). The core symptoms are an inability to communicate adequately with others and include abnormal social behaviour, poor verbal and non-verbal communication, unusual and restricted interests, and persistent repetitive behaviour. There are also non-core symptoms, such as an increased risk of epileptic seizures, anxiety and mood disorders. ASD has a strong genetic component, occurs predominantly in males and tends to run in families.

Genetic ASD may be caused by calcium entering neurons

It has been hypothesised that some genetic forms of ASD can be accounted for by known mutations in the genes for ion channels that result in an increased background concentration of calcium in neurons. This would be expected to lead to neuronal hyperactivity and the formation of sometimes unnecessary and inappropriate synapses, which in turn can lead to ASD (Krey and Dolmetsch 2007).

Electromagnetic fields also let calcium into neurons

There has been a 60-fold increase in ASD in recent years, which cannot be accounted for by improvements in diagnostic methods and can only be explained by changes in the environment. This increase corresponds in time to the proliferation of mobile telecommunications, WiFi, and microwave ovens as well as extremely low frequency fields from household wiring and domestic appliances. We can now explain at least some of this in

terms of electromagnetically-induced membrane leakage leading to brain hyperactivity and abnormal brain development.

How membrane leakage affects neurons

Neurons transmit information between one another in as chemical neurotransmitters that pass across the synapses where they make contact. Their release is normally triggered by a brief pulse of calcium entering their cytosols. If the membrane is leaky due to electromagnetic exposure, it will already have a high internal calcium concentration as calcium leaks in from the much higher concentration outside. This puts the cells into hair-trigger mode so that they are more likely to release neurotransmitters and the brain as a whole may become hyperactive (Beason and Semm 2002; Krey and Dolmetsch 2007, Volkow *et al.* 2011). This results in the brain becoming overloaded with sometimes spurious signals leading to a loss of concentration and attention deficit hyperactive disorder (ADHD).

How does this impact on autism?

Before and just after its birth, a child's brain is a blank canvas, and it goes through an intense period of learning to become aware of the significance of its new sensory inputs, e.g. to recognise its mother's face, her expressions and eventually other people and their relationship to him/her (Hawley and Gunner 2000). During this process, the neurons in the brain make countless new connections, the patterns of which store what the child has learnt. However, after a matter of months, connections that are rarely used are pruned automatically (Huttenlocher and Dabholkar 1997) so that those that remain are hard-wired into the child's psyche. The production of too many spurious signals due to electromagnetic exposure during this period will generate frequent random connections, which will also not be pruned, even though they may not make sense. It may be significant that autistic children tend to have slightly larger heads, possibly to accommodate unpruned neurons (Hill and Frith 2003).

Because the pruning process in electromagnetically-exposed children may be more random, it could leave the child with a defective hard-wired mind-set for social interactions, which may then contribute to the various autistic spectrum disorders. These children are not necessarily unintelligent; they may even have more brain cells than the rest of us and some may actually be savants. They may just be held back from having a normal life by a deficiency in the dedicated hard-wired neural networks needed for efficient communication.

Autism costs the UK economy more than the tax income from cell phones

The incidence of autism has occurred in parallel with the increase in electromagnetic pollution over the last thirty years. The chance of having an autistic child may now be as high as one in fifty. Apart from the personal tragedies for the affected children and their families, autism is of enormous economic importance. In the UK alone, the annual cost to the Nation in care and lost production exceeds the annual tax revenue from the entire cell phone industry, which is about 20billion UK pounds.
http://www2.lse.ac.uk/newsAndMedia/news/archives/2009/05/MartinKnappAutism.aspx If it were all due to cell phones, the Government could close down the entire industry and actually show a profit! There may be ways in which the modulation of the signal can be changed to avoid this (see later), but in the meantime, we should do whatever we can to minimise our exposure to information-carrying microwaves, including those from cell phones, DECT phones, WiFi and smart meters. Failure to do this could be very costly.

.Electromagnetic intolerance (aka electromagnetic hypersensitivity or EHS)

Electromagnetic intolerance is a condition in which some people experience a wide range of unpleasant symptoms when exposed to weak non-ionising radiation. About 3 percent of the population suffers in this way at present, although only a small proportion of these are as yet so badly affected that they can instantly tell whether a radiating device is switched on or off. At the other end of the scale, there are people who are sensitive but do not yet know it because they are chronically exposed to electromagnetic fields and accept their symptoms as being perfectly normal. Electromagnetic intolerance is in fact a continuum with no clear cut-off point. In some cases there may only be relatively mild symptoms on or after using a cell phone but in severe cases it can prevent people living a normal life and force them to live in almost total isolation. There is every reason to believe that prolonged exposure will increase the severity of the symptoms, so if you suffer from any of them you should do whatever possible to minimise further exposure.

Symptoms of electromagnetic intolerance

Symptoms include skin rashes, cardiac arrhythmia, headaches (sometimes severe), pain in muscles and joints, sensations of heat or cold, pins and needles, tinnitus, dizziness and nausea. A more complete list can be found at http://www.es-uk.info/info/recognising.asp Most if not all of these can be explained by the radiation making cells leak.

When skin cells leak, it is perceived by the body as damage to the tissue. This increases the blood supply to the area to repair the damage and causes the rash.

When the cells of the heart muscle leak it weakens the electrical signals that normally control its contraction. The heart then runs out of control to give cardiac arrhythmia. This is potentially life threatening.

When sensory cells leak, they become hyperactive and send false signals to the brain. We have a variety of sensory cells, but they all work in much the same way. Whenever they sense what they are supposed to sense, they deliberately leak by opening ion channels in their membranes. This reduces the natural voltage across these membranes, which makes them send nerve impulses to the brain. Electromagnetically induced cell leakage would have the same effect, but this time it would make them send *false* signals to the brain to give the false sensations of electromagnetic intolerance. This could also be exacerbated by the nerve cells involved being made hyperactive due to calcium ingress.

When leakage occurs in the sensory cells of the skin, it can give sensations such a heat, cold, tingling, pressure etc, depending on which types of cell are most sensitive in the individual concerned.

When leakage occurs in the sensory hair cells of the cochlea of ear it gives tinnitus, which is a false sensation of sound. When it occurs in the vestibular system (the part of the inner ear that deals with balance and motion) it results in dizziness and symptoms of motion sickness, including nausea.

Hypocalcaemia, electromagnetic intolerance and the parathyroid gland

Symptoms of hypocalcaemia are very similar to those of electromagnetic intolerance and include skin disorders, pins and needles, numbness, sensations of burning, fatigue, muscle cramps, cardiac arrhythmia, gastro-intestinal problems and many others. A more comprehensive list can be found at http://www.endotext.org/parathyroid/parathyroid7/parathyroid7.htm . It is possible that some

forms of electromagnetic intolerance are due to low levels of calcium in the blood. Electromagnetic exposure would then remove even more calcium from their cell membranes to push them over the edge and give the symptoms of electromagnetic intolerance.

The amount of calcium in the blood is controlled by the parathyroid hormone secreted by the parathyroid gland, which is in the neck, close to where you hold your cell phone. It is adjacent to the thyroid gland and, if it were to be damaged by the radiation in the same way, the production of the parathyroid hormone would go down, the amount of calcium in the blood would be reduced and the person concerned would become electromagnetically intolerant.

Effects on DNA

Cell phone radiation can damage DNA

Lai and Singh (1995) were the first to show this in cultured rat brain cells, but it has since been confirmed by many other workers. A comprehensive study on this was in the Reflex Project, sponsored by the European Commission and replicated in laboratories in several European countries. They found that radiation like that from GSM (2G) cell phone handsets caused both single and double stranded breaks in the DNA of cultured human and animal cells. Not all cell types were equally affected and some, such as lymphocytes, seemed not to be affected at all (Reflex Report 2004).

In susceptible cells, the degree of damage depended on the duration of the exposure. With human fibroblasts, it reached a maximum at around 16 hours (Diem *et al.* 2005). However, It would be unwise to assume that exposures of less than 16 hours are necessarily safe since DNA damage may give genetically aberrant cells long before it becomes obvious under the microscope. It would also be unwise to assume that the damage would be restricted to the immediate vicinity of the handset since, as described earlier; the effects of the radiation can be transmitted in the bloodstream in the form of magnetically conditioned blood; so nowhere is safe, not even the sex organs.

How the DNA is damaged

Because of the very high stability of DNA molecules, they are unlikely to be damaged directly by weak radiation. The most plausible mechanism is that DNase (an enzyme that destroys DNA) and other digestive enzymes leak through the membranes of lysosomes (organelles that digest waste) that have been damaged by the radiation. Other mechanisms involve the leakage of reactive oxygen species (ROS) such as hydrogen peroxide from damaged peroxisomes and superoxide free radicals from damaged mitochondrial membranes and NADH oxidase in the plasma membrane. According to Friedman *et al.* (2007), the first to respond to non-thermal cell phone frequencies is the NADH oxidase in the plasma membrane, which is activated within minutes of exposure.

However, all of these ROS can initiate peroxidation chain reactions in the polyunsaturated phospholipids of cell membranes (the same thing that makes fats go rancid) which disrupts the membranes further and exacerbates the effect. Only one molecule of ROS is needed to initiate a domino-effect chain reaction, in which each damaged lipid molecule generates a free radical that damages the next one. The process normally stops when it reaches an anti-oxidant molecule, which sacrifices itself by combining with the free radical in such a way that it does not generate a new one. Most of our anti-oxidants come from our diet (e.g. vitamin E) but the most important one that we make ourselves is *melatonin*. It's unfortunate that the production of melatonin by the pineal gland is also

disrupted by electromagnetic fields (Henshaw and Reiter, 2005) which makes matters worse.

These ROS are highly reactive and can also damage DNA. In fact, much of the damage done to cells by *ionising radiation* such as *gamma rays* is due to damage to cell membranes and DNA by free radicals from the radiolysis of water. There may therefore be little difference between holding a cell phone to your head and holding a radioactive source of gamma rays. Both can damage cell membranes, cause the fragmentation of DNA and also do considerable collateral damage to other cellular components, which may either kill the cells or make them lose their normal function over time.

Cell phones increase the risk of cancer

If similar DNA fragmentation were to occur in the whole organism, we would expect an increased risk of cancer, since essential genes that control cell division may be either damaged or lost. Recent studies on the incidence of brain cancer are already beginning to show this. Heavy cell phone use roughly doubles the risk of getting brain cancers in adults on the side of the head used for the cell phone. For younger people, the risk increases to five times more (Hardell and Carlberg 2009). Since brain cancers normally take decades to develop, it is too soon to assess the final impact of the radiation, but the World Health Organisation has already classified cell phones as a Group 2B Carcinogen (possibly carcinogenic) similar to benzene and DDT. Other head cancers are also on the increase, including cancers of the parotid salivary gland (next to where you hold your cell phone) and the thyroid gland, which is in the neck.

Cell phones reduce male fertility

We might expect DNA damage in the cells of the germ-line (the line of cells starting in the embryo that eventually gives rise to eggs and sperm) to result in a loss of fertility. A number of epidemiological studies have shown significant reductions in sperm motility, viability and quantity in men using cell phones for more than a few hours a day (Fejes *et al.*2005; Agarwal *et al.* 2006) and the subject was reviewed by Desai *et al.* (2009). A common finding is that these effects were associated with the production of reactive oxygen species (ROS) which can damage many cellular components, including cell membranes and DNA.

More recently, Agarwal *et al.* (2009) found in controlled experiments that ejaculated sperm from healthy donors showed reduced viability and motility and an increase in ROS after one hour's exposure to a cell phone in talk mode. More recently still, Avandano *et al.* 2012 found that exposing ejaculated semen to a WiFi laptop for four hours gave a decrease in sperm motility and an increase in DNA fragmentation as compared with samples exposed to a similar computer with the WiFi switched off.

A similar relationship between sperm quality and electromagnetic exposure has also been found for low frequency alternating magnetic fields (Li *et al.* 2010). It is therefore advisable for men to avoid strong magnetic fields, restrict their cell phone calls to a minimum and keep them switched off (or in airplane mode if it has this facility). Otherwise, the phones transmit regularly at full power to the base station, even when not in use. If they have to be switched on for any reason, men should at least keep them out of their trouser pockets.

Possible effects on female fertility

We do not yet know the effects of cell phone use on human female fertility, but . Panagopoulos *et al.* (2007) showed that exposing adult *Drosophila melanogaster* (an insect

widely used in genetic experiments) to a GSM phone signal for just six minutes a day for six days fragmented the DNA in the cells that give rise to their eggs and half of these eggs died. We humans should therefore exercise caution since, although our sperm are produced in their countless billions and take about three months to mature, all the eggs that a woman will ever have were in her ovaries before she was born and will be exposed to the radiation (and electromagnetically conditioned blood) throughout her life. There could therefore be considerable cumulative damage, both to the eggs and the follicle cells that nourish and protect them. Damage to either, beginning when the child is in the womb, can be expected to cause a loss of fertility. Pregnant mothers should avoid all present forms of microwave telecommunications, including cell phones and WiFi. Her child could be damaged by their radiation, but she will not know until she reaches puberty and wants a child herself.

Effects on tight junction barriers

Tight junction barriers are layers of cells where the gaps between them are sealed by *tight-junctions* to prevent materials leaking around their sides. They protect all of our body surfaces from the entry of unwanted materials and often protect one part of the body from being unduly influenced by the others. For example, the blood-brain barrier prevents toxins entering the brain from the bloodstream. Normally, these barriers are closed but they are programmed to open if calcium ions enter their cells. This was demonstrated by Kan and Coleman (1988) who showed that the calcium ionophore A23187 (an antibiotic that kills bacteria and fungi by letting calcium ions leak into their cells) opened tight junction barriers in the liver. The electromagnetic opening of the blood-liver barrier could be a contributory factor to the current outbreak of liver disease in the UK among the under forties (the cell phone generation), which is at present being blamed on alcohol abuse. Since all tight junction barriers have basically the same design, unscheduled calcium entry resulting from electromagnetic exposure is likely to open all of them in much the same way. The opening of our tight junction barriers by electromagnetic fields can account for many modern illnesses, ranging from asthma to multiple allergies and Alzheimer's disease.

The blood-brain barrier and early dementia

The blood-brain barrier normally prevents possibly toxic large molecules from the bloodstream entering the brain. The radiation from cell phones, even at one hundredth of the permitted SAR value, can open the blood brain barrier in rats so that protein molecules as large as albumin could enter their brains (Persson *et al.* 1997). Later experiments by Salford *et al.* (2003) showed that this was associated with the death of neurons. We would not expect an immediate effect because the brain has spare capacity, but prolonged or repeated exposure to cell phone or similar radiation would be expected to cause a progressive loss of functional neurons and result in early dementia and Alzheimer's disease in humans. The extreme sensitivity of the blood-brain barrier to the radiation could mean that even sitting close to someone using a cell phone could affect you too. It may not be too surprising to find that early onset Alzheimer's disease is now on the increase in modern society.

The respiratory barrier and asthma

Di *et al.* (2011) showed that exposure to weak ELF electromagnetic fields during pregnancy increased the risk of asthma in the offspring (they did not test microwaves). This can be explained by the radiation removing structural calcium from the cells of the tight junction barrier lining the respiratory tract, which then opens. This is supported by the findings of Chu *et al.* (2001) who showed that either low levels of external calcium or the addition of EGTA, both of which would remove structural calcium ions from cell surfaces, caused massive increases in its electrical conductance (a measure of its permeability to ions) and also to its permeability to much larger virus particles. We would therefore expect many allergens to enter by the same route and predispose the child to asthma. There are

about 5.4 million people with asthma in the UK and the estimated annual cost to the NHS alone is about £1 billion
(http://www.asthma.org.uk/news_media/news/new_data_reveals_hig.html)

The skin barrier, allergies and multiple chemical sensitivities

The skin tight junction barrier is in the *stratum granulosum*, which is the outermost layer of *living* skin cells just underneath the many layers of dead cells (Borgens *et al.* 1989). Furuse *et al.* (2002) showed that mutant mice deficient in Claudin-1 (a vital component of the sealing mechanism) died within a day of birth and their skin barriers were permeable to molecules as large as 600D, which is enough to admit many unwanted foreign materials, including potential allergens. In humans, this could be the basis of *multiple chemical sensitivities*, where people have become allergic to a wide range of chemicals, although they leave most of us unaffected. People suffering from multiple chemical sensitivities are often also electromagnetically intolerant and many of their symptoms are very similar.

Virtually all of our body surfaces are protected by cells with tight junctions, including the nasal mucosa (Hussar *et al.* 2002), the lungs (Weiss *et al.* 2003) and the lining of the gut (Arrieta *et al.* 2006). An electromagnetically-induced increase in the permeability of any of these would allow the more rapid entry into the body of a whole range of foreign materials, including allergens, toxins and carcinogens.

Loss of barrier tightness can trigger autoimmune diseases

An electromagnetically-induced increase in the permeability of any of the tight-junction barriers has been linked to the occurrence of autoimmune diseases, in which lymphocytes the immune system attacks the body's own components as if they were foreign materials or pathogens.

The immune system is quite complicated but basically lymphocytes (a type of white blood cell) are trained and selected before they mature to recognise the body's own cells, which are normally present in the bloodstream, by virtue of chemical patterns on their surfaces (the major histocompatibility complexes).

B-lymphocytes make specific antibodies that combine with foreign cells and substances that do not have this pattern, which marks them for eventual ingestion and digestion by phagocytes (another type of white blood cell). T-lymphocytes kill the body's own cells if they are infected with a virus, which is normally displayed on the cell surface. In both cases, the presence of the foreign material or infected cells trigger the rapid multiplication of a clone of lymphocytes that recognise them. They can then attack it in force.

However, if the substance concerned belongs to the body itself but is normally prevented from entering the bloodstream by a tight-junction barrier such as the blood-brain barrier, when that barrier opens, it increases the likelihood of its leaking unfamiliar materials into the bloodstream and triggering an autoimmune response. For example, Grigoriev *et al* (2010) showed that 30 days exposure to unmodulated 2450MHz microwave radiation triggered a small but significant increase in anti-brain antibodies in the blood of rats. In other words, the radiation had sensitised the body's immune system to one or more components of its own brain, which could then result in an autoimmune attack on the brain and/or nervous system. An example of an autoimmune disease of the brain is Graves disease in which the pituitary gland (at the base of the brain) is affected.

In addition, an increase in the permeability of the gut barrier has been linked to several other autoimmune diseases, including type-1 diabetes, Crohn's disease, celiac disease, multiple sclerosis and irritable bowel syndrome (Arrieta *et al.* 2006).

Cell membranes as current generators and electrical insulators

Cell membranes not only keep apart materials that must not be allowed to mix, they also act as electrical insulators for the natural electric currents upon which all of our cells depend.

Natural electric currents are important in power and information transfer

Almost every living cell is a seething mass of electric currents and amplifiers. For example, these currents are important in energy production in mitochondria (the cell's power stations) and in cell signalling (the transfer of information within and between cells). They are carried as flows of ions, which are the normal ways in which electricity is carried through water and through living cells.

These natural currents are generated by cell membranes.

Natural electric currents are normally generated by molecular ion pumps in cell membranes. These are proteins that use metabolic energy to transport specific ions, usually one or two at a time, from one side of the membrane to the other. This generates a voltage across the membrane (*the membrane potential*) and a chemical imbalance between the concentrations of ions on either side. Their combined effect gives an *electrochemical gradient*, which provides energy for other functions.

Mitochondria use electrochemical gradients to transmit power

Mitochondria are tiny structures, about the size of bacteria, inside almost all of our cells. They evolved when an aerobic bacterium, which used oxygen to metabolise its food, was engulfed by an anaerobic organism, which could not do his, but was more efficient in other respects. From then on they lived together symbiotically, but are still separate in that that the mitochondria are surrounded by two membranes; the inner one belonging to the bacterium and the outer one to its host.

The inner membrane does the electrical work by a process known as chemiosmosis. The inside of the mitochondrion contains enzymes that convert materials from our food into forms that can combine with oxygen. This combination with oxygen occurs using enzymes actually within the membrane, and the released energy is used to expel hydrogen ions to create an electrochemical gradient between the inside and the outside of the mitochondrion. They are then allowed back through another enzyme in the membrane called ATP synthase that uses the gradient to make ATP, which is the main energy currency of the cell. The cycle then repeats to give an electrical circuit with hydrogen ions carrying the electricity from where it is made to where it is used, with the membrane being the insulator (Alberts *et al.* 2002).

What happens if the mitochondrial membrane is damaged?

Damage to the inner mitochondrial membrane can have two main effects. If it just leaked it would short circuit the system, reduce ATP synthesis and deprive the cell of energy. If the damage were also to include the oxidising enzymes, they could release free

radicals, which are normal intermediates in the process. This would damage both the inside of the mitochondrion (including its DNA) and also the rest of the cell. Mitochondrial dysfunction of this sort is thought to be a possible cause of chronic fatigue syndrome.

Other membranes also use ion currents to transfer energy

Most other cell membranes use ion currents as a source of energy. For example, enzymes in the outer membrane of each cell (*the plasma membrane*) use energy from ATP to pump positively charged sodium ions out of the cell. This generates its own membrane potential, which typically makes the inside of the cell about 70-100mV negative to the outside. This provides energy for the active transport of other materials across the membrane against a concentration gradient. In this case, the sodium ions that have been expelled are allowed back in, through transporter enzymes, but they carry with them nutrients from the outside by a process called ion co-transport (Alberts *et al.* 2002) If this membrane leaks, it will short circuit the voltage across it and reduce nutrient uptake as well as a number of other processes which use this voltage as a source of energy.

Ion channels in cell membranes are used for cell signalling

Ion channels are pores in cell membranes that can let large quantities of specific ions through very quickly, but only down their own electrochemical gradient. They normally open and close in response to specific stimuli; e.g. changes in voltage across the membrane or the presence of other chemicals. They can be thought of as amplifiers by which a tiny stimulus can cause a very large current to flow almost instantly to give a rapid biological effect. An example of this is the coordinated opening and closing of sodium and potassium channels that continuously amplify nerve impulses and enable them to travel from one end of the body to the other, both rapidly and without loss.

The mechanisms of cell membrane leakage.

We have known since the work of Suzanne Bawin and her co-workers (Bawin *et al.*1975) that electromagnetic radiation that is far too weak to cause significant heating can nevertheless remove radioactively labelled calcium ions from cell membranes. Later, Carl Blackman showed that this occurs only with weak radiation, and then only within one or more '*amplitude windows*', above and below which there is little or no effect (Blackman *et al.* 1982; Blackman 1990).

The apple harvester: an explanation for amplitude windows

A simple way to explain the selective removal of divalent ions is to imagine trying to harvest ripe apples by shaking the tree. If you don't shake it hard enough, no apples fall off, but if you shake it too hard, they all fall off. However, if you get it just right, only the ripe ones fall off and are 'selectively harvested'.

We can apply the same logic to the positive ions bound to cell membranes. Alternating voltages try to drive these ions off and then back onto the membranes with each cycle. If the voltage is too low, nothing happens. If it is too high, all the ions fly off, but return when the voltage reverses. However, if it is just the right, it will tend to remove only the more strongly charged ones, such as divalent calcium with its double charge. If the frequency is low, at least some of these divalent ions will diffuse away and be replaced at random by other ions when the field reverses. There will then be a net removal of divalent ions with each successive cycle until enough have been removed to cause significant membrane leakage and give a biological effect, but only within a narrow range of field strength to give

an *amplitude window*. Pulses are more effective than smooth sine waves because their rapid rise and fall times catapult the ions quickly away from the membrane and leave more time for them to be replaced by different ions before the field reverses.

Frequency windows and resonance effects

If a molecule or structure has a natural resonant frequency, it may respond selectively to that frequency. For example, if you keep giving a pendulum a gentle push at just the right time at the end of its travel, the energy of each push builds up and is stored in the ever increasing violence of its motion. If you were suddenly to stop it by putting your hand in the way, the combined energy of each push is released in one go and could do more damage to your hand than the energy you gave it from each individual push.

In the same way, if an electrically charged atom or molecule has one or more natural resonant frequencies and you give it an electromagnetic pulse at that frequency, it may store the combined energy of each pulse as some sort of vibration. This could enable it to bring about a chemical reaction that would not have been possible from the energy of each pulse alone, *but only at its resonant frequency.* Some frequencies are especially effective in giving biological effects. An example is 16Hz, which is the ion cyclotron resonance frequency of potassium ions in the Earth's magnetic field.

Ion cyclotron resonance occurs when ions move in a steady magnetic field such as that of the Earth. They are deflected sideways by the magnetic field and go into orbit around its lines of force at a frequency that depends on the charge to mass ratio of the ion and the strength of the steady field (see Liboff *et al.* 1990). If they are simultaneously exposed to an alternating field at this frequency, they absorb its energy and increase the diameter of their orbits, which increases their energy of motion and chemical activity. Potassium resonance is particularly important because potassium is the most abundant positive ion in the cytosols of living cells, where it outnumbers calcium by about ten thousand to one. It is therefore the ion most likely to replace any calcium that has been lost by electromagnetic exposure. An increase in the chemical activity of potassium will therefore increase its ability to replace calcium and so increase calcium loss from the membrane and further reduce its stability.

Calcium loss and leaky membranes underlie many biological effects.

We have seen how the loss of calcium from cell membranes is enhanced at the 16Hz potassium resonant frequency. Also, any metabolic consequences of this calcium loss may be similarly enhanced. Any bioelectromagnetic responses that peak or trough at 16Hz is evidence that they stem from divalent ion depletion in membranes. In fact, many biological responses appear to peak at 16Hz.. These include stimulations of the growth of yeast (Mehedintu and Berg 1997) and higher plants (Smith et al. 1993), changes in rate of locomotion in diatoms (McLeod *et al.* 1987), and the especially severe neurophysiological symptoms reported by electrosensitive people exposed to the radiation from TETRA handsets (which is pulsed at 17.6Hz). All of this supports the notion that a large number of the biological responses to weak electromagnetic radiation stem from the loss of calcium (and possibly other divalent ions) from cell membranes.

How calcium removal makes cell membranes leak

Positive ions strengthen cell membranes because they help bind together the negatively charged phospholipid molecules that form a large part of their structure. Calcium ions are particularly good at this because their double positive charge enables them to bind more strongly to the surrounding negative phospholipids by mutual attraction and hold them

together like mortar holds together the bricks in a wall. However, monovalent ions are less able to do this (Steck *et al.* 1970, Lew *et al.* 1998, Ha 2001). Therefore, when electromagnetic radiation replaces calcium with monovalent ions, it weakens the membrane and makes it more likely to tear and form temporary pores, especially under the stresses and strains imposed by the moving cell contents. Normally, small pores in phospholipid membranes are self healing (Melikov *et al.* 2001) but, while they remain open, the membrane will have a greater tendency to leak. This can have serious metabolic consequences as unwanted substances diffuse into and out of cells unhindered, and materials in different parts of the cell that should be kept separate, become mixed.

Demodulation

Both extremely low frequencies and radio waves that have been amplitude modulated at extremely low frequencies give biological effects, but unmodulated radio waves are relatively (but not completely) innocuous. This implies that living cells can demodulate a modulated signal to extract the biologically active ELF. Furthermore, if they are to respond to cell phone and WiFi signals, they must be able to do it at microwave frequencies, but how do they do it?

The most likely explanation lies in asymmetric electrical properties of ion channels in cell membranes imposed by the *membrane potential* between the inside and outside of the cell. They will behave like electrically biased point contact Schottky diodes in which electricity passes more easily in one direction than the other. This is all that is needed to rectify and demodulate the signal. A non-biological example of this effect is a radio set that was made from a single carbon nanotube (see http://tinyurl.com/m4u75o). The asymmetry induced by applying a DC voltage between its ends allowed it to demodulate and even to amplify radio signals, including those at microwave frequencies.

The nanotube has a similar diameter to a typical ion channel in a cell membrane, so it seems likely that the ion channels in cell membranes could perform a similar function, powered by the cell's membrane potential. The low-frequency component would then appear across the membrane, where it could do most damage. In as much as our *tight junction barriers* have a similar trans-barrier potential (around 70mV for the skin barrier with the inside of body positive) the ion channels of the whole barrier could act in concert to demodulate the signal, the damaging low frequency components of which could then be applied to and affect the whole body.

Natural defence mechanisms

The body is able to detect electromagnetic radiation and so minimise resulting damage. This ability probably evolved over countless millions of years to mitigate the effects of ionising radiation from cosmic rays and non-ionising radio frequencies from lightning during thunderstorms. Some of them are as follows: -

Calcium expulsion

The concentration of free calcium in the cytosols of living cells is normally kept extremely low by metabolically-driven ion pumps in the cell membrane. Under normal circumstances, the entry of free calcium ions is carefully regulated and small changes in their concentration play a vital role in controlling many aspects of metabolism. These processes can be disrupted if electromagnetically-induced membrane leakage lets extra and unscheduled amounts of calcium into the cell, either from the outside or from calcium stores inside. To compensate for this, the mechanism that normally pumps surplus calcium out can go into overdrive. However, its capacity to do this is limited because, if the pumping were too

effective, it would hide the small changes in calcium concentration that normally control metabolism.

Gap junction closure: - If calcium extrusion fails and there is a large rise in internal calcium, it triggers the isolation of the cell concerned by the closure of its gap junctions (tiny strands of cytoplasm that normally connect adjacent cells) (Alberts *et al.* 2002). This also limits the flow of electric currents through the tissue and so reduces the effects of radiation.

Ornithine decarboxylase (ODC)

The activation of the enzyme *ornithine decarboxylase* is triggered by calcium leaking into cells through damaged membranes and by nitric oxide produced by damaged mitochondria. This enzyme leads to the production of chemicals called *polyamines* that help protect DNA and the other nucleic acids needed for protein synthesis. One such polyamine is spermine, which normally protects the DNA of sperm and is also responsible for the characteristic smell of semen.

Heat shock proteins

These were first discovered after exposing cells to heat, but they are also produced in response to a wide variety of other stresses, including weak electromagnetic fields. They are normally produced within minutes of the onset of the stress and combine with the cell's enzymes to protect them from damage and shut down non-essential metabolism (the equivalent of running a computer in "safe mode").

When the production of heat shock proteins is triggered electromagnetically it needs 100 million million times less energy than when triggered by heat, so the effect is truly non-thermal (Blank & Goodman 2000). Their production in response to electromagnetic fields is activated by special base sequences (the nCTCTn motif) in the DNA of their genes. When exposed to electromagnetic fields, they initiate the gene's transcription to form RNA, which is the first stage in the synthesis of the protein (Lin et al. 2001). The job of these heat-shock proteins is to combine with vital enzymes, putting them into a sort of cocoon that protects them from damage. However, this stops them working properly and also drains the cell's energy and resources, so it isn't an ideal solution either.

Our defences protect us from thunderstorm radiation but not from cell towers, DECT phones and WiFi

As we can see, our natural defence mechanisms try to limit the electromagnetically-induced damage, but they cannot be deployed without using extra energy and disrupting the cell's normal functions. They originally evolved to protect us from occasional weak natural radiation, such as that from thunderstorms. However, prolonged or repeated exposure such as that from cell towers, WiFi and most DECT base stations is harmful because they normally run continuously and disrupt metabolism for long periods and is expensive in bodily resources.

These resources have to come from somewhere. Some may be drawn from our physical energy, making us feel tired, some may come from our immune systems, making us less resistant to disease and cancer. There is no hidden reserve. As it is, our bodies are constantly juggling resources to put them to best use. For example, during the day, they are directed towards physical activity but during the night, they are diverted to the repair of accumulated damage and to the immune system. Day and night irradiation from cell phone towers (which run continuously) will affect both, with little or no chance to recover. In the long term, this is likely to cause chronic fatigue, serious immune dysfunction (leading to an increased risk of disease and cancer) and many of the neurological symptoms frequently

reported by people living close to mobile phone base stations (see Abdel-Rassoul *et al.* 2007).

How can we make our electromagnetic environment safe?

Firstly, there may be no need to give up our electrical appliances domestic appliances or cell phones It is possible to make most of them much safer. All that is needed with domestic wiring is low-tech electromagnetic hygiene. As for cell phones, the operators have known for over a decade how to modify the radiated signal to make it safe; they have just chosen not to do so. I will deal with these one at a time.

Domestic wiring

It is easy to screen the electrical field from wiring by enclosing it in earthed metal conduits or using screened cable with an earthed screen. We cannot screen the magnetic field in this way but by careful design of the circuits, we can make the magnetic fields of the live and neutral wires cancel each other out. To do this, all you need is to make sure that the live and neutral wires to any device are as close together as possible (preferably twisted together) with each device having its own connection to the main distribution panel. The cheap UK practice of using ring mains (where many plug sockets are connected in a ring, beginning and ending in the distribution panel) should be made illegal. This is because differences in the resistance of the conductors mean that electricity flowing to any plug socket may not flow back the way it came so that their magnetic fields do not cancel and there will be an unnecessarily high field surrounding the whole ring.

Another source of problems is the use of unearthed double insulated appliances. Although there is very little risk of shock, they still emit strong magnetic fields and electric fields at about half the supply voltage, which some people find intolerable.

Cell phones

While we can block or cancel the electromagnetic fields associated with domestic wiring, we cannot do this with cell phones or DECT phones, which depend on radio frequency radiation transmissions if they are to work. However, we can make this radiation much less biologically active. There are at least two ways to do this. The first was devised tested and patented by Theodore Litovitz working at the Catholic University of America in the 1990s. All you have to do is to add low frequency electromagnetic noise to the signal.

The theory behind Litovitz's method.

His idea was to add a random ELF (noise) magnetic field to the regularly repeating fields from power lines or cell phones. It works on the principle that most of the biological effects of electromagnetic fields are due to the relatively slow but progressive loss of calcium from cell membranes, which then makes them leak. However, the effect on any cell takes place only within certain amplitude windows, as I described earlier. We may not be able to prevent this leakage just by reducing the power of the field. All this might do is to put other cells (perhaps nearer the source) into their amplitude windows and we may be no better off.

However, if we add a second magnetic field with a randomly varying amplitude, cells are constantly being driven in and out of their amplitude windows and do not spend long enough in their windows to lose significant amounts of calcium before leaving their windows. The lost calcium then floods back and there is no biological effect. This theory has been tested in several biological systems and found to work.

Much of Litovitz's work used the in production of the enzyme ornithine decarboxylase (ODC) by tissue cultures as an indicator of radiation damage to living cells. The activity of this enzyme increases several fold when exposed to electromagnetic fields (Byus et al. 1987). ODC is part of a defence mechanism against the radiation and an increase in its production is taken as an indication that damage is occurring. Conversely, if the random signal prevents its production, it is an indication that damage is not occurring.

Work in Litovitz's laboratory was mainly concerned with mitigating the effects of 60Hz power line frequencies and he found that adding a random (noise) magnetic field of about the same strength completely reversed their effects on ODC production in mouse tissue cultures (Litovitz *et al.* 1994b) and also the deformities induced by 60Hz fields in chick embryos (Litovitz *et al.* 1994a)

They then went on to study the effects of modulation frequency on 845MHz microwave radiation on ODC production in mouse tissue cultures. They found that constant frequencies between 6 and 600Hz were harmful as measured by ODC production. Simple amplitude modulated speech (which is more random) did not stimulate ODC production, neither did frequency modulated microwaves and frequency modulated analogue phone signals. Continuous microwaves had only a slight effect.

Most microwave pulse frequencies are harmful

Penafiel et al. (1997) working in Litovitz's laboratory concluded that there were only serious health problems when the microwaves were modulated to give pulses of a standard height (amplitude) generated at frequencies between 6 and 600Hz. There was virtually no effect above 600Hz. This corresponds to Blackman *et al.* (1988) observation that calcium release from brain tissue did not occur above 510Hz.

It would appear that the mobile telecommunications industry had not done their homework before selecting the pulse frequencies for their digital communications, since they virtually all fall within this biologically active range; e.g. 2G GSM cell phones (217Hz), TETRA (17.6Hz), DECT phones (100Hz), WiFi (10Hz), and 3G UMTS signals with time division duplex (100Hz and 200Hz) all of which are potentially harmful. There could be other harmful effects of the radiation that do not trigger ODC production or calcium release but, at the very least, these pulse frequencies should not have been used if the cell phone industry had acted due diligence. .

However, Litovitz (1997 found that even these could be made safe by superimposing a low frequency magnetic field on the signal. They found that it prevents the production of ornithine decarboxylase (ODC) by mouse tissue cultures in response to digital cell phone signals. For example, a random field between 30 and 100Hz with an RMS strength of 5 microtesla completely inhibited the ODC production induced by a cell phone signal with an SAR of about 2.5 W/kg. A coil within the handset could easily deliver a random magnetic field of this magnitude and probably protect the user from the harmful effects of its radiation.

Also Lai (2004) showed that a 6 microtesla random noise field completely reversed the deleterious effect of 2450 MHz continuous waves with an SAR of 1.2 W/kg on rat memory. In none of the above experiments did the random noise have any effect in its own right and, on these criteria, is completely harmless.

Balanced signal technology

While Litovitz's method might protect the user from the radiation, because magnetic fields dissipate rapidly as you move away from the source, they may not protect other people

nearby, who are out of range of the protective random field. By the same token, random low frequency magnetic fields emitted by a cell phone base station would not be able to protect most users. For this you may need something like a system that I devised myself, to which I gave the name "Balanced Signal Technology". I am not claiming any patent rights and anyone who wants to test and use it can do so free of charge.

The principle is very simple and involves transmitting two complementary mirror image signals on different carrier frequencies; i.e. when one has a pulse, the other has a gap. The base station would have no problem with this since they would look like two separate phone calls. However, living cells would be unlikely to distinguish between the two carrier frequencies and the pulses on each would cancel and it would look like a relatively harmless continuous wave. It would need very little extra bandwidth since only one of the signals need be used, with the other one being effectively thrown away and they could all be dumped on the same frequency. In theory, this technology could be applied to both handsets and base stations, but has not yet been tested.

The cell phone companies should know about both methods to make cell phones safer but there is no evidence that they are interested, possibly because to implement them would cost money with no extra benefit to themselves. It looks very much as if they would prefer many people to become sick and perhaps die, rather than admit that that their safety rules are based on false premises and that their current technologies are not yet safe.

What can we do about it ourselves?

Very few people would want to give up their cell phones, but if you have one, for your own personal safety, keep your calls on it short and infrequent so that your body has a chance to recover in between times. Use text (which takes seconds to transmit) rather than voice calls and avoid unnecessary Internet downloads. The choice is yours, but spare a thought for the people living near the base stations. Some may be badly affected by their continuous radiation but they have no choice. Your cell phone calls will contribute to their problems, so your restraint may help them too.

Also, don't forget your own personal sources of continuous radiation such as WiFi routers and DECT phone base stations, which can be even more harmful since they are closer. Avoid using WiFi altogether. Ethernet connections via cable are not only safer, but faster, more reliable and offer greater security. Various "Homeplug" devices that connect an the Ethernet socket of your computer to the router via the household electricity supply are second best alternatives. They are not perfect since there is still some radiation from the wiring; especially with those offering faster speeds.

DECT phones should also be avoided if at all possible. But, if you must have one, a reasonable compromise is to use only one that switches off its base station automatically between calls. At the time of writing, the only DECT phones that do this are the Eco Plus models manufactured by Siemens; e.g. the Siemens Gigaset C595. However, make sure they are programmed to work in the Eco Plus mode since this is not the default setting.

Screening and its limitations

Many electromagnetically intolerant people will want to screen themselves from the fields but we need to understand a little about them to get the best results.

The near-field

An alternating electromagnetic field consist of an electrical, field and a magnetic field. The electrical field is produced by a voltage gradient and is measured in volts per metre. The magnetic field is generated by a flow of current and is measured in tesla. When you are close to the source (typically within one wavelength) you are in the *near-field,* where the electrical and magnetic fields are mainly separate.

At power line frequencies, the wavelengths run into thousands of miles, so you are bound to be in the near field for power lines. For example, standing under an alternating power line would expose you to a voltage gradient due to the difference between the voltage of the line (set by the power company) and the Earth. You would also be exposed to a *magnetic* field proportional to the current actually flowing through the line, which depends on consumer demand. Both the magnetic and the electrical fields can induce electric currents in your body and are potentially harmful, but the magnetic field is worse because it penetrates living tissues more easily, goes through most walls and aluminium foil as if they were not there, and is very difficult to screen.

The far field

However, as you move away from the source, the two fields feed on each other's energy and combine to give photons of radio waves. This is usually complete within a few wavelengths, after which you are in the so called *far-field* where all the power takes the form of radio waves. Your exposure to these is usually measured in units of power (e.g. microwatts per square metre) or its associated voltage gradient (e.g. volts per metre).

The importance of this as far as we are concerned is that radio waves, are like light waves and are relatively easy to absorb and reflect. This can be done, using earthed metal foil or other electrically conductive materials such as carbon-based paints and metallised textiles. For practical purposes, this means that you can screen yourself against the radiation from a cell tower, WiFi router, or DECT phone base station if they are several wavelengths away (several tens of centimetres) but not from a cell phone held against your head, where you are in the near field and the raw magnetic component will penetrate deep into your brain.

To give an idea of the hazard, magnetic fields lower than one microtesla (a millionth of a tesla) can produce biological effects, but using a 2G (GSM) cell phone or a PDA exposes you to low frequency magnetic pulses that peak at several tens of microtesla (Jokela *et al.* 2004; Sage *et al.* 2007). These come mainly from the battery circuits and are well over the minimum needed to give harmful effects. When they are added to the damaging effects of their microwave fields themselves, these devices are potentially the most dangerous sources of electromagnetic fields and radiation that the average person possesses.

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Wireless Radiation in the Etiology and Treatment of Autism: Clinical Observations and Mechanisms

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Abstract

Background

Autism is an enigmatic, disabling neuro-developmental disorder that has increased in incidence almost sixty-fold since the late 1970s, but with the most dramatic increase occurring over the past decade. There is no consensus on the cause of Autism, and thus there are few reliable approaches to either preventive or therapeutic intervention.

Objective

This study was conducted to assess mechanistically the role of wireless device-associated EMR in the etiology and treatment of Autism. Specifically, the relationship between molecular weight-specific heavy metal clearance in children receiving detoxification intervention including energetic nutrition for Autism and the length of time the children were treated in an electro-magnetic radiation (EMR) free environment was evaluated.

Design

Data were recorded from clinical records and arrayed according to the intervention regimen followed by each subject. The pattern of heavy metal clearance was assessed through the three distinct excretion pathways of urine, skin and feces. The first child subjected to the EMR-sensitive protocol was the sentinel indicator. Data from this subject were analyzed as a pilot to assess whether or not any clinical indications were present supporting the working hypothesis that time and molecular weight dependent heavy metal clearance was associated with symptom amelioration. Records were gathered from 20 other subjects in the clinic following the same intervention protocol in subsequent months.

Results

The sentinel subject's history suggested that the efficiency of heavy metal detoxification was dramatically increased when EMR was eliminated. For the larger groups, data indicated that heavy metals were cleared in a time and molecular weight-dependent manner after EMR was eliminated from the treatment environment.

Conclusions

The findings suggest a significant role of EMR in both the etiology of Autism and the efficacy of therapeutic interventions. The mechanism of EMR impact could be direct by facilitating early clinical onset of symptoms or indirect, including trapping heavy metals in cells and both accelerating the onset of symptoms caused by heavy metal toxicity as well as impeding therapeutic clearance. These data also suggest that wireless device EMR is a synergen in the etiology of Autism, acting in conjunction with environmental and genetic factors, and offer a mechanistic explanation for the correlation between concurrent increases in the incidence of Autism and the use of wireless technology.

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Introduction

Autism is an enigmatic, disabling neuro-developmental disorder that has increased in incidence almost sixty-fold since the late 1970s, but with the most dramatic increase occurring over the past decade [1, 2]. The condition most commonly presents in early childhood and occurs in males four times more frequently than in females [3, 4]. Etiologic hypotheses include: genetic predisposition to Autism including impaired methylation capacity with resultant inability to clear heavy metals, increased vulnerability to oxidative stress, and impaired neurological adaptability function; environmental exposures including mercury preservatives in vaccines, trans-generational accumulation of heavy metals and biological conditions including Lyme Disease[5]. There is no consensus on the cause of Autism, and thus there are few reliable approaches to either preventive or therapeutic intervention. As the incidence of Autism continues to increase, the urgency of identifying means of controlling the disease becomes more acute.

Symptoms in Autistic patients include: diminished language skills and deficits in social interactive ability; liver and kidney function deficits; gastro-intestinal disease; autoimmune disease; and mental retardation[6-16]. The constellation of behavioral symptoms is consistent with pathology that involves disruption of normal inter-cellular communication [17].

Heavy metal toxicity has emerged as a primary etiologic focus, with most emphasis on mercury exposure derivative of vaccines, dental amalgams and environmental load from ingestion of contaminated seafood. It is believed that the physiological effects of heavy metals are mediated through interference with protein synthesis and subsequent structure and function of enzymes. From a pathological mechanism perspective, mercury vapor has been shown to inhibit tubulin polymerization into microtubules; mercury ions, uniquely among metals, inhibit the growth of neuronal

somata making it a strong causal factor in neuronal degeneration. Microtubules are important functionaries in intercellular communication and disruption of this primary communication route is a viable mechanism consistent with a number of the etiologic hypotheses for Autism including increased vulnerability to oxidative stress, impaired neurological adaptability and heavy metal accumulation[18-24].

Concurrent with the increased incidence of Autism and its quixotic clinical challenges, have been the dramatic increase in general population usage of mobile telephones and wireless communication devices. Between 1998 and 2007, wireless technology usage has increased from 200 million worldwide to more than 3 billion. Recent environmental impact data regarding migratory birds and honey bee colony collapses suggest that the background concentrations of wireless technology related electro-magnetic radiation (EMR) are reaching saturation points where exposures can not be avoided in most populated areas. The concern here is that increasingly high ambient exposures to EMR over the past decade portend in utero, post-natal and early childhood exposures that are unabated or for which normal physiologic compensatory mechanisms are inadequate [25-30].

The controversy about wireless technology health risks is now well into its second decade, but there is an emerging consensus that electro-magnetic radiation (EMR) emissions from these devices are biologically active. It is noteworthy that the pathology mechanisms reportedly underlying wireless device-related health effects include disruption of microtubule-based intercellular communication mediated through inappropriately triggered cell membrane protective responses that compromise cellular energy. Also included among the cell membrane responses is closing down of active transport channels resulting in decreased cell membrane permeability, further deficits in cellular energy, intra-cellular free radical build-up, disruption of normal DNA repair and a wide range of consequent symptoms[31-48].

Both EMR induced disruption of intercellular communication and lowered cell membrane permeability would be clinically relevant to the etiology and the treatment of Autistic patients with respect to symptom severity (intercellular communication) and diminished ability to clear metals (decreased permeability would result in higher intracellular concentrations of heavy metals).

There is a general consensus emerging among clinicians that first level treatment regimens for Autistic patients should include heavy metal detoxification. Various protocols have been utilized, including aggressive chelation with agents including dimercaptosuccinic acid (DMPS), ethylene diamine tetraacetric acid (EDTA) and dimeracptopropane-1-sulfonic acid (DMSA). These approaches yield varying efficacy and are sometimes accompanied by serious side effects. Nonetheless, the value of metal clearance is underscored by symptom amelioration when significant metal concentrations can be removed[5].

A primary challenge, therefore in managing Autism cases is determining detoxification protocols and methods that effectuate efficient metal clearance without harmful sequelae. During 2005, clinical protocols were adapted in the Internal Balance clinic to address the possible link between wireless device emissions and interference with both intercellular communication and heavy metal clearance capacity. Changes were implemented to create an EMR free treatment regimen, including both a 'clean' clinical environment as an adjuvant treatment and 'take-home' interventions as maintenance.

The implementation of the EMR sensitive treatment protocols provided a unique natural experiment regarding the possible link between EMR and Autism. Following from the epidemiological Koch-Henle postulates for cause and effect, a specific observational study was defined using the unique clinical data gathered to monitor heavy metal detoxification. The working concept was 'dose-response down' with respect to cell membrane kinetics [48]. If it is true that exposure to EMR decreases cell membrane permeability by closing active transport channels, then it would follow that eliminating EMR exposure would open active transport channels and result in heavy metal clearance according to molecular weight – with light metals clearing throughout, but with the heavier metals not clearing until later in the treatment regimen. These same findings would indicate a synergistic role of EMR in the etiology of Autism and would offer a mechanistic explanation for the strong correlation between the rising incidence of Autism and the dramatic increase in the use of wireless technology over the past half decade.

Methods

Objective

The objective of this study was to assess the role of EMR in the etiology and treatment of Autism mechanistically by evaluating the relationship between molecular weight-specific heavy metal clearance in children being treated for Autism and the length of time the subjects were being treated in an EMR-free environment. If heavier metals clear later in the treatment process, that evidences a time-dependent opening of the cell membrane active transport channels following elimination of EMR in the subject's environment. Such a finding would also support the hypothesis that EMR was a factor in closing the active transport channels at the outset in these patients.

Design

The study followed a post-hoc clinical observation design. Data were gathered for clinical purposes and no manipulations of data in terms of definition or gathering were followed to enhance the precision of the measurements. Data were recorded from clinical records and arrayed according to the intervention regimen followed for each subject. The pattern of heavy metal clearance was assessed through the three distinct excretion pathways of urine, skin (estimated through hair) and feces. Analysis of metallic elements in urine provides diagnostic information on toxic elements including lead, mercury, beryllium, arsenic and aluminum, as well as the efficiency of renal resorption of essential metabolic elements including magnesium, calcium, sodium and potassium. Scalp hair element levels indicative of dermal clearance were monitored to provide quantification of systemic metal loads. Fecal metal levels provide insight into the depth of toxic metal burden. For many heavy metals, fecal excretion indicates biliary involvement with feces becoming the primary natural route of elimination from the body.

The first child subjected to the EMR-sensitive protocol was viewed as the sentinel indicator because this subject had a long history of difficulty in clearing metals along with years-long persistence with seriously debilitating Autism related symptoms. This subject had a comprehensive medical records history of metal burden toxicity prior to the implementation of the EMR-free environment intervention, and the longest experience with the new intervention protocol. Data from this subject were first analyzed as a pilot to assess whether or not any clinical indications were present supporting the working hypothesis of time dependent heavy metal clearance and symptom amelioration. Based on the sentinel data, records were gathered from the other subjects in the clinic following the same intervention protocol over subsequent months. Data from the sentinel subject were also included in the summary data of the larger study group.

The general clinical protocol regimen included forty intervention sessions of four hours in duration, two to three times weekly in the EMR-free clinic environment. Subjects were given intervention in a sequential protocol that included a series of non-chelation provocations and nutritional formularies focused on mitochondrial resuscitation depending on the clinical profile of the client. Two general categories of subjects were defined for clinical purposes: those with liver clearance as an indicated vulnerability and those with kidney function weakness. These determinations are critical for precision in intervention for each subject and were based on a priori laboratory analyses, acupuncture meridian tests, medical history, consultations with subject's parents and clinician observations.

The EMR-free clinical environment was constructed by eliminating all wireless communication devices from the building, requiring that cell phones be turned off on the

premises, and installing various EMR filters to electrical circuits and appliances in the clinic. Applications of body worn sympathetic resonance technology, energy resonance technology and molecular resonance effect technology were introduced as appropriate. The premises were tested with appropriate EMR detection devices including gauss meters and radio frequency radiation detection equipment to ensure that the clinic was indeed EMR-free. Further EMR protection was recommended to each subject's parents so that the home environment was also without EMR interference.

Main Outcome Measures

Urine, hair and fecal samples were taken at three points in the course of each subject's treatment: at baseline, following 20 treatments and following 40 treatments. Sampling protocols were implemented according to those recommended by the laboratory contracted for conducting the analyses. It is noteworthy that provocation doses of chelating agents were not utilized. The clinical goal was to assess the subject's capacity to detoxify and clear heavy metals on their own. The clinical assessment did not include provoking outcomes with chelating procedures that were not part of the regular program. The following metals were included for subjects determined to have kidney function as a primary concern: beryllium (Be), aluminum (Al), arsenic (As), antimony (Sb), mercury (Hg), lead (Pb) and uranium (U). For those subjects with liver function as a primary concern, copper (Cu) and tin (Sn) were added. Statistical tests for trend were conducted using Chi-Square procedures. Even though the data were not gathered contemplating statistical trend analyses, it was judged that inclusion of such analyses would be useful for context. However, the primary evaluative tool was qualitative assessment of consistent trend and clinical significance.

Results

Sentinel Indicator

Clinical Presentation Summary. The sentinel subject was a male diagnosed with severe Autism in 1998 at the age of 3. His condition was judged as remaining severe when he presented to the Internal Balance clinic in 2004, despite having worked with many top notch practitioners in the field of Autism. He could not talk; had many urination accidents; did not hold utensils to feed himself very well; and he would repetitively clang his utensil on the plate that held his meal. The only words he could utter were 'yes' and 'no'. His anxiety level was extremely high. He would freeze while transitioning from indoors to outdoors, holding his head (as if he were having a brain freeze from a cold drink) and at the same time he would close his eyes and wait until he had a sense of where he was spatially. He continually had strong histamine reactions to foods, and would crave the foods that gave him the reactions. He would tap repeatedly with his fork on the side of his plate and peer at others while at the dinner table from an angle, not straight on. After eating certain food items he would immediately turn red, begin to have stray arm movements and quickly become giddy and uncontrollable. He was not cooperative in the clinic at all and his father had to coax him and sometimes physically move him into each intervention session for four hours everyday for two weeks. Prior to presentation at the clinic, he had been chelated, virally provocated, detoxed with far-infrared sauna therapy, been given Secretin and IVIG, but still had made only modest progress with his symptoms. No appreciable levels of heavy metals had been cleared despite several years of attempts with various procedures. Although there were times when heavy metals were cleared, it was usually related to spiking the sample with a provocation agent and there was no prolonged successful clearing. In September, 2004, a modified nutritional supplement regime was introduced to him, yet no significant metal clearance changes occurred. In March, 2005, an onsite, intensive detoxification regimen was implemented, with controls for chemicals in the home and in the environment that he would be treated in. Specifically addressed were electrical, water, and air pollution, use of cleaning chemicals, laundering criteria, and controls for scents and bedding. He was classified as both a kidney and liver focused subject. He was treated with two 40-session intervention cycles that included the EMR-free environment. While metals began to clear immediately during the first intervention series, his symptoms remained severe until near the 35th session. During the second intervention series, metals continued to clear significantly and his symptoms began to subside as observed by both his parents and validated by the clinicians attending to him. Clinically, the EMR-free environment was an important facilitator of heavy metal clearance, including mercury. There also appeared to be a direct correlation between significant heavy metal clearance and amelioration of his symptoms.

Metal Excretion Profiles

Table 1 presents the urine, hair and fecal excretion data for the first 40 intervention series, with metals arrayed according to increasing molecular weight. Hair levels of arsenic and mercury decreased over time, while hair antimony levels increased. Fecal arsenic increased along with mercury, lead and uranium. Table 2 presents similar data for the second series.

In the second intervention series, urine arsenic and lead increased significantly while urine mercury decreased. Hair levels of aluminum, arsenic, antimony, mercury, lead and uranium appeared to trend upward. Fecal arsenic decreased, while antimony and mercury trended upward. The concentration of mercury cleared in the second series was higher than in the first.

Kidney and Liver Subject Series

Tables 3 and 4 present urine, hair and fecal excretion profiles for the kidney and liver subject series. Most significant is that among the kidney subjects, heavier metals mercury, lead and uranium show consistent upward excretion trends over time. For liver subjects, the same trend is evident for antimony, mercury, lead and uranium.

These data indicate that heavy metals were cleared in these subjects in a time-dependent and molecular weight-dependent manner after EMR was eliminated from the clinic and home environment. The finding suggests a significant role of EMR in the etiology of Autism as well as in the efficacy of therapeutic interventions to control the disease. The impact of the EMR exposure could be direct in facilitating earlier clinical onset of symptoms related to genetic predispositions or indirect, the result of trapping heavy metals in cells and thus accelerating the onset of symptoms mediated by those metals. These two mechanisms of early onset and acceleration could interact synergistically, leading to the suggestion that wireless device EMR is a synergen in the etiology of Autism, acting in conjunction with environmental and genetic factors.

Clinical Addenda

The sentinel indicator subject showed no appreciable change or improvement in heavy metal clearance for seven years prior to the implementation of the EMR-free intervention protocols. After the implementation of the new protocols, his condition steadily improved clinically during the end of the first intervention series and into the second. Supplemental to the laboratory evaluations, was monitoring for EMR related toxicity through kinesiology and energy system protocols. The qualitative measures scored toxicity on a scale from 0 to 100, with his initial readings at 90. At the conclusion of the second series, his EMR toxicity score was 10. It is clear that the EMR

Table 1

Sentinel Indicator Metal Excretion Data: Urine, Hair, Feces, In EMR Controlled Environment throughout Course of Intervention – First Three-Month Course*

Metal:	Be	Al	As	Sb	Hg	Pb	U	
Molecular Wt:	9.0	26.9	74.9	121.8	200.6	207.2	238.0	
Urine (ug/g creat)								
Baseline	0.0	0.0	130.0	0.00	2.1	1.1	0.0	
Twenty Rx	0.0	0.0	1350.0		0.10	0.0	0.0	0.0
Forty Rx	0.0	67.0	83.0	0.00	2.0	0.0	0.0	
Hair (ug/g)								
Baseline	0.0	9.5	**0.14**	**.035**	**3.9**	1.3	0.005	
Twenty Rx	0.0	8.0	**0.11**	**.071**	**3.5**	1.1	0.001	
Forty Rx	0.0	8.1	**0.08**	**.170****	**2.7**	1.6	0.015	
Feces (mg/kg)								
Baseline	0.003		**0.76**	.094	**0.00**	**0.22**	**.049**	
Twenty Rx	0.000		**1.95**	.068	**0.02**	**0.45**	**.060**	
Forty Rx	0.023		**3.31****	.170	**0.19****	**1.39****	**.253****	

*Readings in bold indicate consistent trend ** Trend significance: p< .05

Table 2

Sentinel Indicator Subject Excretion Data: Urine, Hair, Feces, In EMR-Controlled Environment throughout Course of Intervention – Second Three-Month Course*

Metal:	Be	Al	As	Sb	Hg	Pb	U
Molecular Wt:		9.0	26.9	74.9	121.8	200.6	207.2 238.0
Urine (ug/g creat)							
Baseline	0.0	25.0	**190.0**	0.10	**4.80**	**0.70**	0.00
Twenty Rx	0.0	17.0	**410.0**	0.30	**3.70**	**0.90**	0.00
Forty Rx	0.0	120.0	**830.0****		0.00	**2.00**	**2.60**** 0.00
Hair (ug/g)							
Baseline	0.0	**5.9**	**0.10**	**0.11**	**3.00**	**0.62**	**0.003**
Twenty Rx	0.0	**76.4**	**0.89**	**0.82**	**7.34**	**4.10**	**0.467**
Feces (mg/kg)							
Baseline	0.048		**3.54**	**0.102**	**0.044**	0.92	0.094
Twenty Rx	0.017		**0.61**	**0.126**	**0.116**	0.46	0.067
Forty Rx	0.019		**0.45****	**0.298**	**0.222****		0.80 0.266

*Readings in bold indicate consistent trend ** Trend significance: p< .05

toxicity was concurrent with his inability to excrete cellular toxins and to heal his central nervous system. This subject's father is convinced that the key to unlocking his child's recovery was the link to EMR toxicity and its role in why mercury was being stored in his system and not cleared. The subject presented with severe impairment to brain and hormonal communication networks to the point where he was significantly debilitated. Cortisol levels were elevated prior to the implementation of the EMR-free intervention regimen but were stabilized afterwards. Clinically, he began to speak and told of such occurrences as "the noise was gone from his head". While the satellite radio, halogen and fluorescent lights continued to bother him, the computers, DVD's, and wireless devices no longer seemed to be problematic. Both halogen and fluorescent lights contain mercury and titanium and those could be the source of the adverse reaction.

In the larger series, it is noteworthy that the hepato-toxicity of aluminum and the nephrotoxicity of beryllium were apparent. Liver-focused subjects tended to clear more aluminum while kidney-focused subjects cleared more beryllium. This suggests that there are possibly two categories of injured children: those exposed as a result of trans-generational accumulation and those exposed as a result of trans-gestational accumulation during embryonic and fetal development. Thus, the familial pre-disposition might indeed be the result of combined susceptibility due to insufficient methylation genetics and excessive environmental loading.

The Role of EMR

Current science defines two distinct types of EMR plume capable of contributing to the development of Autism in children exposed to wireless technology related exposures in utero and in early childhood. The near-field plume has been studied most extensively relative to mobile phones, base stations and other EMR generators, because this plume – usually within six to eight inches from the center of the antenna generating a radio frequency signal from a cell phone and several hundred feet for a base station antenna – contains the most intense energy and is therefore able to penetrate more deeply into biological tissue. The far-field or ambient exposure plume that derives from the enormous numbers of simultaneously switched-on wireless devices, has less energy associated with it, although studies indicate that energy intensity is not the primary determinant of adverse biological impact. At least one series of studies has suggested that genetic effects can indeed result from far-field exposures[39-41]. Every person who uses a mobile phone or uses wireless connections to access the Internet is exposed to both the near-field and far-field radiation. Those living or working in the vicinity of base-stations or masts are exposured also to ambient far-field EMR, and that includes children who may subsequently develop Autism.

Given exposure to EMR, studies further show that coherence, or form, of the information carrying wave is the determining factor in biological effects[43, 44]. The likelihood that biological responses associated with both near-field and ambient exposures to wireless device related EMR derives from recognition that a series of events are triggered by biological cell membrane recognition that a coherent, invading radio wave is present. It is noteworthy that the carrier wave in the radiofrequecy bands of the EMR spectrum – ranging from around 837 megahertz to around 1900 megahertz – is not easily recognized by the biological cell membrane. The oscillation is too fast to be picked up by cell membrane ciliary sensor proteins that respond to compatible vibration [44]. Membrane recognition occurs when the information carrying wave – a secondary wave oscillating in the hertz range – is present. For example, there is a 2 hertz signal identifying presence of a cell phone in range of a base station; and hertz frequency waves carry packeted information whenever talking, music, games, etc are transmitted [48-50].

Once membrane recognition occurs, a series of protective biochemical reactions are initiated inside the cell[46]. Included are stress protein responses that serve to effectively "harden" the cell membrane and disrupt active transport. The "membrane hardening" effect causes a build-up of intracellular waste products; including highly reactive free radicals. Where heavy metal exposure including mercury has occurred, it is likely that these large molecules would become trapped intracellularly because the active transport channels would not be opened enough to accomodate their excretion.

These reactive molecules are involved in at least three mechanistic pathways associated with disease induction. The first occurs when mitochondria are attacked resulting in cellular dysfunction – for example, evidenced by studies showing leakage in the blood-brain barrier following EMR exposure. The second is interference with normal DNA repair processes as evidenced by studies showing the presence of micronuclei in cells following EMR exposure. The third involves alterations in mRNA folding and consequent transciption of 'under stress' messages to mitochondrial and nuclear DNA, causing the structure of mitotic daughter cells to be altered. This third mechanism represents an environmentally induced genetic change that could explain the self-replicating pathology present in Autistic patients[51-53].

Table 3

Kidney Subjects Average Excretion Data: Urine, Hair, Feces, In EMR-Controlled Environment throughout Course of Intervention – 3 months average*

Metal:	Be	Al	As	Sb	Hg	Pb	U
Molecular Wt:	9.0	26.9	74.9	121.8	200.6	207.2	238.0
Urine (ug/g creat)							
Baseline (n=13)	18.2	57.1	57.9	0.2	1.6	11.2	**0.00**
Twenty Rx (n=10)	8.7	92.8	179.5	17.1	1.9	1.6	**0.01**
Forty Rx (n=8)	17.5	27.8	168.0	0.1	1.2	3.1	**0.06****
Hair (ug/g)							
Baseline (n=11)	0.008	12.38	0.22	0.07	0.51	2.58	0.04
Twenty Rx (n=9)	0.032	16.78	0.18	0.06	0.91	2.58	0.03
Forty Rx (n=10)	0.025	12.46	0.05	0.08	0.46	0.78	0.09
Feces (mg/kg)							
Baseline (n=13)	**0.053**		0.58	**0.16**	**0.02**	**0.4**	**0.08**
Twenty Rx (n=13)	**0.112**		0.49	**0.12**	**0.06**	**1.1**	**0.12**
Forty Rx (n=9)	**0.312****		0.88	**0.12**	**0.07****	**3.3****	**0.17**

*Readings in bold indicate consistent trend ** Trend significance: p< .05

From a clinical disease perspective, these mechanistic pathways impact all critical levels of neuro-behavioral functioning. DNA repair interference and disruption of normal apoptosis can lead to self-replicating genetic mutational changes – consistent with the familial predisposition to diminished neuro-adaptation. General impairment of normal cellular function, especially mechanisms that are meant to stop aberrant cell growth and compensate for environmental insult, is a mechanism that can explain increased susceptibility to oxidative stress.

The composite effect of cellular dysfunction caused by exposure to EMR is disruption of intercellular communication in both the gap-junction and microtubule systems[42, 47, 52]. When cells are not able to communicate, functional requirements between cells, tissues and organs are not met and physiologic processes become compromised. For example, when intercellular communication is disrupted, messages from local cell groups or tissues are not carried to the immune, nervous or endocrine systems. The effects of this break in communication are felt at the organ and organism level resulting frequently in clinical symptoms consistent with the presentation of Autism.

With respect to synergies between radio wave related EMR and heavy metal burden, mechanisms other than intracellular trapping are likely operating as well. Studies show that electro-magnetic fields (EMFs) produce current in metals and increase the effects of galvanism. The close relationship between antimony and mercury in the clearance profiles could evidence this relationship. Antimony and other heavy metals have a profound impact on whether or not mercury exists in a gaseous or solid state within the cell, with the balance shifted toward vapor in the presence of other metals. Mercury clears only when in the solid state, and it therefore follows that mercury clearance in these patients occurred most profoundly after antimony had also begun to clear, leaving more mercury in a solid state and primed for excretion. EMFs are present in the environment surrounding every biological cell, and it has been shown that these fields are capable of passing through the cell membrane reaching intracellular metals and causing intracellular heating[54-65]. Irrespective of which mechanism or combination of mechanisms is operating, it is clear that each provides biological plausibility to the hypothesis that EMR is a synergen in the etiology of Autism.

Table 4

Liver Subjects Average Excretion Data: Urine, Hair, Feces, In EMR-Controlled Environment throughout Course of Intervention – 3 months average*

Metal:	Be	Al	Cu	As	Sn	Sb	Hg	Pb	U
Molecular Wt:	9.0	26.9	63.5	74.9	118.7	121.8	200.6	207.2	238.0
Urine (ug/g creat)									
Baseline (n=11)	0.0	**4.6**		61.8		0.09	1.69	1.6	0.00
Twenty Rx (n=9)	0.0	**6.4**		220.4		0.54	0.83	17.1	0.01
Forty Rx (n=8)	0.0	**25.3****		138.9		20.2	1.61	3.4	0.01
Hair (ug/g)									
Baseline (n=12)	0.0	**11.1**	**43.3**	**0.11**	0.38	0.14	**1.31**	0.98	0.10
Twenty Rx (n=6)	0.7	**12.7**	**44.0**	**0.15**	0.59	0.14	**1.22**	1.37	0.11
Forty Rx (n=7)	0.0	**17.4**	**198.3****	**0.19**	0.34	0.07	**0.81**	0.86	0.11
Feces (mg/kg)									
Baseline (n=11)	0.0			0.83		**0.11**	**0.03**	**0.47**	0.21
Twenty Rx (n=10)	0.0			0.77		**0.13**	**0.07**	**0.56**	0.26
Forty Rx (n=7)	0.0			0.81		**0.14**	**0.11****	**0.71**	0.29

*Readings in bold indicate consistent trend ** Trend significance: p<.05 Discussion

Strengths and Weaknesses of Study

This study presents the first clinical data to link wireless technology-related EMR in the environment to Autism and thus presents an important trigger for other clinicians with similar databases to assess whether or not these data can be corroborated. It is noteworthy that every important public health threat was first discovered through clinical observations and thus it is important to take these data seriously. The identification of several mechanistic pathways for the concurrence of Autism's increased incidence and the increase in wireless technology usage adds strong evidence of biological plausibility for the relationship. Although statistical significance tests were not the main evaluative tool, there was a consistent qualitative trend evident in the data that would have been unlikely to occur by chance.

Nonetheless, the study was a retrospective observation based on subjects with severe Autism whose parents chose to pursue alternative metal detoxification methods after other traditional approaches had failed. There is a likelihood that the parents and the subjects alike were vested in a positive outcome and it is possible that those strong desires had an impact on the favorable metal clearance through placebo mechanisms. However, the working hypothesis that metal clearance would be time and molecular weight dependent based on measurements of the length of time in an EMR-free treatment environment and the sequence of heavy metal clearance was determined post hoc so there was no operational knowledge of the intent of the study by the subjects, parents or the clinicians.

Clinical Significance

It is important to note that the clinic where this work was completed is not a medical facility and the interventions used are intended to evaluate whether removal of metals would improve the child's life and provide hope for the families involved. All parents signed consent forms understanding that these protocols were not intended to treat a medical condition but to improve the wellness and livelihoods of their children.

While the purpose of the study was to test a working EMR-free protocol implementation, the seemingly dramatic trends observed can not be trivialized. From a clinical perspective, it is clear that heavy metal detoxification was greatly facilitated by the elimination of EMR from the treatment environment. It would be important that other clinicians with similar intervention protocols in place attempt corroboration analyses and publish those as well.

1. Tamara J Mariea, Internal Balance Inc, Nashville TN and Safe Wireless Initiative, Washington, DC

2. George L Carlo, Science and Public Policy Institute, Safe Wireless Initiative and The George Washington University School of Medicine and Health Sciences, Washington, DC

References supplied on request and available on <www.acnem.org>