

Wi-fi in School

Concern about its Health Effects on Children

**Written by a parent for parents and school governors
after the installation of wi-fi in his child's primary school**

Introductory note

There is a substantial body of evidence that microwave radiation, even at the low levels used by wi-fi, may have harmful effects on health, both short-term and long-term, especially the health of children. Despite that evidence, or probably in ignorance of it, many schools have in very recent years installed wi-fi.

Concern about the effects of wi-fi is *not* concern about the use of computers or of the internet. It is concern about how computers are *connected* to the internet.

In countries other than the UK, governments are beginning to act on the evidence. The German federal government has advised everyone, not only children, to avoid wi-fi.¹ In the UK, the government has yet to take the issue seriously.

UK schools have a statutory duty of care towards children in relation to their health. School governors are required by law to ensure that equipment used in school is safe. But the only official advice on the safety of wi-fi to which governors can refer is based on international standards that are widely disputed. These standards do not take into account the evidence of risk from *low-level* microwave radiation.

Schools and parents have therefore to judge for themselves whether or not children should spend their school days exposed to such radiation, and to the dangers experts have associated with it.

The following paper is an update of one I wrote in 2009. I was concerned about the installation of wi-fi at our child's primary school. I am not a scientist or an expert in these matters: my aim was to inform myself and to collect some of the findings of those who are scientists or experts.

I gave copies of the paper to about fifteen other parents of children at the school. Ten of them signed a letter that was sent, with a copy of the paper, to each of the school's governors, requesting that the wi-fi in the school be turned off until research showed it was safe.

In the present update, I have added references to recent research, clarified one or two passages, and made a correction. I have also taken out the name of the school and references that might identify it. I have put the paper on the internet in case it is of use to others who are concerned about wi-fi, especially wi-fi affecting children, and as a result of requests for copies in this country and abroad.

I am indebted to Graham Lamburn for checking the technical details and for his comments on a draft of the paper. I am grateful too to Shayne Mitchell, my wife, for reading the text as it developed and for many improvements to it. Any errors are of course my own.

Martin Aitken
April 2011

Contents

	Summary	4
1	Parents and wi-fi	5
2	The installation of wi-fi in [name of school]	6
3	Child security	7
4	dLAN—a better option than wi-fi	7
5	Convenience or health?	7
6	Wi-fi facts	8
7	Expert concerns about wi-fi	9
8	Action taken elsewhere in Europe	10
9	The research background to current concern	11
10	The importance of phone mast studies	12
11	Evidence that wi-fi can adversely affect health	13
11.1	Behavioural and functional degradation	13
11.2	Brain damage and possible premature senility	14
11.3	Cancer	15
12	The relevance of the evidence for schools	16
13	[Name of county] County Council policy	17
14	Q & A	18
15	Teachers' unions and wi-fi	19
16	What are other schools doing?	20
	Conclusion	21

Appendices

A	Why does the government not take the precautionary approach?	22
B	Why official guidelines on wi-fi are inadequate	23
C	Exposure levels	25
D	Research articles relevant to wi-fi	27
1	Health effects of living near a phone mast	
1.1	Behavioural and functional effects	27
1.2	Cancer induction	28
1.3	Physiological, cellular and sub-cellular effects	30
2	Health effects of using a mobile phone	
2.1	Effects on the brain and central nervous system	31
2.2	Cancer induction	33
2.3	Physiological, cellular and sub-cellular effects	34
3	Animal studies	
3.1	Effects on the brain and central nervous system	35
4	Electromagnetic Hypersensitivity (EHS)	38
5	Documents summarising the dangers of wi-fi /mobile phone technology	39
E	Books	41
F	Websites	41

Footnotes

42- 48

Summary

- The former chair of the government's Health Protection Agency, Sir William Stewart, has called for an urgent review of the potential health risks of wi-fi (wireless) computer systems in schools²
- [Name of school] uses wi-fi
- Wi-fi computer systems operate through the emission of microwaves at a similar frequency and modulation to mobile phone systems
- Scientists have found evidence of behavioural and functional disorders, indications of possible brain damage, and increased rates of cancer, from exposure to microwave radiation at levels found in wi-fi
- At the school, children are exposed to any potential effects of wi-fi for six hours a day, five days a week
- If experts are concerned about the health effects of wi-fi, the lay person must consider that it might pose a risk to health, especially that of children, who are likely to be more vulnerable to microwave radiation than adults
- Government advice that there is "no reason why schools and others should not use wi-fi equipment"³ does not take into account evidence for a wide range of adverse health effects not covered by international guidance
- The new school building was designed with a comprehensive, wired (i.e. *not* wi-fi) computer system
- The wi-fi was added some time after the new building was opened, but an alternative, dLAN, is available that is safer, more secure and functionally superior
- [Name of school] has a duty of care towards the children in its charge, the first priority of which should be their health
- The wi-fi installed in [name of school] should be switched off until it can be shown beyond reasonable doubt to be safe

1. Parents and wi-fi

Most parents would doubt that they have the expertise to judge whether a wi-fi system carries any health risks for their children, and would reasonably feel that they should leave that judgement to government.

At present, however, there are disagreements about wi-fi within the key government body, the Health Protection Agency.⁴ Moreover, **the former chair of the Health Protection Agency, Sir William Stewart, has expressed concern about the adverse health effects that wi-fi systems may have on children, and other experts share his concern.**⁵

In these circumstances, we as parents cannot be confident that the use of wi-fi in school is safe. The dispute among experts, and the nature of the concerns some express, mean that wi-fi could pose serious risks to our children's health.

We do not have to be experts ourselves to make that judgement—or to assert our responsibility for our children.

2. The installation of wi-fi in [name of school]

The new [name of school] building, opened in 2006, was designed with a computer system connected by wire to the internet. It did not have wi-fi. The school later installed wi-fi as part of its 'ICT vision'.⁶ It is not clear from the minutes of governors' meetings when this happened. There also appears to be no record in the minutes of any discussion of wi-fi before it was installed, or of a decision that it should be installed.

The governors did, however, consider wi-fi at their meeting of July 2007, after another parent and I had expressed concerns to one of them. The minutes of the meeting record that the Resources Committee had debated the concerns "at some length", and had referred the matter to the governors for a final decision.⁷ The governors decided to continue using wi-fi, noting "that the (minimal) [*sic*] risk of the school's system needed to be weighed against the educational benefits of the system."⁸

There is no published evidence that I know of that wi-fi has any educational benefits over a wired system.

More importantly, the governors' statement implies that they are prepared to take a risk with children's health for the sake of their education. This position was reflected by the Chair of Governors. In a letter to me he wrote, "we accept that probably no-one knows for certain what the long term effects on health from wi-fi may be."⁹

Most parents would question that order of priorities. **For most parents, the *health* of their children is paramount: education comes afterwards.**

Parents trust schools with the care of their children. Governors have a statutory duty to "take reasonable steps to make sure that the school buildings, equipment and materials are safe and do not put the health of persons at risk whilst they are on the premises."¹⁰

A policy that gives priority to health is one that takes a precautionary approach in face of possible risks to health. **This means deciding *not* to use equipment that might endanger the health of children.**

3 Child security

The new [name of school] building was deliberately designed with only a wired computer system because, according to the architect¹¹, a wired system is more secure than wi-fi. The information it contains on children (and any pictures of them) is safer from outsiders hacking in.¹² **The wi-fi system that has been added does not have the same level of security.**

4 dLAN—a better option than wi-fi

There is an alternative to wi-fi, in practical use, that does not suffer from its disadvantages: dLAN ('domestic local area networks'). dLAN systems make it possible to use the mains electric circuitry of a building to connect by wire to the internet or to other computers from any room that has an electric socket. **It is safer and more secure than wi-fi, faster and more reliable.**

5 Convenience or health?

The present wired (i.e. non-wi-fi) computer system at [name of school], installed with the new building, is state-of-the-art. If there are any benefits to education of adding specifically wi-fi computers—I know of none—they can only be marginal. One commentator remarks:

With dLAN systems¹³ and ordinary CAT5/6 wired networks offering better stability, bandwidth and security, there is simply no need for most homes, organisations and schools to switch to wireless networks, apart from the savings of the slight inconvenience in cables.¹⁴

The choice is not, then, between health and education, but between health and convenience. **Which is more important: a slight increase in convenience, or the health of our children?**

6 Wi-fi facts

A wi-fi enabled laptop can connect to the internet and/or to other computers by communicating through an antenna in the laptop itself with another antenna or node nearby. (The alternative is to connect through a cable). The classroom wi-fi antennae and the laptop wi-fi antennae all emit microwave radiation. **In the school, antennae are located in or near every classroom and operate continuously. The antenna in the laptop operates very close to the child using it.**

Both wi-fi and mobile phone systems work through the emission of microwaves, and they do so at a similar frequency and modulation. In other words, they share the same basic principle of operation. It is the microwave emissions that are the cause of concern. Little research has been done into their health effects with wi-fi. However, **there is a wealth of research into the health effects of microwave emission from mobile phone technology. Because of the common mode of operation, that research applies directly to wi-fi.**

Children are likely to be more vulnerable than adults to the effects of microwave radiation. Their skulls are thinner and their bodies, in particular their brains, nervous systems and reproductive organs, are still developing.¹⁵ It is for this reason that the authors of the Stewart Report (see below) advise that children under 16 years old should not use mobile phones.¹⁶ In France, it is now illegal for health reasons for students to use mobile phones in school, and the Minister of Health can forbid the distribution of radio-enabled equipment for children under six years old.^{17, 18}

Additionally, some people appear to be genetically sensitive to electromagnetic radiation, including wi-fi, and are made physically ill by it.¹⁹ Electromagnetic Hypersensitivity (EHS) is recognized by the World Health Organisation.²⁰ Figures given for its incidence vary. According to studies quoted by the government's Health Protection Agency, they range from 1.5% to 18.8% of those studied.²¹ These figures, applied to [name of school], would mean that between 7 and 88 children could suffer illness as a result of wi-fi.²²

The government's position is that wi-fi is safe if emissions come within international guidelines. However, **the international guidelines are widely thought to be inadequate.²³**

The international body that lays down the guidelines for microwave emission levels is ICNIRP, the International Commission for Non-Ionising Radiation Protection. Britain's Health Protection Agency (HPA) follows ICNIRP guidelines.

ICNIRP's guidelines are based only on the heating (thermal) and induced current or electric shock effects of microwaves.²⁴ **It has no guidelines for microwave emissions relating to non-thermal effects; for example, effects of a cellular, genetic or a functional kind.**

ICNIRP ignores such effects for guideline purposes because scientific understanding of the effects cannot yet meet the criteria ICNIRP has set for showing that they are caused by microwave radiation.²⁵ However, its criteria are so stringent that, had they been applied to smoking, asbestos, thalidomide, lead in petrol, etc., the health risks associated with them would not have been identified.²⁶

It is the non-thermal effects of microwave radiation that are the cause of concern. Researchers have repeatedly seen such effects in animals which, if replicated in humans, would be dangerous (see section 11 below).

7 Expert concerns about wi-fi

In 2000, the government-commissioned report on the health effects of mobile phone technology (the ‘Stewart Report’) recommended the precautionary approach.^{27, 28} In particular, it says that “the beam of greatest intensity [from a phone mast] should not fall on any part of the school grounds or buildings without agreement from the school and parents.”²⁹

According to a Panorama programme broadcast in 2007, **the use of wi-fi in schools is equivalent to having a mobile phone mast in school.**³⁰ The programme’s findings were upheld by the BBC’s Editorial Complaints Unit.³¹

The programme’s findings were also supported by eight members—half—of the Health Protection Agency’s Electromagnetic Fields Discussion Group.³² In a memorandum issued in December 2007, the group draws attention to Stewart’s precautionary approach as applied to schools (see above), and point out that “**the levels [of microwave emissions] inside classrooms from internal WiFi /wLAN³³ equipment will almost always significantly exceed the classroom levels from any nearby base station [phone mast].**”

This means that, without the agreement of parents, the use of wi-fi in schools violates the precautionary principle recommended by the Stewart report.

In calling for a review of the potential health risks linked to wi-fi in schools, Stewart cited findings which indicated changes in brain function, molecular biology changes and cancer.³⁴

In April 2007, Professor Lawrie Challis, then head of the government and industry-funded Mobile Telecommunications and Health Research Programme, called for the health of pupils in schools that have wi-fi to be monitored. He was concerned that few studies have been carried out into the level of exposure in classrooms. He said that **if health problems do emerge as a result of wi-fi they are likely to be more serious in children.**³⁵

In October 2007, the Health Protection Agency announced a programme of research into exposure levels. However, the eight members of the HPA’s EMF Discussion Group cited above point out that the HPA’s programme fails to address the issue of non-thermal health effects. It is these that are the cause of concern. The group calls for an investigation into such effects, particularly on children. **They point out that the signal levels in schools with wi-fi are between 2 and 40 times higher than levels already known to cause adverse symptoms.**³⁶

8 Action taken elsewhere in Europe

The German government has warned against using wi-fi.³⁷ **The warning applies to everyone, not only children.** In France, members of the Senate presented a bill in 2009 proposing that wired connections be obligatory in public buildings, and that wi-fi installations be replaced by wired networks.³⁸ The director of the French Health and Security Agency (Affset) has said that “the time for inaction (on wireless devices) is past”.³⁹ His remark followed **Affset’s publication of a report showing that radiofrequency radiation affects cellular functions.**⁴⁰ In Paris, the Bibliothèque nationale de France has foregone installation of a public wi-fi system on health grounds.⁴¹ **The city of Hérouville St. Clair is removing all wi-fi equipment from primary schools,** the mayor of the city saying, “our job is to protect people’s health”.^{42, 43}

In Austria, the Austrian Medical Association is pressing for a ban on wi-fi in schools. The Public Health Department of the Salzburg Region **has advised schools and kindergartens not to use wi-fi systems.**^{44, 45}

The European Parliament has said that it is greatly concerned by the Bio-Initiative Report on electromagnetic fields, issued by an international group of scientists and public health experts.⁴⁶ The Parliament has advised the 27 member states that they should introduce effective protection for the general public from electromagnetic fields. The Bio-Initiative Report states that “the consequence of long-term exposures in children ... is unknown at this time ... [and] could have serious implications for adult health and functioning in society.” It recommends “that **wired alternatives to wi-fi be implemented, particularly in schools and libraries.**”

9 The research background to current concern

It is sometimes said that there is no research evidence that microwaves have biological effects apart from heating (thermal) effects. There are, however, experts who point to a great deal of evidence.

Professor Henry Lai, a biologist at Washington University who has carried out studies on mobile phones, is reported saying, “I think it is irresponsible to just set standards using a thermal standard. If you set it just based on a thermal effect you are neglecting a large amount of data.”⁴⁷

Dr. Neil Cherry of Lincoln University, New Zealand, wrote in 1999, “**there is a wealth of laboratory evidence of cellular and animal changes at extremely low exposure levels to RF/MW [radiofrequency / microwave] radiation, accompanied by a massive body of epidemiological research which shows adverse health effects in human beings down to extremely low life-time mean exposure levels for chronic exposures.**”⁴⁸

Professor Olle Johansson, of the Karolinska Institute in Sweden, has expressed deep concern about the spread of wi-fi, saying that there are “thousands” of articles in the scientific literature showing “adverse health effects.” “Do we not know enough already to say, ‘Stop!’?” he asks.⁴⁹

10 The importance of phone mast studies

In understanding the possible health effects of wi-fi, research into the effects of living near a mobile phone mast is of special relevance. Phone masts emit microwave radiation at a similar frequency and modulation to wi-fi. Because they do so at a far higher strength than wi-fi, it is often thought that wi-fi radiation is insignificant and safe. The signals emitted by phone masts and wi-fi certainly do differ greatly in strength—but that is only part of the story.

When we compare the strength of wi-fi radiation and phone mast radiation, an important distinction needs to be made: between point of *emission* and point of *exposure* (i.e. where the person subject to the radiation is). At the point of emission, wi-fi signals are obviously much weaker than phone mast signals. However, we are concerned with the radiation a person is actually exposed to.

At the point of *exposure*, someone using a laptop with wi-fi is exposed to microwave radiation similar in strength to that of radiation from a phone mast 100 or 200 metres away. Often the exposure figures for wi-fi are even higher than those for phone masts.

This is because signal strength falls off in proportion to the square of the distance from the point of emission, i.e. very rapidly. Distance from a phone mast is generally measured in hundreds of metres. But from a wi-fi node (antenna) it is a matter of metres—and from the antenna in a laptop, centimetres. (The wi-fi node is for example fixed to the classroom wall, and the laptop is on a child's desk, a few centimetres from the child.) It is these huge differences in distance that, at the point of exposure, make the strength of wi-fi and phone mast signals comparable.

For example, the exposure levels measured in the Panorama programme referred to above were as follows:⁵⁰

100 metres from phone mast:	0.7 V/m (volts per metre, peak reading) ⁵¹
0.5 metres from laptop:	1.7 V/m (volts per metre, peak reading)

Studies of the health effects of microwave radiation from mobile phone masts are thus directly applicable in understanding the possible health effects of microwave radiation from wi-fi. We may note here that adverse health reactions have been reported at exposure levels down to 0.05 V/m.⁵² In Salzburg, the public exposure guideline is 0.02 V/m inside houses.⁵³ (Compare the exposure at 0.5 metres of someone using a laptop of 1.7 V/m.)

11 Evidence that wi-fi can adversely affect health

The evidence that wi-fi can adversely affect health is drawn from both epidemiological studies and studies of animals. Of the effects researchers have shown, the following are clearly extremely serious:

- behavioural and functional degradation
- brain damage and possible premature senility
- cancer induction

The evidence in each case relates to exposure levels equivalent to or below those of wi-fi.

11.1 Behavioural and functional degradation

The experts on the Health Protection Agency's Electromagnetic Fields Discussion Group, referred to above, say that **the most commonly reported adverse effects of microwave radiation are headaches, concentration difficulties, learning and memory problems, chronic fatigue, depression, and behavioural problems.** They point out that these symptoms are present in many ADHD children (Attention Deficit and Hyperactive Disorder), and that there has been a four-fold rise in children diagnosed with ADHD since 1997, when the widespread use of mobile phones and masts began. They suggest that microwave exposure from these sources may be a factor in this rise.⁵⁴

One study of residents living near or under a phone mast showed that **“the prevalence of neuropsychiatric complaints [such] as headache (23.5%), memory changes (28.2%), dizziness (18.8%), tremors (9.4%), depressive symptoms (21.7%), and sleep disturbance (23.5%) were significantly higher among exposed inhabitants than controls: (10%), (5%), (5%), (0%), (8.8%) and (10%), respectively.”** It also showed that “the exposed inhabitants exhibited a significantly lower performance than controls in one of the tests of attention and short-term auditory memory”.⁵⁵

Another study showed that “people living in the vicinity of base stations report various complaints mostly of the circulatory system, but also of sleep disturbances, irritability, depression, blurred vision, concentration difficulties, nausea, lack of appetite, headache and vertigo.”⁵⁶

Some commentators have suggested that many of these symptoms are subjective or psychosomatic: that they result, for example, from anxiety about living close to a phone mast. Significantly, however, the study referred to immediately above showed a dose-response relationship: “[a] relationship between the incidence of individual symptoms, the level of exposure, and the distance between a residential area and a base station.” Moreover,

“This association was observed in both groups of persons, those who linked their complaints with the presence of the base station and those who did not notice such a relation.”⁵⁷ (emphasis added)

Another study had similar results: irritability, depressive tendencies and a lowering of libido, up to 100 metres from a phone mast; headaches, sleep disturbances and a feeling of discomfort, up to 200 metres from a mast; and fatigue 200 to 300 metres from a mast.

It also found that the occurrence of **seven of the reported complaints was significantly higher for women, up to 300 metres from a mast.** The length of time spent living near a mast made no difference to the frequency of complaints.⁵⁸

A group of German doctors, writing of similar symptoms in their patients, point out that **many of the symptoms are “in no way subjective ... sudden deafness, hearing loss, loss of vision, increased blood pressure, hormonal disturbances, concentration impairments, and others can be proved using scientific objective measures.”**⁵⁹

They also emphasise that “[e]ven at 10 μ W/m² (only 0.06 V/m average) many people are becoming ill”.⁶⁰ **This is lower than typical exposure levels for wi-fi.**

11.2 Brain damage and possible premature senility

As mobile phones have only been in widespread use since 1997, and neurological diseases such as Alzheimer’s and Parkinson’s diseases are long-term in their development, there has been little epidemiological study of the links, if any, between these diseases and mobile phone use.

However, **Hallberg and Johansson have shown a correlation between the rise in the incidence of Alzheimer’s disease in Sweden and the use of mobile phones.**⁶¹ In the USA, ten years earlier, Sobel et al connected Alzheimer’s disease with occupational exposure to radiofrequency radiation.⁶²

The main body of evidence linking radiofrequency radiation and possible senility is biological.⁶³ Research shows that microwave radiation

(a) causes DNA breaks, and

(b) increases the permeability of the blood-brain barrier.

(a) Lai and Singh have shown that even very low level microwave radiation leads to DNA breaks in brain cells.⁶⁴ Radiofrequency radiation does not itself have the energy to cause the breaks, but it does create free radicals, and these are known to cause such damage.⁶⁵

Lai points out that, while the accumulation of DNA damage can cause cancer, beyond a certain level of damage, a cell will die. **Cumulative DNA damage in nerve cells of the brain is associated with Alzheimer’s, Huntington’s, and Parkinson’s diseases.**⁶⁶

(b) It has been known for more than two decades that electromagnetic radiation has the potential to alter the permeability of the blood-brain barrier.⁶⁷ Nittby et al discuss 14 studies showing the effect.⁶⁸ The danger of a break in the blood-brain barrier is that the brain ceases to be protected from compounds in the blood that are harmful to the nervous system.

Researchers in Sweden have run experiments subjecting rats to microwave radiation at an intensity equivalent to that received by a mobile phone user. They have found that **after two minutes the blood-brain barrier breaks down, allowing substances toxic to the central nervous system to cross over from the blood into the brain.**⁶⁹ Consequent neural damage has also been demonstrated.⁷⁰ The researchers warn that these results mean that mobile phone use amongst young people may lead to degenerative brain diseases in middle age.

Research findings have also shown repeatedly that *very low* emission energy levels cause *more* leakage across the blood brain barrier than higher levels.^{71, 72} Recent research has shown neurological damage at exposure levels of 0.12 mW/kg.⁷³ This is less than an eighth of the average exposure level of 1.00 mW/kg found 150–200 metres from a mobile phone mast.⁷⁴ The researchers conclude that “**the weakest fields are the biologically most harmful**”.^{75, 76}

This means that neurological damage has been seen at levels of exposure at, and lower than, those typical of wi-fi.

11.3 Cancer

There are many media articles on the internet linking cancer clusters with mobile phone masts.⁷⁷ A number of studies appear to confirm the link.

- In 2004 German doctors found that over a period of ten years patients who had lived within 400 metres of a phone mast had a significantly increased likelihood of developing cancer. Tumours appeared on average 8 years earlier than in the rest of the population.⁷⁸ **Breast cancer appeared on average nearly 20 years earlier. Over a period of 5 years, the cancer rate within the 400 metre radius was three times as high as outside it.**
- Cancer rates were also found to be markedly raised in a study of a community living near a phone mast in Israel.⁷⁹ **There were more than four times more cases of cancer within 350 metres of the mast than further away. Cancer rates for women were more than 10 times the rate for the whole town.**

The risk of cancer does not appear to be restricted to microwave radiation, but seems to attach to radiofrequency radiation generally. There have been several studies of cancer rates near radio and TV transmission masts. **Rates of adult and childhood leukaemia in particular have been found to be raised.**

Adult leukaemia was found in one study to have increased 1.83 times within 2 km of a TV mast in Sutton Coldfield.⁸⁰ Within 6 km of Vatican Radio, the rate of childhood leukaemia has been found to be raised 2.2 times.⁸¹ Korean researchers have shown childhood leukaemia to be 2.15 times more likely 2 km from an AM transmitter than 20 km from one.⁸² In Sydney, the rate of mortality from childhood lymphatic leukaemia (the most common type) near three TV towers is 2.74 times the rate further afield.^{83, 84}

Cherry refers to many other studies that have found similar effects, and other cancers, and emphasises that findings of a dose-response relationship—or the reduction in cancer rates with distance from a phone mast—indicate a biological explanation.⁸⁵ **The principal mechanism appears to be breaks in DNA and consequent chromosome damage that have been shown to result from radiofrequency exposure.** The accumulation of DNA damage can lead to cancer. Cherry details much of the research, and comments, “[m]ultiple independent studies, in 32 papers, show significant increases in chromosome aberrations from RF/MW [radiofrequency / microwave] exposure. Four studies show dose-response relationships. **This is more than adequate to classify RF/MW radiation as genotoxic.**”⁸⁶

12 The relevance of the evidence for schools

Epidemiological studies of the health effects of living near a phone mast are relevant to an understanding of the possible health effects of wi-fi in school because

- wi-fi also uses microwave radiation, and at a similar frequency and modulation
- the exposure levels from phone masts are equivalent to or lower than those for wi-fi
- **children are likely to be more vulnerable to microwave radiation than adults, and**
- **in children, any health effect has almost a lifetime to develop.**

The last point relates especially to cancer and brain or neurological damage.

The epidemiological evidence appears to be strongest in relation to cancer induction and behavioural and functional degradation. It is also notable that in both cases **researchers have found indications that women are more vulnerable to microwave radiation than men. This has especial relevance for a school staff that is made up largely of women.**

The likelihood that children are more vulnerable than adults to microwave radiation has particular relevance for women who are pregnant.

The biological evidence, which appears strongest in relation to cancer induction and brain damage, also applies at levels of exposure equivalent to that of wi-fi.

The above account of the possible health effects of microwave exposure is not comprehensive. But it seems to me more than enough to stress the seriousness of a decision on whether to use wi-fi.

13 [Name of county] County Council policy

Following the Panorama programme on wi-fi in schools, [name of county] Education ICT Service circulated schools with the following advice from the government Health Protection Agency:

“On the basis of current scientific information WiFi equipment satisfies international guidelines. There is no consistent evidence of health effects from RF [radiofrequency, including microwave] exposures below guideline levels and therefore no reason why schools and others should not use WiFi equipment.”

The international guidelines apply to thermal effects. There are *no* guidelines for non-thermal effects, which are the focus of concern.

If the phrase “no consistent evidence” means that there is no evidence of health effects, the claim is untrue. The evidence is extensive and detailed. If the phrase means that there is evidence—as it implies—the appropriate conclusion is that advised by Stewart and his colleagues: that the precautionary approach should be taken. **This means treating wi-fi as *not* currently being safe for schools to use.**

14 Q & A

1 We have wi-fi at home. How can I ask the school to switch off its wi-fi?

(a) At home, you can switch your wi-fi off when children are there. At school, the wi-fi system is on all the time and children cannot escape any effects it may have.

(b) Some parents may not know that it is possible to connect to the internet by wire, and would do so if they did.

(c) Many parents may not know that dLAN systems give landline access to the internet anywhere in the house that there is an electric socket.⁸⁷

(d) Many children at school come from homes that do not have wi-fi.

(e) The school has a duty of care towards children irrespective of what happens at home.

2 There are devices in domestic use with a signal strength greater than that of wi-fi: e.g. mobile phones, cordless phones, baby monitors, etc. Is it not inconsistent to call for a ban on wi-fi in school when we use these things?

(a) There is evidence that lower levels of exposure pose a risk equal to or greater than risk found at higher levels (see above).

(b) Such devices may not be used continuously. The wi-fi at school is on all the time and the children are subjected to it constantly.

(c) The school has no control over the use of domestic devices, but it does have control over the use of wi-fi in school.

(d) Unless parents choose home schooling, they have by law to send their children to school for much of the day. **They have a right to expect their school to aim for the highest standards of safety.**

3 Do we not have to take natural background microwave radiation into account when looking at the effects of microwave radiation on health?

There is virtually no natural background microwave radiation. At its levels of emission, and in its pervasiveness, mobile phone technology has introduced a completely new environmental hazard, against which humanity has had no cause to develop natural protection. One scientist has described it as **“the largest human biological experiment ever.”**⁸⁸

4. Does the evidence of adverse health effects described above not also relate to the large phone mast next to [Name] Community College, overlooking [name of school]’s playing field? And if it does, isn’t that more worrying than the wi-fi?

The evidence does indeed apply to the phone mast. Every time children are in the playground they are exposed to its emissions, as they are to a lesser extent inside the school building, especially if their classroom windows face the mast. However, any attempt to get the mast switched off or removed is likely to take time. The wi-fi carries at least as much risk when children are inside, the children are inside a great deal more than they are outside— and the school can switch off the wi-fi now.

15 Teachers' unions and wi-fi

The General Secretary of Voice (formerly the Professional Association of Teachers), Philip Parkin, has said, “the proliferation of wireless networks could be having serious implications for the health of some staff and pupils without the cause being recognised.”⁸⁹ The union advocates that new wi-fi systems should not be installed in schools, that existing systems should be turned off when not required and that **schools should consider whether they really need to use wi-fi.**⁹⁰

The Association of Teachers and Lecturers (ATL), has expressed concern at the widespread use of wi-fi in schools, and that Stewart’s precautionary approach has not been taken. The union has called for the government to investigate the biological effects of wi-fi, asserting its belief that **the welfare and safety of children and education professionals are paramount.**⁹¹ Mark Langhammer, Director of ATL Northern Ireland, has said that, “a safety-first approach ... could allow for parents to withdraw their children from wi-fi areas of the school.”⁹² The union calls for parents to be informed if a school has installed wi-fi and for them to have some input into decisions about wi-fi.⁹³

16 What are other schools doing?

Schools—state as well as private—decide their own policy on the use or not of wi-fi. Some have decided to stop using it.

- The Prebendal School in Chichester has removed its wi-fi network. The head said: “**We listened to the parents’ views. We also did a lot of research. The authorities say it’s safe, but there have been no long-term studies to prove this.**”⁹⁴
- Ballinderry Primary School in Lisburn, Northern Ireland, disconnected its wi-fi after considering the health concerns expressed by a parent. The principal said: “I wondered if the advantages of wi-fi outweighed the risks to the children and staff. **I looked at evidence from both sides and have decided not to use this new technology in our school at present.**”⁹⁵
- Ysgol Pantycelyn, a comprehensive in Carmarthenshire, has switched off its wi-fi network after parents expressed their concerns. The head teacher said, “**the concerns of the parents were of greater importance than our need to have a wireless network.**”⁹⁶
- Stowe School, the Buckinghamshire public school, removed part of its wi-fi network after a teacher became ill. **His reaction to the network was so strong he could not teach.**⁹⁷

A report prepared for Stowe School contains the following paragraph:

The consequence of such a precautionary approach is that **wi-fi is inappropriate for infant, primary and most secondary schools or colleges.** Use and exposure in secondary schools could depend on pupil age but, to avoid known health risks, a wired solution is highly preferable. **Where pupils are under 18, schools and parents should see their duty of care as protecting children from avoidable radiation.**⁹⁸

Conclusion

- The health of our children is paramount
- The former chair of the government's Health Protection Agency has called for an urgent review of potential health risks of wi-fi in school
- Government advice that wi-fi is safe fails to take into account substantial evidence that wi-fi may have adverse health effects
- Schools have a duty of care towards children
- [Name of school] should take the precautionary approach, and not use wi-fi until it has been shown beyond reasonable doubt to be safe

WiFi Concern

Appendices and references

Appendix A

Why does the government not take the precautionary approach?

If there is so much evidence of adverse health effects from microwave-based communications technology, it is on the face of it puzzling that the government and the local authority do not take the precautionary approach advised by the Stewart Report.

From my reading it appears that the *evidence* for adverse health effects is scientifically accepted; i.e. the methods, equipment and materials used, and the results, are not in dispute. The problem in some cases is that while some research studies have shown that there are health effects, others have not.⁹⁹

If this view is correct, the problem is not the evidence, but how to *explain* the evidence. This is a matter of theory, of how to describe what is going on. Any theory would have show why adverse health effects are sometimes observed, and why at other times, they are not.¹⁰⁰

The absence of evidence for adverse health effects in some cases cannot then be said to disconfirm its presence in others, and vice versa.

Given scientific consensus over the evidence, but uncertainty over the theory, any attempt to prioritise *either* evidence for adverse health effects, *or* evidence of none, is bound to arise from reasons outside science, relating in particular to health, politics or commerce. As parents, we inevitably give priority to the evidence *for* such effects: our paramount concern is the health of our children. If there is evidence for adverse health effects, that is what counts.

Government and industry however have huge financial interests in disregarding that evidence, emphasising research in which no evidence for health effects is found.¹⁰¹ While this does not mean that government and industry do not recognise the possibility of such effects, it does perhaps help to explain their lack of action. Some people have likened the telecoms industry in this respect to the tobacco industry.¹⁰²

The present scientific uncertainty does not then mean that the evidence for adverse health effects may be mistaken or that it can be disregarded. It means only that scientists have not come to an agreement on how to understand it. In view of the political and commercial interests in turning a blind eye to the health issue, parents *themselves* have to decide whether the precautionary principle should be applied for their children.

Appendix B

Why official guidelines on wi-fi are inadequate

As we have seen, the Health Protection Agency (HPA) follows ICNIRP guidelines on the safety of wi-fi, and ICNIRP's main concern in establishing guidelines is to maintain a stringent level of proof in relation to cause and effect. As a way of ensuring safety, this approach is seriously misguided.

In ICNIRP's view, research results must be:

- peer-reviewed
- replicated by separate research groups
- consistently find the same effects at approximately the same magnitude
- show a clear mechanistic cause and effect.¹⁰³

As an account of scientific method, these criteria are unexceptionable.

Many studies of the health effects of microwave exposure satisfy the first three criteria, and this applies in the three categories considered above: behavioural / functional degradation, neurological damage and cancer. Some studies suggest plausible mechanisms.¹⁰⁴ But the mechanisms have not been established, meaning that the fourth criterion is not satisfied.

The fourth criterion refers to theory, the description of what is going on, discussed in Appendix A above. For this criterion to be satisfied, ICNIRP requires the demonstration of four separate scientific stages: physical, chemical, biological, and the connection of the interactions in each case with health effects.

This requirement ensures that the level of proof of a causal relationship will be 95% certain or more. If the requirement is not met—and so far it has not been met—ICNIRP will not take evidence of adverse health effects into account in determining guidelines for microwave exposure.

But this is not how we normally make judgements of safety. We look at *two* questions, not one:

- the likelihood that harm or damage will occur, and
- *the gravity of the harm or damage, if it does occur.*

ICNIRP addresses itself to the first question, but not the second. It concerns itself only with the science. But if we are concerned about *safety*, *both* questions are important, and we treat them as linked.

If the harm or damage would be great if it happened, we do not look for 95% certainty that it will happen before we take precautions against it. A much lower level of proof is enough for us to be concerned: perhaps 20%, or 10% or even lower.

In other words, if we know something grave may occur, we take the precautionary approach, even if we don't know how likely it is to occur.

Moreover, in taking precautions, we are not concerned principally with theory, but with experience. If I see that a tree is about to topple onto me, I do not think to myself, “I don’t understand how gravitational fields work, so there is nothing to worry about.” I don’t even think about gravity. I act on what experience shows me gravity could do. *I act because the cost to me of action if it turns out not to have been required is negligible compared to the cost of inaction if it is shown afterwards to have been necessary.*

In judgements of safety, questions about theory—or ‘mechanism’—are a red herring. What matters is the evidence of effects.

On the basis of evidence to date, the harm done by exposure to microwave radiation could be very grave, and the likelihood of its occurring has been shown repeatedly to be high enough to give reason for concern and action.

The level of proof ICNIRP requires is inappropriate, and the HPA is mistaken in following ICNIRP’s guidance.

Appendix C

Exposure levels

[An extract from *Wi-fi in the classroom: health advice to schools*, a report prepared by Michael Bevington of Stowe School:

<http://www.scribd.com/doc/24004604/Wi-Fi-in-the-Classroom-Health-Advice-to-Schools>]

Health studies

Health studies on specifically wi-fi radiation have not yet been made, but the pulsed microwaves used are similar to those for mobile phones and seem to have similar health effects to other forms of EMR [electromagnetic radiation]. These have been studied for the general population but not often specifically as regards children. The Schwarzenburg study (1995) showed among the general population health problems with concentration, fatigue, sleep, depression and cardiovascular conditions, all typical symptoms of sensitivity to EMR, at EMR exposures down to 0.05 V/m [volts per metre]. The Oberfranken study (2005) showed typical sensitivity symptoms in 30% of people at under 0.06 V/m, and 95% in the range 0.2 – 0.6 V/m. The Naila study (2004) showed that cancer rates are trebled within 400 metres of a mobile phone mast at 0.6 V/m in a dose-response relationship after 5 years' exposure, and the Netanya study (2004) showed female cancers increased ten times within 350 metres of a mast.

Radiation intensity

A laptop (100 or 200 mW WLAN cards) can emit radiation with electric fields of 4.0 - 6.0 V/m at its transmitter, 1.1 - 4.9 V/m at 50 cm, a typical sitting distance, and 0.7 - 2.8 V/m at 1 m. In a classroom with 30 laptops transmitting, the electric field could be greater. In comparison, mobile phones can reduce their emissions during a call down to about 0.0002 V/m. Even so, some studies suggest that mobile phone use can determine the side of the head in which tumours can appear after 10 years.

Sensitivity

Much of the damage from low levels of EMR to human cell tissue appears to be cumulative and thus the symptoms may not be felt for many years. A child's cell tissues in the head are said to absorb 60% more radiation from a mobile phone than an adult's. Wi-fi radiation affects the whole body surface and not just the head. Since the development of digital transmissions, the number of people becoming sensitised to EMR has grown rapidly. Although it is likely that all human beings are subconsciously sensitive, in that the existing electrical fields within their cell tissues are influenced by external fields, most humans are not yet aware of how the typical sensitivity symptoms relate to exposure from EMR. In Sweden about 3.1% of the population may suffer from Electro-Hyper-Sensitivity.

Guidelines

1 Thermal (heating)

UK government guidelines on limits (41 V/m at 2.4 GHz) are only to avoid heating human tissue more than 1 degree, based on the Specific Energy Absorption Rate (SAR).

2 Non- thermal (below heating levels)

Salzburg sets the non-thermal indoor limit at 0.02 V/m (peak pulse). This is to help protect people from non-thermal or bioelectromagnetic effects of EMR, such as DNA damage, cancer growth, and fertility and neurological problems. Salzburg's Public Health Department warns against wireless systems and DECT phones in schools and nurseries. The UK does not have any non-thermal guidelines.

3 Peak pulse measurements

Many scientists think the peak level of the radiation pulses is particularly dangerous. For wLAN (wi-fi), the difference between the base and peak levels is 1,000 times (DECT phones: 100 times) of the power flux density. Therefore measuring the average level or the root mean square (RMS) is inadequate.

4 Measurements at a Norwich school on a Panorama programme (BBC1, 21.5.07)

- (a) 100 m from the phone mast: peak readings of 0.7 V/m
- (b) 50 cm from the laptop: peak readings of 1.7 V/m

References

Schwarzenburg study, Switzerland: Abelin, T. et al., 'Study of health effects of the Shortwave Transmitter Station of Schwarzenburg, Berne, Switzerland,' University of Berne, Institute for Social and Preventative Medicine, *Bundesamt für Energiewirtschaft Schriftenreihe Studie*, 56, 1995.

Oberfranken study, Germany: Bamberg doctors' Report and Appeal, based on records of 357 patients, 2005.

Naïla study, Germany: Eger, H. et al., 'The Influence of Being Physically Near to a Cell Phone Transmission Mast on the Incidence of Cancer,' *Umwelt-Medizin-Gesellschaft*, 17.4, 2004.

Netanya study, Israel: Wolf, D. & Wolf, D., 'Increased Incidence of Cancer near a Cell-Phone Transmitter Station,' *International Journal of Cancer Prevention*, 1(2), April 2004.

Some other studies:

La Ñora, Mercia, Spain: Navarro, E. A., et al., 'The microwave syndrome: a preliminary study in Spain,' *Electromagnetic Biology & Medicine*, 22 (2 & 3), 2003, 161-169;

Oberfeld, G., et al., 'The microwave syndrome—Further Aspects of a Spanish Study,' *International Conference Proceedings*, Greece, 2004.

French study: Santini, 'Study of the health of people living in the vicinity of mobile phone base stations,' *Pathologie Biologie* (Paris), 50 (2002), 369-373.

Skrunda study, Latvia: Kolodynski, A. & Kolodynska, V., 'Motor and psychological functions of school children living in the area of the Skrunda Radio Location Station in Latvia,' *The Science of the Total Environment*, 180, 88-93, Elsevier, 1996.

Appendix D

Research articles relevant to wi-fi

Listed below are just some of the articles published on the health effects of microwave exposure, but they indicate something of the range of the effects scientists have found. The list includes research references in the text. Articles are arranged in reverse date order for each section. Some are listed under their main finding but could come under more than one heading.

1 Health effects of living near a phone mast

1.1 Behavioural and functional effects

Khurana, VG et al (2010), *Epidemiological evidence for a health risk from mobile phone base stations*, Int J Occup Environ Health, 2010 Jul-Sep;16(3):263-7

“Human populations are increasingly exposed to microwave/radiofrequency (RF) emissions from wireless communication technology, including mobile phones and their base stations. By searching PubMed, we identified a total of 10 epidemiological studies that assessed for putative health effects of mobile phone base stations. Seven of these studies explored the association between base station proximity and neurobehavioral effects and three investigated cancer. We found that eight of the 10 studies reported increased prevalence of adverse neurobehavioral symptoms or cancer in populations living at distances < 500 meters from base stations. None of the studies reported exposure above accepted international guidelines, suggesting that current guidelines may be inadequate in protecting the health of human populations. We believe that comprehensive epidemiological studies of long-term mobile phone base station exposure are urgently required to more definitively understand its health impact.”

<http://www.ncbi.nlm.nih.gov/pubmed/20662418>

Thomas S, et al (2010), *Exposure to radio-frequency electromagnetic fields and behavioural problems in Bavarian children and adolescents*, Eur J Epidemiol 2010 Feb;25(2):135-4

“We aimed to investigate a possible association between measured exposure to RF EMF fields and behavioural problems in children and adolescents. 1,498 children and 1,524 adolescents were randomly selected from the population registries of four Bavarian (South of Germany) cities ... Seven percent of the children and 5% of the adolescents showed an abnormal mental behaviour ... [T]he results showed an association between exposure and conduct problems for adolescents ... and children.”

<http://www.ncbi.nlm.nih.gov/pubmed/19960235>

Abdel-Rassoul G, El-Fateh OA, et al, (March 2007) *Neurobehavioral effects among inhabitants around mobile phone base stations*. Neurotoxicology. 28(2):434-40

“Inhabitants living nearby mobile phone base stations are at risk for developing neuropsychiatric problems and some changes in the performance of neurobehavioral functions either by facilitation or inhibition.”

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=16962663

Oberfeld G, Navarro A E, et al, (August 2004). *The Microwave Syndrome—Further aspects of a Spanish Study*. Conference Proceedings

“Researchers from Valencia University in Spain, investigated people’s health in a small town near Murcia, where two mobile phone masts had been erected in the past 7 years. The results of the investigations have been plotted against levels of radiation in their homes from the masts, to see if there is any link between the radiation levels and health problems. Many symptoms of ‘microwave sickness’ increased considerably with exposure to microwave radiation, in particular Depression, Fatigue,

Concentration Loss, Appetite Loss and Heart and Blood Pressure Problems. These occurred at radiation levels found around most masts.”

http://www.powerwatch.org.uk/news/20040809_spain.asp

Bortkiewicz A et al (2004) *Subjective symptoms reported by people living in the vicinity of cellular phone base stations*: review Med Pr 55(4):345-51

“[P]eople living in the vicinity of base stations report various complaints mostly of the circulatory system, but also of sleep disturbances, irritability, depression, blurred vision, concentration difficulties, nausea, lack of appetite, headache and vertigo. The performed studies showed the relationship between the incidence of individual symptoms, the level of exposure, and the distance between a residential area and a base station.”

<http://www.ncbi.nlm.nih.gov/sites/entrez?Db=pubmed&Cmd=ShowDetailView&TermToSearch=15620045>

Santini R, Santini P, et al, (2003) *Survey Study of people living in vicinity of cellular phone base stations*, Biol. Med., 1:41-49

“The complaints nausea, loss of appetite, and visual disturbances were experienced only in the immediate vicinity of cellular phone base stations (up to 10 m). Irritability, depressive tendencies and lowering of libido were experienced up to 100 m whereas headaches, sleep disturbances and feeling of discomfort were noticed in the distance up to 200 m to base stations. Only the complaint of fatigue was experienced in vicinity of 200 to 300 m to base stations. The occurrence of complaints was for seven of the reported symptoms and for the distance up to 300 m significantly higher for women compared to men.”

<http://www.emf-portal.de/viewer.php?sid=b9fdffbdf6a0be2a3607c535890955c6&sform=1&aid=10062&l=e>

Santini R, Santini P, et al, (July 2002). *Investigation on the health of people living near mobile telephone relay stations: I/Incidence according to distance and sex*. Pathol Biol (Paris). 50(6):369-373

“This first study on symptoms experienced by people living in vicinity of base stations shows that, in view of radioprotection, minimal distance of people from cellular phone base stations should not be < 300 m.”

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=12168254

1.2 Cancer induction

Ha M, et al (2007), *Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer*, Am J Epidemiol 2007 Aug 1;166(3):270-9. Epub 2007 Jun 7

“The odds ratio for all types of leukemia was 2.15 (95% confidence interval (CI): 1.00, 4.67) among children who resided within 2 km of the nearest AM radio transmitter as compared with those resided more than 20 km from it. For total RFR exposure from all transmitters, odds ratios for lymphocytic leukemia were 1.39 (95% CI: 1.04, 1.86) and 1.59 (95% CI: 1.19, 2.11) for children in the second and third quartiles, respectively, versus the lowest quartile. Brain cancer and infantile cancer were not associated with AM RFR.”

<http://www.ncbi.nlm.nih.gov/pubmed/17556764>

Hallberg Ö (2006). *A theory and model to explain the skin melanoma epidemic*. Melanoma Research, 2006; 16; 115-118

“The aims of this study were to examine this sudden change in melanoma trends and to develop an explanatory model ... The proposed model may shed light on the melanoma epidemic and may be useful in predicting future melanoma trends based on known birth cohort data and possible effects from policy changes with regard to population exposure to electromagnetic radiation.”

<http://www.melanomaresearch.com/pt/re/melres/abstract.00008390-200604000-00003.htm;jsessionid=JCPfJ15bGKGjyBJ4Q512hwVTTVNYn9xy71frp0MJpvfjdrVlgQw!-348297060!181195629!8091!-1>

Eger H et al (2004) *The influence of being physically near to a cell phone transmission mast on the incidence of Cancer* Umwelt Medizin Gesellschaft 17.4.2004

“The result of the study shows that the proportion of newly developing cancer cases was significantly higher among those patients who had lived during the past ten years at a distance of up to 400 metres from the cellular transmitter site, which has been in operation since 1993, compared to those patients living further away, and that the patients fell ill [developed tumours] on average 8 years earlier.”

<http://www.vws.org/documents/NailaMastscancerstudy.pdf>

Park SK, et al (2004), *Ecological study on residences in the vicinity of AM radio broadcasting towers and cancer death: preliminary observations in Korea*, Int Arch Occup Environ Health 2004 Aug; 77(6):387-94. Epub 2004 Jul 31

“All cancers-mortality was significantly higher in the exposed areas [near the AM radio broadcasting towers] ... Leukemia mortality was higher in exposed areas (MRR [mortality rate ratio] = 1.70 ...), especially among young adults aged under 30 years (0-14 years age group, MRR = 2.29...; 15-29 age group, MRR = 2.44, ...).”

<http://www.ncbi.nlm.nih.gov/pubmed/15338224>

Wolf R & Wolf D (2004), *Increased incidence of cancer near a cell-phone transmitter station*, Int J of Cancer Prevention 1(2)

“In the area of exposure (area A) [within 350 metres of the phone mast] eight cases of different kinds of cancer were diagnosed in a period of only one year ... Relative cancer rates for females were 10.5 for area A, 0.6 for area B and 1 for the whole town of Netanya ... A comparison of the relative risk revealed that there were 4.15 times more cases [of cancer] in area A than in the entire population. The enormous[ly] short latency period, less than 2 years, indicates that if there is a real causal association between RF radiation emitted from the cell-phone base station and the cancer cases (which we strongly believe there is), then the RF radiation should have a very strong promoting effect on cancer at very low radiation.”

http://www.powerwatch.org.uk/news/20050207_israel.pdf

Hallberg Ö, Johansson O (2002), *Cancerdödlighet och långtidssjukskrivning (Cancer mortality and long-term sick leave)*, Tidskriften Medikament 2002; 7: 40-41

“In 1997 the mortality starts to increase clearly again, ... It is interesting to note that the radio and TV broadcasting net changes exactly these years.”

<http://home.swipnet.se/~w-78067/leave.PDF>

Paola Michelozzi et al (2002), *Adult and Childhood Leukemia near a High-Power Radio Station in Rome, Italy*, American Journal of Epidemiology Vol. 155, No. 12 : 1096-1103

“The risk of childhood leukemia was higher than expected for the distance up to 6 km from the radio station (standardized incidence rate = 2.2, 95% confidence interval: 1.0, 4.1), and there was a significant decline in risk with increasing distance both for male mortality (p = 0.03) and for childhood leukemia (p = 0.036)”

<http://aje.oxfordjournals.org/cgi/content/full/155/12/1096>

Neil Cherry (2000), *Health effects associated with mobile base stations in communities: the need for health studies*, Lincoln University, Environmental Management and Design Division, Canterbury, New Zealand

“Public health surveys of people living in the vicinity of cell site base stations should be being carried out now, and continue progressively over the next two decades. This is because prompt effects such as miscarriage, cardiac disruption, sleep disturbance and chronic fatigue could well be early indicators of the adverse health effects. Symptoms of reduced immune system competence, cardiac problems, especially of the arrhythmic type and cancers, especially brain tumour and leukaemia are probable. However, since cell phone radiation has already been shown to reduce melatonin, damage DNA and chromosomes, surveys should look for a very wide range health effects and not be limited to a narrow set.”

http://mapcruzin.mobi/radiofrequency/cherry/neil_cherry1.htm

Helen Dolk et al (1997), *Cancer Incidence near Radio and Television Transmitters in Great Britain I. Sutton Coldfield Transmitter*, American Journal of Epidemiology Vol. 145, No. 1: 1-9

“The risk of adult leukemia within 2 km was 1.83 (95% confidence interval 1.22–2.74), and there was a significant decline in risk with distance from the transmitter ($p = 0.001$) ... In the context of variability of leukemia risk across census wards in the West Midlands as a whole, the Sutton Coldfield findings were unusual.”

<http://aje.oxfordjournals.org/cgi/content/abstract/145/1/1>

Lai, H. and Singh, N.P. (1996): *Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation*. Int. J. Radiation Biology, 69 (4): 513-521.

“An increase in both types of DNA strand breaks was observed after exposure to either the pulsed or continuous-wave radiation ... We speculate that these effects could result from a direct effect of radiofrequency electromagnetic energy on DNA molecules and/or impairment of DNA-damage repair mechanisms in brain cells. Our data further support the results of earlier in vitro and in vivo studies showing effects of radiofrequency electromagnetic radiation on DNA.”

<http://www.ingentaconnect.com/content/apl/trab/1996/00000069/00000004/art00012?crawler=true>

Bruce Hocking et al (1996), *Cancer incidence and mortality and proximity to TV towers*, Medical Journal of Australia, 1996; 165: 601

“We found an association between increased childhood leukaemia incidence and mortality and proximity to TV towers.”

<http://www.mja.com.au/public/issues/dec2/hocking/hocking.html>

1.3 Physiological, cellular and sub-cellular effects

Falzone, N et al (2011), *The effect of pulsed 900-MHz GSM mobile phone radiation on the acrosome reaction, head morphometry and zona binding of human spermatozoa*, Int J Androl 2011 Feb;34(1):20-6

“Several recent studies have indicated that radiofrequency electromagnetic fields (RF-EMF) have an adverse effect on human sperm quality, which could translate into an effect on fertilization potential. This study evaluated the effect of RF-EMF on sperm-specific characteristics to assess the fertilizing competence of sperm ... [It] concludes that although RF-EMF exposure did not adversely affect the acrosome reaction, it had a significant effect on sperm morphometry. In addition, a significant decrease in sperm binding to the hemizona was observed. These results could indicate a significant effect of RF-EMF on sperm fertilization potential.”

<http://www.ncbi.nlm.nih.gov/pubmed/20236367>

Baste V et al (April 2008), *Radiofrequency electromagnetic fields; male infertility and sex ratio of offspring*, Eur J Epidemiol. 2008 Apr 16

“[A] cross-sectional study among military men employed in the Royal Norwegian Navy, [who work] close to equipment emitting radiofrequency electromagnetic fields ... In all age groups there were significant linear trends with higher prevalence of involuntary childlessness with higher self-reported exposure to radiofrequency fields ... For self-reported exposure both to high-frequency aerials and communication equipment there were significant linear trends with lower ratio of boys to girls at birth.”

<http://www.ncbi.nlm.nih.gov/pubmed/18415687>

Yurekli AI (2006), *GSM base station electromagnetic radiation and oxidative stress in rats*, Electromagn Biol Med 25(3):177-88

“When EM fields at a power density of 3.67 W/m² (specific absorption rate = 11.3 mW/kg), which is well below current exposure limits, were applied, MDA (malondialdehyde) level was found to increase and GSH (reduced glutathione) concentration was found to decrease significantly ($p < 0.0001$). Additionally, there was a less significant ($p = 0.0190$) increase in SOD (superoxide dismutase) activity under EM exposure.”

http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=16954120

Balmori A (2005), *Possible Effects of Electromagnetic Fields from Phone Masts on a Population of White Stork*, *Electromagnetic Biology and Medicine*, 24:109–119

“Monitoring of a white stork population in Valladolid (Spain) in the vicinity of Cellular Phone Base Stations was carried out, with the objective of detecting possible effects. The total productivity, in the nests located within 200 meters of antennae, was 0.86 ± 0.16 . For those located further than 300 m, the result was practically doubled, with an average of 1.6 ± 0.14 ... Twelve nests (40%) located within than 200 m of antennae never had chicks, while only one (3.3%) located further than 300 m had no chicks.”

http://www.livingplanet.be/Balmori_EBM_2005.pdf

2. Health effects of using a mobile phone

2.1 Effects on the brain and central nervous system

Aalto S, Haarala C, et al (July 2006), *Mobile phone affects cerebral blood flow in humans*. *J Cereb Blood Flow Metab.* 26(7):885-90

“Our results provide the first evidence, suggesting that the EMF emitted by a commercial mobile phone affects rCBF [regional cerebral blood flow] in humans. These results are consistent with the postulation that EMF induces changes in neuronal activity.”

<http://www.ncbi.nlm.nih.gov/pubmed/16495939?dopt=Abstract>

Esen F, Esen H (March 2006), *Effect of electromagnetic fields emitted by cellular phones on the latency of evoked electrodermal activity*. *Int J Neurosci.* 116(3):321-9

“[T]he findings point to the potential risks of mobile phones on the function of CNS and consequently, possible increase in the risk of phone-related driving hazards.”

<http://www.ncbi.nlm.nih.gov/pubmed/16484058?dopt=Abstract>

Hallberg Ö, Johansson O. (2005), *Alzheimer mortality—why does it increase so fast in sparsely populated areas?* *European Biology and Bioelectromagnetics.* 2005; 1: 225-246.

“The mortality in Alzheimer’s disease appears to be associated with mobile phone output power. The mortality is increasing fast and is expected to increase substantially within the next 10 years.”

<http://www.scribd.com/doc/24980389/Alzheimer-Mortality---Why-Does-It-Increase>

Huber R, Treyer V, et al, (Feb 2005), *Exposure to pulse-modulated radio frequency electromagnetic fields affects regional cerebral blood flow*. *Eur J Neurosci.* 21(4):1000-6

“We investigated the effects of radio frequency electromagnetic fields (RF EMF) similar to those emitted by mobile phones on waking regional cerebral blood flow (rCBF) in 12 healthy young men ... We observed an increase in relative rCBF in the dorsolateral prefrontal cortex on the side of exposure ... This finding supports our previous observation that pulse modulation of RF EMF is necessary to induce changes in the waking and sleep EEG, and substantiates the notion that pulse modulation is crucial for RF EMF-induced alterations in brain physiology.”

<http://www.ncbi.nlm.nih.gov/pubmed/15787706?dopt=Abstract>

Kramarenko AV, Tan U (July 2003), *Effects of high-frequency electromagnetic fields on human EEG: a brain mapping study*. *Int J Neurosci.* 113(7):1007-19

“Cell phones emitting pulsed high-frequency electromagnetic fields (EMF) may affect the human brain, but there are inconsistent results concerning their effects on electroencephalogram (EEG) ... The results [of our study] suggested that cellular phones may reversibly influence the human brain, inducing abnormal slow waves in EEG of awake persons. [I]n children, ... the slow-waves with higher amplitude appeared earlier in children (10-20 s) than adults, and their frequency was lower (1.0-2.5 Hz) with longer duration and shorter intervals. ”

<http://www.ncbi.nlm.nih.gov/pubmed/12881192?dopt=Abstract>

Huber R, Schuderer J, et al (May 2003), *Radio frequency electromagnetic field exposure in humans: Estimation of SAR distribution in the brain, effects on sleep and heart rate*. *Bioelectromagnetics*, 24(4):262-76

“In two previous studies we demonstrated that radiofrequency electromagnetic fields (RF EMF) similar to those emitted by digital radiotelephone handsets affect brain physiology of healthy young subjects exposed to RF EMF ... either during sleep or during the waking period preceding sleep ... Here we report an extended analysis of the two studies.”

<http://www.ncbi.nlm.nih.gov/pubmed/12696086?dopt=Abstract>

Krause CM, Sillanmäki L, et al (December 2000), *Effects of electromagnetic fields emitted by cellular phones on the electroencephalogram during a visual working memory task*. *Int J Radiat Biol*. 76(12):1659-67

“The results suggest that the exposure to EMF modulates the responses of EEG oscillatory activity approximately 8 Hz specifically during cognitive processes.”

<http://www.ncbi.nlm.nih.gov/pubmed/11133048?dopt=Abstract>

Huber R, Graf T, et al (October 2000), *Exposure to pulsed high-frequency electromagnetic field during waking affects human sleep EEG*. *Neuroreport*. 11(15):3321-5

“The aim of the study was to investigate whether the electromagnetic field (EMF) emitted by digital radiotelephone handsets affects brain physiology ... The present results demonstrate that exposure during waking modifies the EEG during subsequent sleep. Thus the changes of brain function induced by pulsed high-frequency EMF outlast the exposure period.”

<http://www.ncbi.nlm.nih.gov/pubmed/11059895?dopt=Abstract>

Krause CM, Sillanmäki L, et al (March 2000), *Effects of electromagnetic field emitted by cellular phones on the EEG during a memory task*. *Neuroreport*. 11(4):761-4

“Our results suggest that the exposure to EMF does not alter the resting EEG per se but modifies the brain responses significantly during a memory task.”

<http://www.ncbi.nlm.nih.gov/pubmed/10757515?dopt=Abstract>

Eulitz C, Ullsperger P, et al (October 1998), *Mobile phones modulate response patterns of human brain activity*. *Neuroreport*. 9(14):3229-32

“Our investigations show that these electromagnetic fields alter distinct aspects of the brain's electrical response to acoustic stimuli.”

<http://www.ncbi.nlm.nih.gov/pubmed/9831456?dopt=Abstract>

Eugene Sobel et al (1995), *Occupations with Exposure to Electromagnetic Fields: A Possible Risk Factor for Alzheimer's Disease*, *American Journal of Epidemiology* Vol. 142, No. 5: 515-524

[Research into effects of extremely low frequency (ELF) radiation; ELF is radiofrequency.] “The most obvious, possibly etiologically relevant exposure is that of electromagnetic fields, which may have biologic plausibility because they may adversely influence calcium homeostasis and/or inappropriately activate immune system cells such as microglial cells, initiating events that result in neuronal degeneration.”

<http://aje.oxfordjournals.org/content/142/5/515.abstract>

2.2 Cancer induction

Hardell L, et al (August 2010), *Mobile phone use and the risk for malignant brain tumors: a case-control study on deceased cases and controls*, Neuroepidemiology. 2010 Aug; 35(2):109-14. Epub 2010 Jun 15.

“We investigated the use of mobile or cordless phones and the risk for malignant brain tumors in a group of deceased cases ... This investigation confirmed our previous results of an association between mobile phone use and malignant brain tumors.”

<http://www.ncbi.nlm.nih.gov/pubmed/20551697>

Lehrer, S et al (June 2010), *Association between number of cell phone contracts and brain tumor incidence in nineteen U.S. States*, J Neurooncol, 2011 Feb;101(3):505-7. Epub 2010 Jun 30

“Some concern has arisen about adverse health effects of cell phones, especially the possibility that the low power microwave-frequency signal transmitted by the antennas on handsets might cause brain tumors or accelerate the growth of subclinical tumors. We analyzed data from the Statistical Report: Primary Brain Tumors in the United States, 2000-2004 and 2007 cell phone subscription data from the Governing State and Local Sourcebook ... The very linear relationship between cell phone usage and brain tumor incidence is disturbing and certainly needs further epidemiological evaluation. In the meantime, it would be prudent to limit exposure to all sources of electro-magnetic radiation.

<http://www.ncbi.nlm.nih.gov/pubmed/20589524>

Hardell L et al (September 2007), *Long-term use of cellular phones and brain tumours—increased risk associated with use for > 10 years*, Occup Environ Med. 2007 Sep;64(9):626-32

“Results from present studies on use of mobile phones for > or =10 years give a consistent pattern of increased risk for acoustic neuroma and glioma. The risk is highest for ipsilateral exposure.”

<http://www.ncbi.nlm.nih.gov/pubmed/17409179>

Hardell L, et al (2006), *Tumour risk associated with use of cellular telephones or cordless desktop telephones.*, World J Surg Oncol 2006 Oct 11;4:74

“We found for all studied phone types an increased risk for brain tumours, mainly acoustic neuroma and malignant brain tumours.”

<http://www.ncbi.nlm.nih.gov/pubmed/17034627>

Lonn S et al (November 2004), *Mobile phone use and the risk of acoustic neuroma*, Epidemiology. 2004 Nov;15(6):653-9

“Our findings do not indicate an increased risk of acoustic neuroma related to short-term mobile phone use after a short latency period. However, our data suggest an increased risk of acoustic neuroma associated with mobile phone use of at least 10 years’ duration.”

<http://www.ncbi.nlm.nih.gov/pubmed/15475713>

Leszczynski D, Joenväärä S, Reivinen J, Kuokka R (May 2002), *Non-thermal activation of the hsp27/p38MAPK stress pathway by mobile phone radiation in human endothelial cells: molecular mechanism for cancer- and blood-brain barrier-related effects*. Differentiation. 70(2-3):120-9

“Based on the known functions of hsp27, we put forward the hypothesis that mobile phone radiation-induced activation of hsp27 may (i) facilitate the development of brain cancer by inhibiting the cytochrome c/caspase-3 apoptotic pathway and (ii) cause an increase in blood-brain barrier permeability through stabilization of endothelial cell stress fibers. We postulate that these events, when occurring repeatedly over a long period of time, might become a health hazard because of the possible accumulation of brain tissue damage.”

<http://www.ncbi.nlm.nih.gov/pubmed/12076339?dopt=Abstract>

Neil Cherry (2001), *Evidence that Electromagnetic Radiation is Genotoxic: The implications for the epidemiology of cancer and cardiac, neurological and reproductive effects*.

“Many studies have shown that radiofrequency/microwave (RF/MW) radiation and extremely low frequency (ELF) fields cause increased DNA strand breakage and chromosome aberrations. This has been shown in cell lines, human blood, animals and living human beings. This means that

epidemiological studies of people exposed to electromagnetic radiation (EMR) are likely to show increased cancer, miscarriage and reproductive adverse effects. In fact many epidemiological studies have shown these effects, Goldsmith (1995, 1996, 1997, 1997a), Szmigielski (1991, 1996).”

http://www.neilcherry.com/documents/90_m2_EMR_Evidence_That_EMR-EMF_is_genotoxic.pdf

2.3 Physiological, cellular and sub-cellular effects

Wuart, J. et al (2008), *Analysis of RF exposure in the head tissues of children and adults*, Phys Med Biol, 2008 Jul 7;53 (13):3681-95. Epub 2008 Jun 19

“The simulations that have been performed ... indicate that the maximum SAR [specific absorption rate, a measure of energy absorbed] in 1 g of peripheral brain tissues of the child models aged between 5 and 8 years is about two times higher than in adult models. This difference ... can be explained by the lower thicknesses of pinna, skin and skull of the younger child models.”

<http://www.ncbi.nlm.nih.gov/pubmed/18562780>

De Salles, A.A., et al (2006), *Electromagnetic absorption in the head of adults and children due to mobile phone operation close to the head*, Electromagn Biol Med 2006; 25(4):349-60.

“The SAR results are compared with the available international recommendations. It is shown that under similar conditions, the 1g-SAR calculated for children is higher than that for the adults. When using the 10-year old child model, SAR values higher than 60% than those for adults are obtained.”

<http://www.ncbi.nlm.nih.gov/pubmed/17178592>

Nylund R, Leszczynski D (2006), *Mobile phone radiation causes changes in gene and protein expression in human endothelial cell lines and the response seems to be genome- and proteome-dependent*, Proteomics Sep;6(17):4769-80

“[T]he same genes and proteins were differently affected by the exposure in each of the cell lines. This suggests that the cell response to mobile phone radiation might be genome- and proteome-dependent. Therefore, it is likely that different types of cells and from different species might respond differently to mobile phone radiation or might have different sensitivity to this weak stimulus. Our findings might also explain, at least in part, the origin of discrepancies in replication studies between different laboratories.”

<http://www.ncbi.nlm.nih.gov/sites/pubmed/16878295>

Belyaev IY, Hillert L, et al (April 2005), *915 MHz microwaves and 50 Hz magnetic field affect chromatin conformation and 53BP1 foci in human lymphocytes from hypersensitive and healthy persons* Bioelectromagnetics. 26(3):173-84

“In conclusion, 50 Hz magnetic field and 915 MHz microwaves under specified conditions of exposure induced comparable responses in lymphocytes from healthy and hypersensitive donors that were similar but not identical to stress response induced by heat shock.”

<http://www.ncbi.nlm.nih.gov/pubmed/15768430?dopt=Abstract>

Czyz J, Guan K, et al (May 2004), *High frequency electromagnetic fields (GSM signals) affect gene expression levels in tumor suppressor p53-deficient embryonic stem cells*. Bioelectromagnetics, 25(4):296-307

“Our data indicate that the genetic background determines cellular responses to GSM modulated EMF.”

<http://www.ncbi.nlm.nih.gov/pubmed/15114639?dopt=Abstract>

Sarimov R, Malmgren LOG, et al (2004), *Nonthermal GSM Microwaves Affect Chromatin Conformation in Human Lymphocytes Similar to Heat Shock*. IEEE Trans Plasma Sci 32:1600-1608

“The findings have shown that microwaves from GSM mobile phone affected chromatin conformation in human normal and transformed lymphocytes. Because of the very low SAR value in the exposed samples, the microwave effects could not be attributed to heating induced by the exposure system. The exposure level in this study was far below the ICNIRP value. GSM microwaves under specific

conditions of exposure affected human lymphocytes similar to stress response. The findings indicated that the microwave effects differ at various GSM frequencies and vary between donors.”

<http://www.emf-portal.de/viewer.php?sid=f7b8ff4a67c918b19266545a39fb7ce6&form=1&aid=13460&l=e>

Hallberg Ö, Johansson O. (2004), *Does GSM 1800 MHz affect the public health in Sweden?* Experimental Dermatology Unit, Department of Neuroscience, Karolinska Institute, Stockholm, Sweden

“The results show that there is an apparent connection between the increasing use of mobile phones, and especially handsets that are capable of communicating at 1800 MHz, and the degrading health status of the Swedish population.”

<http://hudcancer.nu/GSM1800/Kos3.pdf>

Gandhi, OP, Kang, G (2002), *Some present problems and a proposed experimental phantom for SAR compliance testing of cellular telephones at 835 and 1900 MHz*, Phys Med Biol, 2002 May 7;47(9):1501-18.

“The paper also expands the previously reported study of energy deposition in models of adults versus children to two different and distinct anatomically-based models of the adult head, namely the Utah model and the ‘Visible Man’ model, each of which is increased or reduced by the voxel size to obtain additional head models larger or smaller in all dimensions by 11.1% or -9.1%, respectively. The peak 1 g body-tissue SAR calculated using the widely accepted FDTD method for smaller models is up to 56% higher at 1900 MHz and up to 20% higher at 835 MHz compared to the larger models.”

<http://www.ncbi.nlm.nih.gov/pubmed/12043816>

Allan H. Frey (1998), *Headaches from Cellular Telephones: Are They Real and What Are the Implications?* Environmental Health Perspectives, Vol 106 No 3 March 1998

“There have been numerous recent reports of headaches occurring in association with the use of hand-held cellular telephones. Are these reported headaches real? Are they due to emissions from telephones? There is reason to believe that the answer is “yes” to both questions. There are several lines of evidence to support this conclusion ... Could the current reports of headaches be the canary in the coal mine, warning of biologically significant effects?”

<http://www.ehponline.org/members/1998/106p101-103frey/frey-full.html>

3 Animal studies

3.1 Effects on the brain and central nervous system

Narayanan, SN et al (2010), *Effect of radio-frequency electromagnetic radiations (RF-EMR) on passive avoidance behaviour and hippocampal morphology in Wistar rats*, Ups J Med Sci 2010 May;115(2):91-6

“We evaluated the effect of RF-EMR from mobile phones on passive avoidance behaviour and hippocampal morphology in rats ... Passive avoidance behaviour was significantly affected in mobile phone RF-EMR-exposed rats demonstrated as shorter entrance latency to the dark compartment when compared to the control rats. Marked morphological changes were also observed in the CA(3) region of the hippocampus of the mobile phone-exposed rats in comparison to the control rats.”

<http://www.ncbi.nlm.nih.gov/pubmed/20095879>

Ragbetli, MC et al (2010), *The effect of mobile phone on the number of Purkinje cells: a stereological study*, Int J Radiat Biol, 2010 Jul; 86(7):548-54

“The World Health Organisation proposed an investigation concerning the exposure of animals to radiofrequency fields because of the possible risk factor for health. At power frequencies there is evidence to associate both childhood leukaemia and brain tumours with magnetic field exposures. There is also evidence of the effect of mobile phone exposure on both cognitive functions and the cerebellum. Purkinje cells of the cerebellum are also sensitive to high dose microwave exposure in rats ... A significant decrease in the number of Purkinje cells and a tendency for granule cells to increase in cerebellum was found.”

<http://www.ncbi.nlm.nih.gov/pubmed/20545571>

Arendash, GW, et al (2010), *Electromagnetic field treatment protects against and reverses cognitive impairment in Alzheimer's disease mice*, J Alzheimers Dis 2010;19(1):191-210

"[T]his report presents the first evidence that long-term EMF exposure directly associated with cell phone use (918 MHz; 0.25 w/kg) provides cognitive benefits. Both cognitive-protective and cognitive-enhancing effects of EMF exposure were discovered for both normal mice and transgenic mice destined to develop Alzheimer's-like cognitive impairment ... Although caution should be taken in extrapolating these mouse studies to humans, we conclude that EMF exposure may represent a non-invasive, non-pharmacologic therapeutic against Alzheimer's disease and an effective memory-enhancing approach in general." [See footnote no. 63]

<http://www.ncbi.nlm.nih.gov/pubmed/20061638>

Eberhardt JL et al (2008), *Blood-brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phone*, Electromagn Biol Med. 2008;27(3):215-29

"Ninety-six non-anaesthetized rats were either exposed to microwaves or sham exposed in TEM-cells for 2 h at specific absorption rates of average whole-body Specific Absorption Rates (SAR) of 0.12, 1.2, 12, or 120 mW/kg. ... Albumin extravasation and also its uptake into neurons was seen to be enhanced ... neuronal albumin uptake was significantly correlated to occurrence of damaged neurons."

<http://www.ncbi.nlm.nih.gov/pubmed/18821198>

Nittby et al (2008), *Radiofrequency and Extremely Low-Frequency Electromagnetic Field Effects on the Blood-Brain Barrier*, Electromagnetic Biology and Medicine, 27:2, 103-126, esp. pp. 119-

"One remarkable observation, which we have made in our studies throughout the years is that exposure with whole-body average power densities below 10 mW/kg gives rise to a more pronounced albumin leakage than higher power densities, all at non-thermal levels."

<http://www.scribd.com/doc/3935076/Radiofrequency-and-Extremely-Low-Frequency-Electromagnetic-Field-Effects-on-the-Blood-Brain-Barrier>

Leif G. Salford et al (2007), *Non-thermal effects of EMF upon the mammalian brain: the Lund experience*, The Environmentalist, Volume 27, Number 4 / December, 2007 (Special Issue on Biological Effects of Electromagnetic Fields)

"Since 1988 our group has studied the effects upon the mammalian blood-brain barrier (BBB) by non-thermal radio frequency electromagnetic fields (RF-EMF). These have been revealed to cause significantly increased leakage of albumin through the BBB of exposed rats as compared to non-exposed animals—in a total series of about two thousand animals. One remarkable observation is the fact that the lowest energy levels give rise to the most pronounced albumin leakage. If mobile communication, even at extremely low energy levels, causes the users' own albumin to leak out through the BBB, also other unwanted and toxic molecules in the blood, may leak into the brain tissue and concentrate in and damage the neurons and glial cells of the brain."

<http://www.springerlink.com/content/81612n327545835v/>

Panagopoulos DJ, et al, (2006) *Cell death induced by GSM 900-MHz and DCS 1800-MHz mobile telephony radiation*, Mutat Res 2006 Oct 10

"[F]lies were exposed in vivo to either GSM 900-MHz (Global System for Mobile telecommunications) or DCS 1800-MHz (Digital Cellular System) radiation from a common digital mobile phone ... Our present results suggest that the decrease in oviposition previously reported, is due to degeneration of large numbers of egg chambers after DNA fragmentation of their constituent cells, induced by both types of mobile telephony radiation."

<http://www.ncbi.nlm.nih.gov/pubmed/17045516?dopt=Abstract>

Leif Salford et al (2003), *Nerve Cell Damage in Mammalian Brain after Exposure to Microwaves from GSM Mobile Phones*, in Environmental Health Perspectives, Online 29 January 2003

"We have previously shown that weak pulsed microwaves give rise to a significant leakage of albumin through the blood-brain barrier. In this study we investigated whether a pathologic leakage across the blood-brain barrier might be combined with damage to the neurons. Three groups each of eight

rats were exposed for 2 hr to Global System for Mobile Communications (GSM) mobile phone electromagnetic fields of different strengths. We found highly significant ($p < 0.002$) evidence for neuronal damage in the cortex, hippocampus, and basal ganglia in the brains of exposed rats.”

<http://www.ehponline.org/members/2003/6039/6039.html>

Henry Lai (1998), *Neurological effects of radiofrequency electromagnetic radiation*, Mobile Phones and Health, Symposium, October 25-28, 1998, University of Vienna, Austria

“We reported an increase in DNA single and double strand breaks, two forms of DNA damage, in brain cells of rats after exposure to RFR [radio frequency radiation]. DNA damages in cells could have an important implication on health because they are cumulative ... DNA damage that accumulates in cells over a period of time may be the cause of slow onset diseases, such as cancer ... However, when too much DNA damage is accumulated over time, the cell will die ... Particularly, cumulative DNA damage in nerve cells of the brain has been associated with neurodegenerative diseases, such as Alzheimer’s, Huntington’s, and Parkinson’s diseases.”

<http://www.feb.se/emfguru/Research/dr-henry.html>

Leif Salford et al (1997), *Blood-brain barrier permeability in rats exposed to electromagnetic fields used in wireless communication*, in *Wireless Networks*, Volume 3, Issue 6 (December 1997).

“The frequency of pathological rats was 170/481 (0.35 ± 0.03) among rats exposed to pulse modulated (PW) and 74/149 (0.50 ± 0.07) among rats exposed to continuous wave exposure (CW). These results are ... highly significantly different to their corresponding controls.”

<http://www.springerlink.com/content/115m20650587mm73/>

Henry Lai (1997), *Neurological Effects of Radiofrequency Electromagnetic Radiation Relating to Wireless Communication Technology*, Paper presented at the IBC-UK Conference: “Mobile Phones—Is there a Health Risk?” September 16-17, 1997 in Brussels, Belgium

“Data available suggest a complex reaction of the nervous system to RFR. The response is not likely to be linear with respect to the intensity of the radiation. Other parameters of RFR exposure, such as frequency, duration, waveform, frequency- and amplitude-modulation, etc, are also important determinants of biological responses and affect the shape of the dose (intensity)-response relationship. Some of the studies described above also suggested frequency and power window effects, i.e., effect is only observed at a certain range of frequency and intensity and not at higher or lower ranges; and dependency on the duration of individual exposure episodes. In order to understand the possible health effects of exposure to RFR from cellular telephones, one needs first to understand the effects of these different parameters and how they interact with each other.”

http://www.mapcruzin.com/radiofrequency/henry_lai1.htm

Salford, LG et al (1994), *Permeability of the blood-brain barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50, and 200 Hz.*, *Microsc Res Tech* 1994 Apr 15;27(6):535-42

“The results show albumin leakage in 5 of 62 of the controls and in 56 of 184 of the animals exposed to 915 MHz microwaves.”

<http://www.ncbi.nlm.nih.gov/pubmed/8012056>

Lai H, Carino MA, et al (1989), *Low-level microwave irradiation and central cholinergic systems*, *Pharmacol Biochem Behav* 33(1):131-8

“Our previous research showed that 45 min of exposure to low-level, pulsed microwaves (2450-MHz, 2-microseconds pulses, 500 pps, whole-body average specific absorption rate 0.6 W/kg) decreased sodium-dependent high-affinity choline uptake in the frontal cortex and hippocampus of the rat. The effects of microwaves on central cholinergic systems were further investigated in this study. Increases in choline uptake activity in the frontal cortex, hippocampus, and hypothalamus were observed after 20 min of acute microwave exposure, and tolerance to the effect of microwaves developed in the hypothalamus, but not in the frontal cortex and hippocampus.”

<http://www.ncbi.nlm.nih.gov/pubmed/2675124?dopt=Abstract>

Albert, EN, Kerns JM (1981), *Reversible microwave effects on the blood-brain barrier*, Brain Res. 1981 Dec 28;230(1-2):153-64.

“Low level microwave exposure of Chinese hamsters resulted in reversible permeability of the blood-brain barrier (BBB) to horseradish peroxidase (HRP). Lesions were grossly visible in random areas of the brain immediately following exposure, but were not as common following a 1 h recovery period and were absent after a 2 h recovery period.”

<http://www.ncbi.nlm.nih.gov/pubmed/7317776>

Oscar KJ, Hawkins TD (1997), *Microwave alteration of the blood-brain barrier system of rats*, Brain Res. 1977 May 6;126(2):281-93

“Our findings suggest that microwaves induce a temporary change in the permeability for small molecular weight saccharides in the blood-brain barrier system of rats.”

<http://www.ncbi.nlm.nih.gov/pubmed/861720>

4 Electromagnetic Hypersensitivity (EHS)

Eltiti S, Wallace D, et al. (2007), *Development and evaluation of the electromagnetic hypersensitivity questionnaire*. Bioelectromagnetics 28: 137-151

“EHS individuals showed a higher severity of symptoms on all subscales compared to the control group”

<http://www.ncbi.nlm.nih.gov/sites/pubmed/17013888>

Johansson O. (2006), *Electrohypersensitivity: State-of-the-art of a fundamental impairment*. Electromagnetic Biol. Med. 25: 235-258

“In summary, it is evident from our preliminary data that various alterations are present in the electrohypersensitive person’s skin. In view of recent epidemiological studies, pointing to a correlation between long-term exposure from power-frequent magnetic fields or microwaves and cancer, our data ought to be taken seriously and further analyzed.”

<http://www.ncbi.nlm.nih.gov/sites/pubmed/17178584>

Schreier N, Huss A, Röösl M. (2006) *The prevalence of symptoms attributed to electromagnetic field exposure: a cross-sectional representative survey in Switzerland*, Soz Präventivmed. 51(4):202-9

“We found a prevalence of 5% (95% CI 4-6%) for electromagnetic hypersensitivity (EHS) in our study sample. The most common health complaints among EHS individuals were sleep disorders (43%) and headaches (34%), which were mostly attributed to power lines and mobile phone handsets. In addition, 53 percent (95% CI 51-55%) were worried about adverse health effects from EMF, without attributing their own health symptoms to them.”

<http://www.ncbi.nlm.nih.gov/pubmed/17193782?dopt=Abstract>

Health Protection Agency (2005), *Definition, Epidemiology and Management of Electrical Sensitivity: Report for the Radiation Protection Division [formerly NRPB] of the Health Protection Agency, 2005* (The Irvine Report)

“Electrical sensitivity (ES) [or EHS] is one of a number of terms ... used by some people to describe symptoms they attribute to exposure to commonly occurring electric, magnetic, and electromagnetic fields (EMFs) ... Many reports predate the extensive roll out of mobile telephony ... The NRPB ... recognised scientific uncertainties associated with new technologies particularly mobile telephony.”

<http://www.hpa.org.uk/Publications/Radiation/HPARPDSeriesReports/HpaRpd010/>

Leitgeb N, Schröttner J, (2003), *Electrosensibility and electromagnetic hypersensitivity*, Bioelectromagnetics, Sep;24(6):387-94

“The presented data show that the variation of the electrosensibility among the general population is significantly larger than has yet been estimated by non-ionising radiation protection bodies, but much smaller than claimed by hypersensitivity self-aid groups.”

<http://www.ncbi.nlm.nih.gov/pubmed/12929157?dopt=Abstract>

5 Documents summarising the dangers of wi-fi / mobile phone technology

The Seletun Scientific Statement (2011)

“The Seletun Scientific Panel has adopted a Consensus Agreement that recommends preventative and precautionary actions that are warranted now, given the existing evidence for potential global health risks. We recognize the duty of governments and their health agencies 1) to educate and warn the public, 2) to implement measures balanced in favor of the Precautionary Principle, 3) to monitor compliance with directives promoting alternatives to wireless, and 4) to fund research and policy development geared toward prevention of exposures and development of new public safety measures as well as new, safer communications technologies.”

<http://www.kawarthasafetechnology.org/wp-content/uploads/2011/03/SeletunStatement.pdf>

<http://www.iemfa.org/index.php/publications/seletun-resolution>

Carpenter, DO (2010), *Electromagnetic fields and cancer: the cost of doing nothing*, Rev Environ Health, 2010 Jan-Mar; 25(1):75-80

“Recent studies demonstrate elevations in rates of brain cancer and acoustic neuroma only on the side of the head where individuals used their cell phone. Individuals who begin exposure at younger ages are more vulnerable. These data indicate that the existing standards for radiofrequency exposure are not adequate. While there are many unanswered questions, the cost of doing nothing will result in an increasing number of people, many of them young, developing cancer.”

<http://www.ncbi.nlm.nih.gov/pubmed/20429163>

Updated Memorandum on WiFi Research, 10.12.07, published by eight members of the Health Protection Agency’s Electromagnetic Fields Discussion Group

“On the 12 October 2007, the HPA [Health Protection Agency] announced a new “systematic programme of research” into wireless local area networks . We welcome the extra money for research in this area. However, we believe that this programme needs a different focus in order for it to result in valuable new information for the required re-evaluation of the ICNIRP Guidelines. As the project is presently planned to ignore reported health effects, we question if this is appropriate expenditure by a public body responsible principally for the protection of public health.”

http://www.powerwatch.org.uk/pdfs/20080425_wifi_memorandum.pdf

Magda Havas (2007), *Analysis of Health and Environmental Effects of Proposed San Francisco Earthlink Wi-Fi Network*

“The Board of Supervisors of the City and County of San Francisco should adopt the

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

http://www.buergerwelle.de/pdf/snafu_havas_wifi.pdf

Michael Bevington (2007), *Wi-fi in the classroom: health advice to schools*

“Until further research has been undertaken into the health effects of wi-fi, especially on children, it is recommended that it should not be used in schools. Studies of similar types of radiation, both epidemiological and mechanistic, over several decades have shown serious health effects on the general population.”

<http://www.scribd.com/doc/24004604/Wi-Fi-in-the-Classroom-Health-Advice-to-Schools>

Carpenter D and C Sage (2007), *BioInitiative Report: A Rationale for a Biologically based Public Exposure Standard for Electromagnetic Fields*, Pathophysiology, Vol. 16, Issues 2-3, Pages 67 – 250, August 2009, Electromagnetic Fields (EMF) Special Issue.

Contents include:

Evidence for effects on gene and protein expression (Dr. Xu and Dr. Chen)

Evidence for genotoxic effects—RFR and ELF DNA damage (Dr. Lai)

Evidence for stress response (stress proteins) (Dr. Blank)

Evidence for effects on immune function (Dr. Johansson)

Evidence for effects on neurology and behaviour (Dr. Lai)

Evidence for brain tumours and acoustic neuromas (Dr. Hardell, Dr. Mild, Dr. Kundi)

<http://www.bioinitiative.org>

Chris Busby and Roger Coghill (September 2006), *Health Effects of Mobile Phone Transmitter Masts and the Planning Application by Orange plc for a mast in St Michael's Church, Aberystwyth*, Green Audit Aberystwyth

<http://www.llrc.org/microwave/orangesci.pdf>

Bamberg Report (July 2005), *Open letter to Edmund Stoiber, president of the federal state of Bavaria, from a group of general medical doctors regarding 357 patients, with supporting details of symptoms and microwave exposure levels.*

http://www.powerwatch.org.uk/news/20050722_bamberg.asp

The Freiburg Appeal, originally issued in 2002 by over sixty medical doctors, in which they associate mobile phone technology with “a dramatic rise in severe and chronic diseases among our patients”, now has over 36,000 signatories, of whom 1,000 are medical. The document is available at a number of websites, including:

http://www.laleva.cc/environment/freiburger_appeal.html

Neil Cherry (2002), *Criticism of the health assessment in the ICNIRP guidelines for radiofrequency and microwave radiation (100 kHz - 300 GHz)*, Human Sciences Division, Lincoln University, Canterbury, New Zealand (pp. 128 & 131)

“The ICNIRP assessment is grossly biased by selectively choosing studies, consistently misrepresenting the results, the significance of results, the implications of the results of cellular experiments, animal experiments and human studies. The large number of published studies are a consistent and coherent set of evidence, that RF/MW is causally associated with reproductive and cancer effects, as well as altering and impairing brain function, reaction times, sleep and learning, and impairment of the immune system. There is compelling and consistent evidence of cancer, especially leukaemia and brain cancer ... It is simply not scientifically credible to claim that there are no established non- thermal effects and hence it is wrong to adopt a guideline such as the ICNIRP guideline as a public exposure standard.”

http://www.neilcherry.com/documents/90_m4_EMR_ICNIRP_critique_09-02.pdf

Appendix E

Books

Michael Bevington (2010), *Electro sensitivity and Electro hypersensitivity—A Summary*, pub. ES-UK, BM Box ES-UK, London WC1N 3XX, UK (43 pp including 800 references to scientific papers relating to EHS.)
http://www.es-uk.info/news/20100415_es_and_ehs.asp

Devra Davis (2010), *Disconnect: The Truth About Cell Phone Radiation—What the Industry Has Done to Hide It, and How to Protect Your Family*, Dutton (pub. by Penguin Group (USA) Inc.)
 ISBN 9780525951940

Camilla Rees and Magda Havas (2009), *Public Health SOS: The Shadow Side of the Wireless Revolution*, pub. Wide Angle Health, Boulder, USA
 ISBN 9781441458797

Kerry Crofton (2009), *Radiation Rescue: 4 Steps to Safeguard Your Family from the Other Inconvenient Truth—The Health Hazards of Wireless Technology*, pub. iUniverse, Bloomington, USA
 ISBN 9781440139628, 9781440139635

Robert O. Becker (1990, 2004), *Cross Currents: The Perils of Electropollution, The Promise of Electromedicine*, pub. Tarcher (Penguin Group (USA) Inc.)
 ISBN 0874776090

Appendix F

Websites

<http://www.AmericanAssociationforCellPhoneSafety.org>

<http://bemri.org>

<http://www.bioinitiative.org>

<http://www.cavisoc.org.uk>

<http://citizensforsafetechnology.org>

<http://www.electromagnetichealth.org>

<http://www.emfacts.com>

<http://www.emf-portal.de/>

<http://www.emrpolicy.org>

<http://www.es-uk.info>

<http://www.iemfa.org>

<http://www.mastaction.co.uk>

<http://www.mastsanity.org>

<http://www.powerwatch.org.uk>

<http://www.priartem.fr>

<http://www.radiationresearch.org>

<http://www.safeinschool.org>

<http://www.safeschool.ca>

<http://www.ssita.org.uk>

<http://www.wifiinschools.org.uk>

<http://wiredchild.org>

- 1 Germany warns citizens to avoid using Wi-Fi, *Independent*, 9.9.07
<http://www.independent.co.uk/environment/green-living/germany-warns-citizens-to-avoid-using-wifi-401845.html>
- 2 'Health chief seeks review of wi-fi risks in schools', *Daily Telegraph*, 21.5.07 (main headline).
- 3 Statement issued by the Health Protection Agency, May 2007 <http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/ElectromagneticFields/WiFi/>
- 4 The official position of the Health Protection Agency (HPA) has to date been that wi-fi is safe, but the former chair of the HPA, Sir William Stewart, expressed concern while in post about the health effects of wifi; and the investigation into wi-fi announced by the HPA has been criticised as failing to cover the principal health issues by experts within the HPA (see below on both points).
- 5 'Health chief seeks review of wi-fi risks in schools', *Daily Telegraph*, 21.5.07 (main headline).
- 6 The school's ICT vision is referred to in the minutes of the Full Governing Body, 19th March 2007, paragraph 8.1.2
- 7 Minutes, Meeting of the Full Governing Body, 9th July 2007, paragraph 13.1
- 8 Minutes, Meeting of the Full Governing Body, 9th July 2007, paragraph 13.2
- 9 Letter from [name], Chair of Governors, to Martin Aitken, 7 October 2007
- 10 Department for Education and Skills (2006), *A Guide to the Law for School Governors*, Chapter 15, paragraph 7
- 11 The architect told me this when I asked him about school computer systems during a tour of the new building organised for local residents before the school moved in.
- 12 On computer security, see http://en.wikipedia.org/wiki/Wireless_security
- 13 dLAN: Domestic Local Area Network, which provides landline access to the internet from any room in a building using its mains circuitry.
- 14 Alasdair Philips, Powerwatch, <http://www.powerwatch.org.uk/rf/wifi.asp>. (under 'Scientific Evidence')
- 15 See for example Wiart, J. et al (2008), *Analysis of RF exposure in the head tissues of children and adults*, *Phys Med Biol*, 2008 Jul 7;53 (13):3681-95. Epub 2008 Jun 19 <http://www.ncbi.nlm.nih.gov/pubmed/18562780>; De Salles, A.A., et al (2006), *Electromagnetic absorption in the head of adults and children due to mobile phone operation close to the head*, *Electromagn Biol Med* 2006; 25(4):349-60. <http://www.ncbi.nlm.nih.gov/pubmed/17178592>; Gandhi, OP, Kang, G (2002), *Some present problems and a proposed experimental phantom for SAR compliance testing of cellular telephones at 835 and 1900 MHz*, *Phys Med Biol*, 2002 May 7;47(9):1501-18. <http://www.ncbi.nlm.nih.gov/pubmed/12043816>
- 16 'Clarification of Issues Discussed in the Report', <http://www.iegmp.org.uk/report/clarification.htm>.
- 17 "Dans les écoles maternelles, les écoles élémentaires et les collèges, l'utilisation durant toute activité d'enseignement et dans les lieux prévus par le règlement intérieur, par un élève, d'un téléphone mobile est interdite". Article L511-5, créé par LOI no. 2010-788 du 12 juillet 2010 – art. 183 (V) http://www.legifrance.gouv.fr/affichCodeArticle.do;jsessionid=FAE37CC637E870B03DCBBF6058EB8283.tpdjo03v_2?cidTexte=LEGITEXT000006071191&idArticle=LEGIARTI000022494861&dateTexte=
- 18 "La distribution à titre onéreux ou gratuit d'objets contenant un équipement radioélectrique dont l'usage est spécifiquement dédié aux enfants de moins de six ans peut être interdite par arrêté du ministre chargé de la santé, afin de limiter l'exposition excessive des enfants." Article L5231-4 créé par LOI no. 2010-788 du 12 juillet 2010 – art.183 (V) http://www.legifrance.gouv.fr/affichCodeArticle.do;jsessionid=95A3D059D983B410684AA6593EAB5A36.tpdjo16v_1?cidTexte=LEGITEXT000006072665&idArticle=LEGIARTI000022494853&dateTexte=
- 19 Independent Expert Group on Mobile Phones (2000), *Mobile Phones and Health* (The Stewart Report), paragraph 1.19. The text is available at <http://www.iegmp.org.uk/report/text.htm>
- 20 World Health Organisation <http://www.who.int/mediacentre/factsheets/fs296/en/>
- 21 Health Protection Agency (2005), *Definition, Epidemiology and Management of Electrical Sensitivity: Report for the Radiation Protection Division of the Health Protection Agency* (The Irvine Report), p. 25. I have included only figures given for general sensitivity, not for VDU users. http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947416613
- 22 This estimate assumes there are 470 pupils in the school.
- 23 See for example *Updated Memorandum on WiFi Research*, 10.12.07 http://www.powerwatch.org.uk/pdfs/20080425_wifi_memorandum.pdf

- 24 Statement by the National Radiological Protection Board. *Advice on Limiting Exposure to Electromagnetic Fields (0-300 GHz)* [The National Radiological Protection Board (NRPB) is now part of the Health Protection Agency] http://www.hpa.org.uk/web/HPAweb&HPAwebStandard/HPAweb_C/1254510609795
- 25 See Appendix B
- 26 For a discussion of ICNIRP's approach to microwave radiation, see the report on a conference held in September 2008 entitled "EMF & Health—a Global Issue ... Exploring appropriate precautionary approaches" at http://www.powerwatch.org.uk/news/20080917_rrt_conference.asp See also Appendix B below.
- 27 Independent Expert Group on Mobile Phones (2000), *Mobile Phones and Health* (The Stewart Report). Sir William Stewart, who was previously Chief Scientific Advisor to the government, chaired the group.
- 28 In 2002, over sixty medical doctors issued the Freiburg Appeal, in which they associate mobile phone technology with "a dramatic rise in severe and chronic diseases among our patients" (the document is available at a number of websites, including http://www.laleva.cc/environment/freiburger_appeal.html). It now has over 36,000 signatories, of whom 1,000 are medical.
- 29 Stewart Report, paragraph 1.42
- 30 Wi-fi: A Warning Signal, 21.5.07. The programme can be viewed in three 10 minute parts on YouTube:
<http://www.youtube.com/watch?v=IuNaDj6VLHw>
<http://www.youtube.com/watch?v=aGplEnWptk>
<http://www.youtube.com/watch?v=-VqnPtq4GbU>
- 31 http://www.bbc.co.uk/complaints/text/ecu_julsept07.html#page_8 The programme was attacked by an article in The Guardian under the title "Bad Science", and three complaints were lodged with the BBC. However, the BBC Editorial Complaints Unit backed the experiment shown in the programme, pointing out that "(the) measurements of wi-fi and mobile phone mast radiation were taken at the points where schoolchildren were likely to be exposed to the respective signals, thus avoiding the false impression that the level of radiation from wi-fi was higher at source." The complaints unit did uphold the complaint that the programme had not presented a balanced picture of the state of scientific opinion, as it had focused principally on those scientists whose research has led them to be concerned about the health effects of wi-fi.
- 32 *Updated Memorandum on WiFi Research*, 10.12.07. The group gives figures from reports from both the UK and abroad that agree with the Panorama figures. http://www.powerwatch.org.uk/pdfs/20080425_wifi_memorandum.pdf
- 33 wLAN = wireless local area network
- 34 *Daily Telegraph*, 21.5.07
- 35 *Daily Telegraph*, 28.4.07
- 36 *Updated Memorandum on WiFi Research*, 10.12.07 http://www.powerwatch.org.uk/pdfs/20080425_wifi_memorandum.pdf
- 37 'Germany warns citizens to avoid using Wi-Fi', *Independent*, 9.9.07 <http://www.independent.co.uk/environment/green-living/germany-warns-citizens-to-avoid-using-wifi-401845.html>
- 38 http://www.robindestoits.org/SENAT-PROPOSITION-DE-LOI-0,6V-m-maximal-pour-la-telephonie-mobile-et-suspension-du-Wifi-Wimax-17-04-2009_a806.html
- 39 "The time for inaction has passed," Martin Guespereau, director of the French Health and Security Agency (Afsset), said at a press conference, adding, "let's not wait until the indications become pathologies before moving forward with limiting exposure," he said. <http://www.france24.com/en/node/4902128>
- 40 The report by the French Agency for Environmental and Occupational Health Safety (Afsset) shows that radiofrequency radiation affects cellular functions, as reported by around ten experimental studies. Other studies did not show an effect, but Afsset considers the ten studies indicated as being indisputable. http://www.afsset.fr/upload/bibliotheque/571239502268152904457160100178/09_10_ED_Radiofrequences__CP_EV.pdf
- 41 'La Bibliothèque Nationale renonce au wifi', Ariasse 4.4.08 "La direction de la BNF a décidé d'appliquer le principe de précaution, et de ne plus exposer son personnel et les visiteurs à d'éventuels risques liés l'exposition aux ondes électromagnétiques." <http://www.ariasse.com/fr/news/bnf-danger-wifi-article-1551.html>
- 42 <http://www.next-up.org/France/Calvados.php>

- 43 “Inquiétée par les dangers des ondes électromagnétiques, la Ville d’Hérouville-Saint-Clair a décidé d’appliquer un principe de précaution vis-à-vis des antennes-relais. D’ici la fin de l’année scolaire, l’ensemble des équipements Wi-Fi sera supprimé dans les écoles primaires.” http://www.ouest-france.fr/ofdernmin_-Herouville-Saint-Clair-supprime-le-Wi-Fi-dans-ses-ecoles_-912902--BKN_actu.Htm
- 44 ‘Danger on the airwaves: Is the Wi-Fi revolution a health time bomb?’ *The Independent* 22.4.07 <http://www.independent.co.uk/life-style/health-and-families/health-news/danger-on-the-airwaves-is-the-wifi-revolution-a-health-time-bomb-445732.html>
- 45 “Salzburg sets the non-thermal indoor limit at 0.02 V/m (peak pulse). This is to help protect people from non-thermal or bioelectromagnetic effects of EMR [electromagnetic radiation], such as DNA damage, cancer growth, and fertility and neurological problems. Salzburg’s Public Health Department warns against wireless systems and DECT phones in schools and nurseries. The UK does not have any non-thermal guidelines.” (from Michael Bevington, *Wi-fi in the classroom: health advice to schools* <http://www.scribd.com/doc/24004604/Wi-Fi-in-the-Classroom-Health-Advice-to-Schools>)
- 46 On the European Parliament, see <http://www.wifiinschools.org.uk/5.html>. For the Bio-Initiative Report, see Carpenter D and C Sage (2007) *BioInitiative Report: A Rationale for a Biologically based Public Exposure Standard for Electromagnetic Fields*, Pathophysiology, Vol. 16, Issues 2-3, Pages 67 – 250, August 2009, Electromagnetic Fields (EMF) Special Issue; available at <http://www.bioinitiative.org>. The European Environmental Agency advised in 2007, “There are many examples of the failure to use the precautionary principle in the past, which have resulted in serious and often irreversible damage to health and environments. Appropriate, precautionary and proportionate actions taken now to avoid plausible and potentially serious threats to health from EMF are likely to be seen as prudent and wise from future perspectives. We must remember that precaution is one of the principles of EU environmental policy.” <http://www.eea.europa.eu/highlights/radiation-risk-from-everyday-devices-assessed>
- 47 *Daily Telegraph*, 21.5.07
- 48 Neil Cherry (1999), *Criticism of the proposal to adopt the ICNIRP guidelines for cellsites in New Zealand*, Lincoln University, Environmental Management and Design Division, Canterbury, New Zealand. This article no longer appears to be available on the internet. A later article, Neil Cherry (2002), *Criticism of the Health Assessment in the ICNIRP Guidelines for Radiofrequency and Microwave Radiation (100 kHz - 300 GHz)*, Human Sciences Division, Lincoln University, Canterbury, New Zealand may be found at http://www.neilcherry.com/documents/90_m4_EMR_ICNIRP_critique_09-02.pdf
- 49 *Independent on Sunday*, 22.4.07 See also the letter in which he makes these remarks: go to <http://www.powerwatch.org.uk/rf/wifi.asp>, click on Wifi in the menu column for the page entitled ‘WiFi Overview—WiFi and Health’, scroll down to ‘Other resources’ and click on ‘letter from Prof. Olle Johansson.’
- 50 Figures taken from Michael Bevington, *Wi-fi in the classroom: health advice to schools* <http://www.scribd.com/doc/24004604/Wi-Fi-in-the-Classroom-Health-Advice-to-Schools>
- 51 The signals used in wi-fi are pulsed, as they are for mobile phones. (Until the advent of digital broadcasting, all TV and radio transmissions were continuous wave). Many scientists believe that the peak level is especially dangerous, which means that measuring the average exposure level or the root mean square (RMS) is inadequate as a measure of the risk.
- 52 *Updated Memorandum on WiFi Research*, 10.12.07 http://www.powerwatch.org.uk/pdfs/20080425_wifi_memorandum.pdf
- 53 The ICNIRP exposure guideline at 1800 MHz, which the UK follows, is 58 V/m (International Commission on Non-Ionizing Radiation Protection (1998), *Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)*, Health Phys 74:494-522; 1998a) <http://www.icnirp.de/documents/emfgdl.pdf>
- 54 *Updated Memorandum on WiFi Research*, 10.12.07 http://www.powerwatch.org.uk/pdfs/20080425_wifi_memorandum.pdf
- 55 Abdel-Rassoul G, El-Fateh OA, et al (March 2007), *Neurobehavioral effects among inhabitants around mobile phone base stations*. Neurotoxicology. 28(2):434-40 http://www.ncbi.nlm.nih.gov/sites/entrez?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=16962663
- 56 Bortkiewicz A et al (2004), *Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review* Med Pr 55(4):345-51 <http://www.ncbi.nlm.nih.gov/sites/pubmed/15620045>
- 57 Bortkiewicz A et al (2004), *Subjective symptoms reported by people living in the vicinity of cellular phone base stations: review* Med Pr 55(4):345-51 <http://www.ncbi.nlm.nih.gov/sites/pubmed/15620045>

- 58 Santini R, Santini P, et al (2003), *Survey Study of people living in vicinity of cellular phone base stations*, Biol.Med., 1:41-49 <http://www.emf-portal.de/viewer.php?sid=b9fdfbdbf6a0be2a3607c535890955c6&sform=1&aid=10062&l=e>
- 59 Bamberg Report (July 2005) http://www.powerwatch.org.uk/news/20050722_bamberg.asp
- 60 $10\mu\text{W}/\text{m}^2$ = 10 micro Watts per square metre (a measure of power or energy level)
- 61 Hallberg O. et al (2005), *Alzheimer Mortality—why does it increase so fast in sparsely populated areas?* Experimental Dermatology Unit, Department of Neuroscience, Karolinska Institute, Sweden: <http://www.emf-portal.de/viewer.php?aid=12803&l=e>
- 62 Eugene Sobel et al (1995), *Occupations with Exposure to Electromagnetic Fields: A Possible Risk Factor for Alzheimer's Disease*, American Journal of Epidemiology Vol. 142, No. 5: 515-524 <http://aje.oxfordjournals.org/cgi/content/abstract/142/5/515>
- 63 Widespread publicity was given in 2010 to research that appears to suggest the opposite possibility: that exposure to microwave radiation protects against and reverses Alzheimer's-like diseases. However, the research, using mice, also showed a rise in brain temperature during exposure, that may account for the improved performance found in the cognitive interference tasks used, and—unlike research showing neurological damage (see below)—did not examine brain tissue after exposure. *Biological effect is the key test.*
Arendash, GW, et al (2010), *Electromagnetic field treatment protects against and reverses cognitive impairment in Alzheimer's disease mice*, J Alzheimers Dis 2010;19(1):191-210 <http://www.ncbi.nlm.nih.gov/pubmed/20061638>
- 64 Lai, H. and Singh, N.P. (1996), *Single- and double-strand DNA breaks in rat brain cells after acute exposure to radiofrequency electromagnetic radiation*. Int. J. Radiation Biology, 69 (4): 513-521. <http://www.ingentaconnect.com/content/apl/trab/1996/00000069/00000004/art00012?crawler=true>
- 65 Henry Lai (1998), *Neurological effects of radiofrequency electromagnetic radiation*, Mobile Phones and Health, Symposium, October 25-28, 1998, University of Vienna, Austria <http://www.feb.se/emfguru/Research/dr-henry.html>
- 66 Henry Lai (1998), *Neurological effects of radiofrequency electromagnetic radiation*, Mobile Phones and Health, Symposium, October 25-28, 1998, University of Vienna, Austria <http://www.feb.se/emfguru/Research/dr-henry.html>
- 67 See for example:
Salford LG et al (2003), *Blood-brain barrier permeability in rats exposed to electromagnetic fields used in wireless communication*, in Wireless Networks, Volume 3 , Issue 6 (December 1997) This article does not appear to be available on the internet. However, see the proceedings of the 3rd International EMF Seminar in China: Electromagnetic Fields and Biologic Effects, Guilin, China, October 13-17 2003, Section 4-5, for a similar article. <http://www.scribd.com/doc/26216168/Electromagnetic-Fields-and-Biological-Effects-3rd-International-EMF-Seminar-in-China>
Allan H. Frey (1998), *Headaches from Cellular Telephones: Are They Real and What Are the Implications?* Environmental Health Perspectives, Vol 106 No 3 March 1998 <http://www.ehponline.org/members/1998/106p101-103frey/frey-full.html>
Salford, LG et al (1994), *Permeability of the blood-brain barrier induced by 915 MHz electromagnetic radiation, continuous wave and modulated at 8, 16, 50, and 200 Hz.*, Microsc Res Tech 1994 Apr 15;27(6):535-42 <http://www.ncbi.nlm.nih.gov/pubmed/8012056>
Albert, EN, Kerns JM (1981), *Reversible microwave effects on the blood-brain barrier*, Brain Res. 1981 Dec 28;230(1-2):153-64. <http://www.ncbi.nlm.nih.gov/pubmed/7317776>
Oscar KJ, Hawkins TD (1977), *Microwave alteration of the blood-brain barrier system of rats*, Brain Res. 1977 May 6;126(2):281-93 <http://www.ncbi.nlm.nih.gov/pubmed/861720>
- 68 Nittby et al (2008), *Radiofrequency and Extremely Low-Frequency Electromagnetic Field Effects on the Blood-Brain Barrier*, Electromagnetic Biology and Medicine, 27:2, 103–126 <http://www.scribd.com/doc/3935076/Radiofrequency-and-Extremely-LowFrequency-Electromagnetic-Field-Effects-on-the-BloodBrain-Barrier>
- 69 Leif Salford et al (1997), *Blood-brain barrier permeability in rats exposed to electromagnetic fields used in wireless communication*, Wireless Networks, Volume 3 , Issue 6 (December 1997). <http://www.springerlink.com/content/115m20650587mm73/>
- 70 Leif Salford et al (2003), *Nerve Cell Damage in Mammalian Brain after Exposure to Microwaves from GSM Mobile Phones*, Environmental Health Perspectives Online, 29 January 2003 <http://www.ehponline.org/members/2003/6039/6039.html>
- 71 Nittby et al (2008), *Radiofrequency and Extremely Low-Frequency Electromagnetic Field Effects on the Blood-Brain Barrier*, Electromagnetic Biology and Medicine, 27:2, 103–126 <http://www.scribd.com/doc/3935076/Radiofrequency-and-Extremely-LowFrequency-Electromagnetic-Field-Effects-on-the-BloodBrain-Barrier>

- 72 Leif G. Salford et al (2007), *Non-thermal effects of EMF upon the mammalian brain: the Lund experience*, The Environmentalist, Volume 27, Number 4 / December, 2007 <http://www.springerlink.com/content/81612n327545835v/>
- 73 Eberhardt JL et al, (2008), *Blood-brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phones*, Electromagn Biol Med. 2008;27(3):215-29 <http://www.ncbi.nlm.nih.gov/pubmed/18821198>
The exposure measures mW/kg and W/kg are measures of exposure in terms of the heating effect of microwaves (the specific absorption rate or SAR).
- 74 Nittby et al (2008), *Radiofrequency and Extremely Low-Frequency Electromagnetic Field Effects on the Blood-Brain Barrier*, Electromagnetic Biology and Medicine, 27:2, 103–126 <http://www.scribd.com/doc/3935076/Radiofrequency-and-Extremely-LowFrequency-Electromagnetic-Field-Effects-on-the-BloodBrain-Barrier>
- 75 Eberhardt JL et al, (2008), *Blood-brain barrier permeability and nerve cell damage in rat brain 14 and 28 days after exposure to microwaves from GSM mobile phones*, Electromagn Biol Med. 2008;27(3):215-29 <http://www.ncbi.nlm.nih.gov/pubmed/18821198>
I have not been able to find the full article on the internet, but the following quotation is available from the website at the end of this footnote: “The indications from our study that the weakest fields are the biologically most harmful, poses a complicated problem. The most pronounced BBB-opening effect [BBB = blood brain barrier] of the mobile telephone may not be in the most superficial layers of the brain, but several centimeters deep in central cerebral structures. It seems quite possible that bystanders in the vicinity of mobile phone users may be affected through passive GSM exposure, as well as larger groups exposed from distant base-stations.” <http://www.emfacts.com/weblog/?p=995>
- 76 In accounting for this result, it has been suggested that the blood brain barrier shows a ‘window effect’, the weaker pulse having greater effect through mimicking biological signals or resonating with them. Lai refers to both power and frequency windows, citing research from a number of sources. Henry Lai (1997), *Neurological Effects of Radiofrequency Electromagnetic Radiation Relating to Wireless Communication Technology*, Paper presented at the IBC-UK Conference: “Mobile Phones—Is there a Health Risk?” September 16-17, 1997 in Brussels http://www.mapcruzin.com/radiofrequency/henry_lai1.htm (In another study, he cites over 10 papers showing frequency effects: Henry Lai (1998), *Neurological effects of radiofrequency electromagnetic radiation*, Mobile Phones and Health, Symposium, October 25-28, 1998, University of Vienna, Austria <http://www.feb.se/emfguru/Research/dr-henry.html>)
- 77 Putting ‘phone masts cancer’ into Google on 13.4.11 brought up about 126,000 links (the number varies widely with date of entry).
- 78 Eger H et al (2004), *The influence of being physically near to a cell phone transmission mast on the incidence of Cancer* Umwelt Medizin Gesellschaft 17.4.2004 (the Naila study) <http://www.tetrawatch.net/papers/naila.pdf>
- 79 Wolf R & Wolf D (2004), *Increased incidence of cancer near a cell-phone transmitter station*, Int J of Cancer Prevention, 2004 1(2) http://bemri.org/publications/cat_view/2-publications/5-biological-effects-of-non-ionizing-radiation/13-masts.html (Scroll down for article)
- 80 Helen Dolk et al (1997), *Cancer Incidence near Radio and Television Transmitters in Great Britain I. Sutton Coldfield Transmitter*, American Journal of Epidemiology 1997 Vol. 145, No. 1: 1-9 <http://aje.oxfordjournals.org/cgi/content/abstract/145/1/1>
- 81 Paola Michelozzi et al (2002), *Adult and Childhood Leukemia near a High-Power Radio Station in Rome, Italy*, American Journal of Epidemiology 2002 Vol. 155, No. 12 : 1096-1103 <http://aje.oxfordjournals.org/cgi/content/full/155/12/1096>
- 82 Ha M et al (2007), *Radio-frequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer*, Am J Epidemiol 2007 Aug 1;166(3):270-9. Epub 2007 Jun 7 <http://www.ncbi.nlm.nih.gov/pubmed/17556764>
See also Park SK et al (2004), *Ecological study on residences in the vicinity of AM radio broadcasting towers and cancer death: preliminary observations in Korea*, Int Arch Occup Environ Health 2004 Aug; 77(6):387-94. Epub 2004 Jul 31 <http://www.ncbi.nlm.nih.gov/pubmed/15338224>
- 83 Bruce Hocking et al (1996), *Cancer incidence and mortality and proximity to TV towers*, Medical Journal of Australia, 1996; 165: 601 <http://www.mja.com.au/public/issues/dec2/hocking/hocking.html>
- 84 It is notable in this connection that in 2009 three prominent German doctors wrote an open letter to US President Obama saying, “In Germany, we see strong evidence of a direct temporal association between the start-up of terrestrial digital broadcast television and the occurrence of severe health symptoms” [which they detail], and appealing to him to prevent the same development in the US. <http://www.globalresearch.ca/index.php?context=va&aid=12596>
- 85 Neil Cherry (2000), *Health effects associated with mobile base stations in communities: the need for health studies*,

- Lincoln University, Environmental Management and Design Division, Canterbury, New Zealand <http://www.whale.to/a/cherry4.html>
- 86 Neil Cherry (2001), *Evidence that Electromagnetic Radiation is Genotoxic: The implications for the epidemiology of cancer and cardiac, neurological and reproductive effects*. http://www.neilcherry.com/documents/90_m2_EMR_Evidence_That_EMR-EMF_is_genotoxic.pdf
- 87 dLAN kits are available on the internet
- 88 Leif Salford et al (2003), *Nerve Cell Damage in Mammalian Brain after Exposure to Microwaves from GSM Mobile Phones*, in *Environmental Health Perspectives*, Online 29 January 2003 <http://www.ehponline.org/members/2003/6039/6039.html>
- 89 <http://www.voicetheunion.org.uk/index.cfm?cid=709>. See also Philip Parkin, interview with ePolitix.com, 8.5.09 <http://www.epolitix.com/interviews/interview-detail/newsarticle/potential-hazards-of-wi-fi-technology-in-schools/> — and the following references from the Voice website: <http://www.voicetheunion.org.uk/index.cfm?cid=712>
- 90 Voice website <http://www.voicetheunion.org.uk/index.cfm?cid=495>
- 91 ATL Conference 2009 <http://www.atl.org.uk/policy-and-campaigns/conference/conf09/conference-2009-wednesday-am.asp#tcm:13-39606> Some teachers at the conference called for the use of wi-fi in schools to be suspended immediately until its health risks have been properly assessed.
‘Fears that wi-fi may cause cancer in children’, *Education Matters*, 9/4/09 <http://www.educationmatters.ie/2009/04/09/fears-that-wi-fi-may-cause-cancer-in-children/>
‘Wifi in school should be stopped say teachers’, *Daily Telegraph* 8.4.09 <http://www.telegraph.co.uk/education/educationnews/5125161/Wifi-in-school-should-be-stopped-say-teachers.html>
- 92 ‘Warning signal to schools using wi-fi’, *Belfast Telegraph*, 30.10.08 http://groups.google.com/group/mobilfunk_newsletter/browse_thread/thread/3b2c06b777eac53d
- 93 ‘Union calls for schools wi-fi review’, ni4kids, May 2009 http://www.ni4kids.com/Features/article.aspx?listing_id=9b26db35-b3fd-4528-9eea-a2f3e187a287&cat_id=6f4911ae-9396-4932-94b4-f541b4215a20
- 94 ‘Health fears lead schools to dismantle wireless networks’, *Times Online*, 20.11.06
- 95 ‘Warning signal to schools using wi-fi’, *Belfast Telegraph*, 30.10.08 http://groups.google.com/group/mobilfunk_newsletter/browse_thread/thread/3b2c06b777eac53d
- 96 ‘Health fears lead schools to dismantle wireless networks’, *Times Online*, 20.11.06
- 97 ‘Health fears lead schools to dismantle wireless networks’, *Times Online*, 20.11.06
- 98 Michael Bevington, *Wi-fi in the classroom: health advice to schools* <http://www.scribd.com/doc/24004604/Wi-Fi-in-the-Classroom-Health-Advice-to-Schools>
- 99 See for example the Discussion section of the following paper, in which the subject is addressed in relation to the blood brain barrier: Nittby et al (2008), *Radiofrequency and Extremely Low-Frequency Electromagnetic Field Effects on the Blood-Brain Barrier*, *Electromagnetic Biology and Medicine*, 2008 27:2, 103–126 <http://www.scribd.com/doc/3935076/Radiofrequency-and-Extremely-LowFrequency-Electromagnetic-Field-Effects-on-the-BloodBrain-Barrier>
Also Henry Lai (1998), *Neurological effects of radiofrequency electromagnetic radiation*, *Mobile Phones and Health*, Symposium, October 25–28, 1998, University of Vienna, Austria <http://www.feb.se/emfguru/Research/dr-henry.html>
- 100 It is the absence of an agreed theory of this kind that enables the HPA to say that there is no ‘consistent’ evidence of adverse health effects. The job of theory is to provide a consistent account of what is going on. But the first priority in relation to health is not theory—which is a matter of ideas—but *evidence*, or the observation of effects.
- 101 For example, in 2000, the government raised £22.5 billion from the sale of third-generation mobile phone licences (2.5% of GNP). <http://www.nuff.ox.ac.uk/users/klemperer/biggestsept.pdf>. In addition, “the telecommunications industry contributes over £13.6 billion to the UK GDP ... and the government receives £15 billion in tax revenue.” Alasdair and Jean Philips (2009), *Mobile Phone Masts and Wireless Computing*, p.3 (ISBN 0 - 95245 033 - X) http://www.powerwatch.org.uk/library/downloads/phone_masts-20090105.pdf
- 102 Professor Lawrie Challis, who heads the Government’s official mobile safety research, is reported as saying that the mobile phone could turn out to be “the cigarette of the 21st century”. (Quoted in ‘Danger on the airwaves: Is the Wi-Fi revolution a health time bomb?’, *Independent*, 22.4.07) <http://www.independent.co.uk/life-style/health-and-families/health-news/danger-on-the-airwaves-is-the-wifi-revolution-a-health-time-bomb-445732.html>

- 103 Report on a conference held in September 2008 entitled EMF & Health—a Global Issue ... Exploring appropriate precautionary approaches, section entitled, 'ICNIRP, WHO and international guidance', at http://www.powerwatch.org.uk/news/20080917_rrt_conference.asp Some of the following information is also drawn from this report.
- 104 For example:
- Roux D et al (2008), *High frequency (900 MHz) low amplitude (5 V m⁻¹) electromagnetic field: a genuine environmental stimulus that affects transcription, translation, calcium and energy charge in tomato*, *Planta*. 2008 Mar;227 (4):883-91. Epub 2007 Nov 20 <http://www.ncbi.nlm.nih.gov/pubmed/18026987>
- Friedman J et al (2007), *Mechanism of short-term ERK activation by electromagnetic fields at mobile phone frequencies*, *Biochem J*, 2007 Aug 1;405(3):559-68. <http://www.ncbi.nlm.nih.gov/pubmed/17456048>
- Nylund R, Leszczynski D (2006), *Mobile phone radiation causes changes in gene and protein expression in human endothelial cell lines and the response seems to be genome- and proteome-dependent*, *Proteomics*, 2006 Sep;6(17):4769-80 <http://www.ncbi.nlm.nih.gov/pubmed/16878295>
- Neil Cherry (2000), *Health effects associated with mobile base stations in communities: the need for health studies*, Lincoln University, Environmental Management and Design Division, Canterbury, New Zealand <http://www.whale.to/a/cherry4.html>
- Henry Lai (1998), *Neurological effects of radiofrequency electromagnetic radiation*, Mobile Phones and Health, Symposium, October 25-28, 1998, University of Vienna, Austria <http://www.feb.se/emfguru/Research/dr-henry.html>