The Dangers of Electromagnetic Smog

Andrew Goldsworthy, August 2007

Weak non-ionising electromagnetic radiation in the environment can be linked to more 'modern illnesses' than even the pessimists thought possible. Modern science can now begin to explain how.

Abstract

Weak electromagnetic radiation removes structurally important calcium (and possibly magnesium) ions from cell membranes, making them weaker and more prone to transient pore formation. This makes them leaky to even large molecules. Prolonged exposure to mobile phone radiation causes serious damage to the DNA in living cells, probably because of digestive enzymes leaking from lysosomes. This may be responsible for the reduction in sperm quantity and quality found in recent studies of people using mobile phones for more than a few hours a day. We might also expect it lead to an increase in the incidence of cancer, but this may not become apparent for many years. Electromagnetic exposure also increases the permeability of the blood-brain barrier to large molecules and allows potentially damaging substances to enter the brain from the bloodstream. The blood-brain barrier is characterised by having cells joined by 'tight junctions', where the gaps between the cells are sealed by impermeable materials. Equivalent layers of cells with tight junctions cover all of our body surfaces and a similar increase in their permeability could allow the entry of a wide range of potential toxins, allergens and carcinogens from the environment. There is evidence that this increase in permeability is mediated by the loss of calcium from cell membranes and should also be enhanced by electromagnetic exposure. This effect can link the current rise in the incidence of multiple chemical sensitivities, various allergy-related diseases and skin cancer to the electromagnetic environment. Electrosensitive individuals can be thought of as people who have abnormally weak permeability barriers that are more easily compromised by electromagnetically-induced calcium or magnesium loss. In general, the symptoms resemble those of hypocalcaemia and hypomagnesaemia, which suggests a common aetiology based on a reduction in membrane stability. Low concentrations of either calcium or magnesium ions in the blood may be predisposing factors, but once the condition is established, it can be progressive with increasing exposure to radiation. It then appears to be irreversible.

Introduction

Nearly all of us are exposed to weak non-ionising electromagnetic radiation from all sorts of electrical appliances and even the wiring in our own homes. If we could see it, it would look like a fog over almost everything, with particularly dense patches around people using mobile phones and DECT cordless phones. There would be other dense patches hovering permanently over their base stations and Wi-Fi routers. People have dubbed this

'electromagnetic smog' and, like real smog, it can have serious effects on our health. Electrosensitive people have known this for a long time because they experience pain and other symptoms when they are exposed to the denser patches. However, the dangers go well beyond that. Many people have attributed the recent rise in the incidence of a large number of medical conditions such as asthma, other allergies, various cancers, diabetes and multiple sclerosis to electromagnetic exposure. However, until very recently no one has been able explain just how this could happen, but we are now learning about the likely mechanisms and just how serious the situation is.

Calcium loss makes cell membranes porous

The most important factor giving adverse health effects from electromagnetic exposure seems to be the electromagnetically-induced loss of calcium ions (electrically charged calcium atoms) from cell membranes. We have known for over thirty years that weak electromagnetic fields remove calcium ions from the surfaces of cell membranes (Bawin et al. 1975.; Blackman et al. 1982; Blackman 1990). In theory, magnesium ions can be removed by a similar mechanism (See Goldsworthy 2006). However, divalent ions (ions with a double charge) such as calcium are important in maintaining membrane stability (Steck et al. 1970; Lew et al. 1988; Ha 2001) and their loss would make the membranes more prone to the formation of transient pores and increase their general permeability to a wide range of materials.

Pore formation can have many biological effects

Spontaneous pore formation has already been reported in stationary artificial phospholipid membranes exposed to DC fields (Melikov et al. 2001) and we would expect an even greater effect on the membranes of living cells, which are routinely subjected to stresses and strains from being adjacent to moving cytoplasm. If these membranes were in addition suffering from electromagnetically-induced calcium depletion, we would expect pore formation to be more frequent and give rise to larger pores that are slower to heal. In this way, exposure to weak non-ionising radiation would give a non-specific increase in membrane permeability. Such an increase can explain a large number of non-thermal biological effects of electromagnetic fields, ranging from changes in the growth rate of plants to accelerated rates of healing and changes in gene expression in animals (See Goldsworthy 2006; 2007). However, it can also cause serious damage.

Mobile phone radiation can damage DNA

Low-level, non-thermal (i.e. not strong enough to generate significant heat) microwave radiation similar to that from mobile phones has been shown to do serious damage to the DNA in cultures of living cells. Lai and Singh (1995) were the first to show this in rat brain cells, but many other workers have since confirmed it. The most comprehensive study on this was the Reflex Project sponsored by the European Commission and replicated in laboratories in several European countries. They found that radiation from GSM mobile 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 seemed not to be affected at all (Reflex Report 2004). The degree of damage depended on the duration of

the exposure. With human fibroblasts, it reached a maximum at around 16 hours. Intermittent exposure (5 minutes on, ten minutes off) was considerably more damaging than continuous exposure, thus emphasising its non-thermal nature. (Diem et al. 2005). Because of the high stability of DNA molecules, the only plausible mechanism for this so far is the release of DNAase and possibly other digestive through the membranes of lysosomes (organelles that digest waste) that had been perforated or ruptured by the radiation. If this is correct, there is likely to be considerable collateral damage to other cellular systems.

If similar DNA fragmentation were to occur in the whole organism, we would expect a more or less immediate reduction in male fertility as developing sperm become damaged, an increased risk of cancer, which (by analogy with tobacco and asbestos) may take several years to appear, and genetic mutations that will appear in future generations. It would be unwise to assume that exposures of less than 16 hours are necessarily safe, since covert DNA damage to give aberrant cells could occur long before it becomes obvious under the microscope. Claims made by the mobile phone industry that their devices are safe because not all cells are affected are rather like clutching at straws, since very few genetically aberrant cells are needed to initiate a tumour.

Mobile phones can reduce fertility

We might expect DNA damage to result in a loss of fertility. Recent studies have shown significant reductions in sperm motility, viability and quantity in men using mobile phones for more than a few hours a day (Fejes et al. 2005; Agarwal et al. 2006; Agarwal et al. 2007) so it is advisable to keep your mobile calls to a minimum. Since similar experiments have not yet been performed with mobile phone base stations, it would be premature to assume that they are necessarily safe, particularly since living near one will involve a considerably longer exposure.

Electromagnetic exposure disrupts tight junction barriers

We might expect radiation that is strong enough to disrupt lysosomes also to be strong enough to disrupt the outer membranes of cells so that these too are made more permeable to large molecules. The effects of this would be most serious in the cells of the various barriers within our bodies that prevent the passage of unwanted substances. These are characterised by cells joined by ‘tight junctions’, in which the gaps between the cells are sealed with impermeable materials to prevent leakage around their sides. One such barrier is the blood-brain barrier, which normally prevents unwanted substances in the bloodstream from entering the brain. We know that the radiation from mobile phones can increase the permeability of this barrier even to protein molecules as large as albumin (Persson et al. 1997) and this increase in permeability can damage the neurones beneath (Salford et al. 2003).

Calcium ions control barrier tightness

The loss in tightness of the blood-brain barrier could be due to an increase in membrane leakiness as proposed by Goldsworthy (2006; 2007) and/or to a disruption of the tight

junctions themselves, either of which could be triggered by an electromagnetically-induced loss of calcium from their membranes. The central role of membrane-bound calcium in controlling the 'tightness' of these layers is supported by an observation by Chu et al. (2001). They found that either low levels of external calcium or the addition of EGTA (a substance that removes calcium ions from surfaces) caused massive increases in the electrical conductance and permeability to virus particles of respiratory epithelia, which also has tight junctions.

We have many other tight junction barriers

There is a protective layer in the skin in the *stratum granulosum*, which is the outermost layer of living skin cells, in which the cells are connected by tight junctions (Borgens et al. 1989; Furuse et al. 2002). In addition to this, virtually all of our other 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). A similar 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 tightness can exacerbate many illnesses

Electromagnetically induced losses of barrier tightness at our body surfaces can explain how the general increase in public exposure to electromagnetic fields may be responsible for our ever-increasing susceptibility to various allergies, multiple chemical sensitivities, asthma, skin rashes and bowel cancer to name just a few. In addition, a non-specific increase in the permeability of the gut has been linked to type-1 diabetes, Crohns disease, celiac disease, multiple sclerosis, irritable bowel syndrome and a range of others (Arrieta et al. 2006). The list is truly horrendous and points to a very real need to reduce our exposure to non-ionising radiation.

Electrosensitivity

Electrosensitivity (sometimes called electromagnetic hypersensitivity) is a condition in which some people experience a wide range of unpleasant symptoms when exposed to weak non-ionising radiation. Only a small proportion of the population is electrosensitive (currently estimated at around three percent) and an even smaller proportion is so badly affected that they can instantly tell whether a device is switched on or off. At the other end of the scale, there are people who may be electrosensitive but do not know it because they are chronically exposed to electromagnetic fields and accept their symptoms (headaches, pins and needles, numbness, fatigue, irritability and many others.) as being perfectly normal. Electrosensitivity is in effect a continuum and there is no clear cut-off point.

Causes and symptoms of electrosensitivity

The cause of the condition is uncertain and not everyone shows the same symptoms, but they seem to be characterised by having skins that have an unusually high electrical

conductance (Eltiti *et al.* 2007). This is consistent with them having a *stratum granulosum* which is abnormally leaky, and may account for the high incidence of allergies and chemical sensitivities commonly found in this group. One explanation for this is that they normally have asymptomatic low levels of calcium and/or magnesium in their blood, which gives low concentrations of these ions on their cell membranes. This means that less has to be removed by electromagnetic exposure to produce biological effects; hence their greater sensitivity.

The range of electromagnetically-induced symptoms reported by electrosensitives, which includes skin disorders, various paresthesias (pins and needles, numbness, burning sensations) fatigue, muscle cramps, cardiac arrhythmia, and gastro-intestinal problems are remarkably similar to those from hypocalcaemia (low blood calcium) (http://tinyurl.com/2dwwps) and hypomagnesaemia (low blood magnesium) (http://tinyurl.com/3ceevs). This suggests that they share a common aetiology, that being that there are inadequate concentrations of these divalent ions on the cell membranes to maintain stability, which promotes poration and gives rise to an unregulated flow of materials across them. If a patient reporting symptoms of electrosensitivity is diagnosed as having sub-clinical low levels of either of these ions in the blood, and if caught at an early stage, it may be possible to mitigate the effects of electromagnetic exposure by conventional treatment for hypocalcaemia and/or hypomagnesaemia.

Unfortunately, it does not end there. When electrosensitive people to are subjected to further exposure to electromagnetic fields, it seems to do permanent damage. This could be due to DNA or other cellular damage from ruptured lysosomes. The affected cells may then not function properly and become incapable of protecting themselves fully from further damage. This could include an ever-increasing loss of their ability to form adequate tight junction barriers, so making the victim progressively more sensitive to the radiation. It is important, therefore, to protect electrosensitive people from further electromagnetic exposure, but sadly, there is no Government provision for this in the UK because the condition is not officially recognised.

Postscript

Virtually all of the observations cited above came originally from peer-reviewed journals. I obtained them in my retirement by piecing together the findings from many scientific papers, often on unrelated topics, for which I thank the Library at Imperial College. However, there has been very little research specifically directed at discovering, either the full range of the adverse health effects of electromagnetic exposure or of the mechanisms by which they occur. I hope that the time for this will soon come. In the meantime, if you would like to learn more about electromagnetic fields and how to avoid them, visit www.powerwatch.org.uk. If you want to know more about electrosensitivity, visit www.es-uk.info.

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