

Mobile Phones

The Mobile Phones set of articles is separated into 9 sections, each of which can be individually downloaded. It is a 'work in progress' incorporating new information whenever time permits.

Section 2

Are mobile phones a health problem?

1. Introduction; children and safety; mobile phone addiction; tracking and tapping phones; the impact of adverse weather patterns on phone calls; the environmental impact of the technology
2. Are mobile phones a health problem? Is the data trustworthy?
3. Brain tumours and other cancers; 13-nation Interphone study findings, and others; brain tumours; eye cancer; leukaemia; melanoma; personal experiences; pituitary; prostate; salivary gland tumours; skin tumours; stem cells; thyroid cancer; implications; Legal viewpoints
4. Dementia; reproductive effects; neurological effects; cognitive effects; brain activity, children
5. Biological control systems; heat shock protein; DNA; interaction with other environmental exposures and indirect affects; cellular mechanisms; blood changes; oxidative stress
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7. UK and international regulations and guidelines; exposure places and bans, hospitals, physical therapies, prisons, railways, rural areas; Austria; Belgium; EU; France; Germany; India; Israel; Italy; Japan; Poland; Russia; Taiwan; USA
8. Things you can do to reduce your RF exposure. Phone, time, signal strength, switching off Blackberrys; vulnerable areas; texting; standby; other people; when travelling; headsets; SARs; antennas; electromagnetic noise; protective gizmos; jammers; supplements
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Are mobile phones a health problem?

In January 2012, the Mobile Operators Association reported the results of a survey of almost 2,000 adults in Britain. Two fifths of the respondents said there is so much conflicting information about alleged health issues relating to mobile phones and masts that they'd rather not hear about it. The study suggested that people are generally not worried about these alleged health effects, with levels of concern at half the level of a decade ago. Around 90% of adults now use a mobile, and 83% agree that they are a 'necessity' for modern life. When asked about children using mobile phones, just under a half agreed that advantages of a child having a mobile phone outweighed the disadvantages.

Despite this reluctance to look at whether the favourite technological accessory is responsible for health effects, the evidence that there are possible or probable problems with mobile phone use is growing rapidly. Most of the research findings of cancer and other health effects arising from the use of mobile phones are detailed in sections 3 to 6.

Rumiantsev, as long ago as [2004](#) said in their review that the data so far demonstrated a distinctly potential threat coming from the biological effects of irradiations from mobile phones.

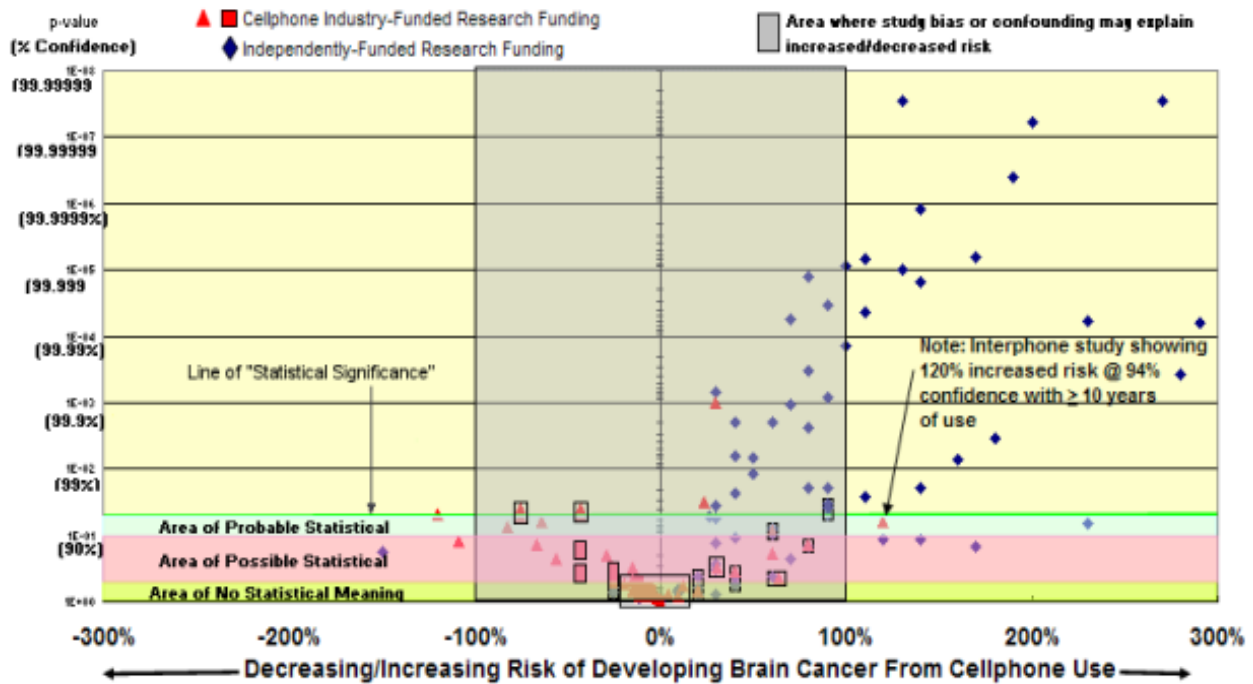
Several studies indicate an increase in cortical excitability and/or efficiency with EMF exposure, which appears to be more prominent in fronto-temporal regions and has been associated with faster reaction time. Cortical excitability might also underpin disruption to sleep. However, several inconsistent findings exist, and conclusions regarding adverse effects of EMF exposure are currently limited. It also should be noted that the crucial scientific question of the effect of longer-term MP EMF exposure on brain function remains unanswered and essentially unaddressed (J Zhang [2017](#)).

Is the data trustworthy?

Cynics may ask "Surely the fact that more than 15 billion pounds income goes to the UK government each year in taxes from the sale of phones and the calls made would not influence the funding or results of health research?" No tests for safety were carried out before they were put on the market.

The results reported by Lloyd Morgan, Director of a USA Cancer Registry, are clearly not good news for the mobile telecommunications companies, and their concerns may have influenced the research, as shown in the graph below.

Dr Henry Lai said that industry-funded studies are roughly twice as likely as government-funded ones to conclude that mobile phones are harmless.



Two leading EMF and health experts, Professor Ross Adey and Dr Henry Lai, revealed in May 1999 that multi-national companies had tried to influence the results of their research. Professor Adey, a biologist, said he had had his funding withdrawn by Motorola before completing his research which showed that mobile phone emissions affected the number of brain tumours in animals. Professor Lai, who has been studying the biological effects of electromagnetic fields for over 20 years, was asked three times to change his findings on how such fields caused DNA strand breaks in rats. Dr Jerry Phillips' work, supporting Professor Lai's experiments, led to his contract with Motorola being terminated when he published his results. Dr George Carlo, who used to be a spokesman and researcher for the mobile phone industry, bitterly criticised the industry for failing to act on his findings and for not taking safety seriously. Lloyd Morgan's graph (above) seems to confirm this bias.

Telstra (an Australian telecommunications company) employed a medical officer, Dr Bruce Hocking, who referred four employees to a neurologist after they reported headaches and dizziness when using their mobile phones. The company lawyers decided to cancel the employees' appointments and Dr Hocking was made redundant. Professor Roger Santini in France reported on 530 people who were exposed to mobile phone mast antenna radiation and 18 of their symptoms, before he was told to 'shut up or leave' by his employer INSA, a state-funded research institution.

A [review](#), in 2006, funded by the Department of Social and Preventative Medicine at the University of Berne in Switzerland, by Huss found that studies exclusively funded by industry were least likely to report a statistically significant result, and concluded that *"The interpretation of results from studies of health effects of radiofrequency radiation should take sponsorship into account."*

Some studies which use questionnaire responses as the basis for their information, have been criticised as subject to recall bias and therefore are likely to be inaccurate. Often the criticisms suggested that the bias would result in risks being exaggerated. However, recent work by the Interphone group, an International research collaboration involving 13 countries (Vrijheid et al [2006](#)) and a study by Schüz & Johansen [2007](#), claim that heavy users tend to overestimate their total usage which, if correct, would mean that e.g. statistically significant increases found by the Hardell group in heavy mobile phone users may in fact be for less usage than actually reported. If

so, this consequently implies that the brain tumour risk from mobile phone usage may be greater than that suggested by Hardell, see Section 3 for details of Hardell's work. Lennart Hardell is an oncologist who has published many papers, we list some of them, ([2000](#), [2001](#), [2002](#), 2002, [2002](#), [2003](#), 2006, [2006](#), [2008](#), [2009](#), [2010](#)) showing strong links between mobile phone and cordless phone use and brain tumour risk. The use of cordless phones was not assessed in most Interphone studies, which would dilute the risk estimates. Cordless phones have a median power in the same magnitude as GSM phones, and are used for longer calls.

Smartphones are now owned by most young adults in many countries. Installed applications regularly update while the phone is in standby. If it is kept near the body, this can lead to considerably higher exposure to radiofrequency electromagnetic radiation than occurred without internet access (Redmayne [2017](#)). In the last week the most common locations of the phone when not in use or during passive use was off-body (86%), in the hand (58%), a skirt/trouser pocket (57%), or against the breast (15%). Pocket and near-the-breast storage were significant by age, positively influenced by the youngest group (aged 15-20). More than half kept the phone 20-50 cms from their head at night (53%), while 13% kept it closer than 20 cms. Clearly this 'non-use' exposure needs to be taken into account when evaluating the risks of smartphone usage.

Because of increasing public concern, in 1999, the Government Health Minister instructed the UK National Radiological Protection Board, (which became the HPA -RPD), to set up a completely independent committee to examine the science of mobile phone safety. The committee was chaired by Sir William Stewart. The report was made public in May 2000, becoming known as the "Stewart Report".

Following the publication of this report, Sir William Stewart commented to the Trade & Industry Select Committee: *"It is simply not possible to say that there are no potential effects on the human population. It is difficult to talk about the population because populations vary. Antibiotics do a wonderful job for the general population, but there is a subgroup in the population that is allergic to antibiotics; they cannot take them. There is a sub-group in the general population who cannot eat nuts because they are allergic to them. That is why we refer to the general population. The other point is that we mentioned health effects and well-being effects. On the basis of discussions such as those we came to advise on the need for a precautionary approach."* [Trade & Industry 10th Report April 2001]

In a study by Denny-Bas ([2014](#)) scores for the 11 psychometric properties of the risk attributed to cell phones were higher than those associated with smoking, especially for dissatisfaction with information and the capacity of authorities to master the risk. Anxious subjects are more certain about the hazards of cell phones and masts than non-anxious subjects.

People are likely to respond in a variety of ways to the electromagnetic fields emitted by mobile phone technology. We believe that some people will suffer ill-health effects and some may possibly be able to use the technology in an almost unlimited way and not experience any related problems. Many of the symptoms reported by mobile phone users are also associated with other medical conditions and may not be recognised as reasonably common side effects of mobile phone use by either the patient or the GP.

We are unable to predict with any reliability the individuals who will develop idiopathic (allergic) responses to common substances. Mobile phones are thought to behave in a similar way to other allergens and trigger unusual adverse responses in a susceptible proportion of the population.

Although the subject is still being vigorously debated, most of the leading independent researchers, though not all, in this field are clear that there are biological effects (Lantow [2006](#), Valbonesi [2008](#)), though some suggest it is purely psychological (van Rongen [2009](#)). Changes in cell structure and communication, changes in reaction time ([Cao 2000](#), [Koivisto 2000](#)),

concentration and memory problems ([Koivisto 2000](#)), summarised in a 19 study meta-analysis by Barth ([2008](#)), are being widely reported. What is as yet unclear is whether these changes are short-term, or whether there is a cumulative effect that may have quite serious health consequences in the medium to long term. It has been suggested that probably 5 -10% of the population suffers from short-term effects. This represents between 2½ - 5 million adults in the UK alone who may be vulnerable to adverse health effects due to microwave radiation and pulsed EMFs from the batteries in their phone. Phone radiation has also been associated with harmful interactions with medical implants and with drugs prescribed for various medical conditions.

An increase in SAR levels (thermal effects from mobile phone emissions) can be found with facial piercings, (Fayos-Fernandez [2006](#)) by 3 times at 1800 MHz for an eyebrow pin. These re-distribute the energy absorbed in the head and focus this energy towards the area of the head nearest to the centre of the pin (Whittow [2008](#)).

In most experimental conditions looking at the effects of mobile phones on people, only RF radiation is taken into account. ELF from the phones' battery is discounted. In a study by de Tommaso ([2009](#)), it is clearly shown that ELF EMFs from the battery and internal circuits had as much of an effect as the RF. This finding is very important for researchers who devise 'sham' exposure to take into account, in order that ELF exposures are also removed. In a study by Cranfield ([2003](#)), the authors suggested that the 2-Hz magnetic field pulse generated by battery currents could interact with magnetite in the human brain which could be responsible for some of the biological effects found in mobile phone research.

Dr Carl Blackman (2009) criticised the public exposure standards *“More recent studies of modulated RF signals report changes in human cognition, reaction time, brainwave activity, sleep disruption and immune function... Current standards have ignored modulation as a factor in human health impacts, and thus are inadequate in the protection of the public in terms of chronic exposure to some forms of ELF-modulated RF signals. The current IEEE and ICNIRP standards are not sufficiently protective of public health with respect to chronic exposure to modulated fields.”* He also says *“The collective papers on modulation appear to be omitted from consideration in the WHO and IEEE science reviews. This body of research has been ignored by current standard setting bodies that rely only on traditional energy-based (thermal) concepts.”* Robert Becker in his book *“The Body Electric”* adds *“experiments in which cells or organisms are exposed to a single unmodulated frequency, though sometimes useful, are irrelevant outside the laboratory.”*

Marino ([2017](#)) found that simulated mobile phone radiation affected brain electrical activity associated with nonlinear cognitive processing of radiation-induced thermal afferent signals. The authors concluded that radiation standards for mobile phones based on a thermal/nonthermal binary distinction do not prevent neurophysiological consequences of mobile phone radiation.

When a mobile phone is used, the radiation comes from the whole phone not just the antenna, so the face, ear and back of the phone-side of the head are all exposed. Some of the radiation given off by the phone passes through the body, some bounces back from the surface of the body and typically, 60-80% of the phone's total radiation is absorbed by the user; the exact level depends critically on the make and model and how it is held. Also, because of the pulsing nature of the signals, real low-frequency (217 Hz) magnetic field pulses are generated in the handset that travel right through the user's brain at levels of several microtesla; note that the level of ELF fields associated with childhood leukaemia is only 0.4 microtesla. The smaller the user's head, the further into the brain the microwave radiation can penetrate. The fact that children's neurological systems are still developing underlies some of the concern about the use of mobile phones by young people. For further information, see our article *“Children and Mobile Phones”*. A study by Peyman on the conductive qualities of rat brain tissues exposed to RF found ([2001](#)) that they changed with the age of the rat. If we can map this onto human brain tissue, which we may not

be able to, it may show that what happens at some ages may not always be the same at other ages.

Will the use of a bluetooth ear device help a user avoid the radiation from a phone? The answer is not straightforward, it will expose you to less than the phone handset, but, being wireless, it is also transmitting itself, and therefore also exposing you.

Cancer is a disease that very roughly doubles in frequency of occurrence every decade of our lives. The mechanism for suppressing potential cancers must allow exceptions for normal growth and proliferation. If this mechanism is interfered with by RF radiation, our children are likely to suffer from a much higher incidence of cancers than previous generations as they get older. A review of data between 2004-2007 by Habash ([2009](#)) stated that there are a number of potential issues from RF radiation, sufficient to promote caution and further research, especially use by children.

Dr Taal of the Tallinn Technical University in Estonia found some mobile phone handsets that emitted magnetic fields of several microtesla and electric fields of over 1,000 volts per metre (Taal 2001). These figures seem high, but certainly several hundreds of volts per metre have been measured by several researchers close to handset antennas. Pedersen and Andersen (1999) found that ELF magnetic fields can be up to about 3 microtesla in the centre of the user's head. We know that pineal melatonin synthesis (melatonin has a significant role in maintaining our immune system, repairing pre-cancerous damage among other things (Henshaw 2002)) can be reduced at 1.6 microtesla and so this could be one of the mechanisms by which mobile phone handset use could also increase the number of cases of clinical depression (depression being associated with low levels of melatonin)(Cao [2000](#)). Burch ([2002](#)) found that prolonged use of cellular telephones may lead to reduced melatonin production, especially when combined with power-frequency exposure.

The emergency services communications system, TETRA, caused concern about the possible increase in cancer of the spine, liver and kidneys that was believed to result from handsets being worn on the belt. Professor Colin Blakemore suggested that, if police officers (the first users of the system) were concerned, protective screening can be designed into the police uniform to protect against the emissions from a TETRA handset. The Medical Devices Agency (MDA) (www.medical-devices.gov.uk) carried out tests on TETRA handsets and found that 47% were found to cause interference problems, 23% of these were seen as serious, including effects on heart pacemakers and hearing aids. The Royal Society of Canada (www.rsc.ca/english/Rfreport.pdf) concluded that there are potential risks to the eyes, with little or no risk assessment having been carried out.

Apparently some police officers were required to take their TETRA handsets home to re-charge the batteries. This resulted in several members of different families suffering from epileptic attacks, some for the first time as they pass by the equipment on charge. After 12 months use by the Lancashire police, nearly two hundred instances of ill-health were reported by officers attributed to electromagnetic fields from the new TETRA equipment, including migraines, nausea, deafness, nose bleeds and fatigue.

We understand from Andrew Goldsworthy, a retired University lecturer, that the biological mechanism underlying the effects that some people report as a result of using the handsets can be explained (at least in part) by the following: *“The pulse frequency used in TETRA handsets is very close to the ion cyclotron resonance frequency for potassium which is especially good at giving biological effects. Potassium is by far the most abundant positive ion in living cells. Exposure at its resonant frequency increases its chemical activity, which enables it to drive structural calcium from cell membranes and make them more prone to “accidental” tearing. When it occurs in brain tissue it’s quite likely to generate false action potentials. This would degrade the signal to noise ratio of the brain, reduce its ability*

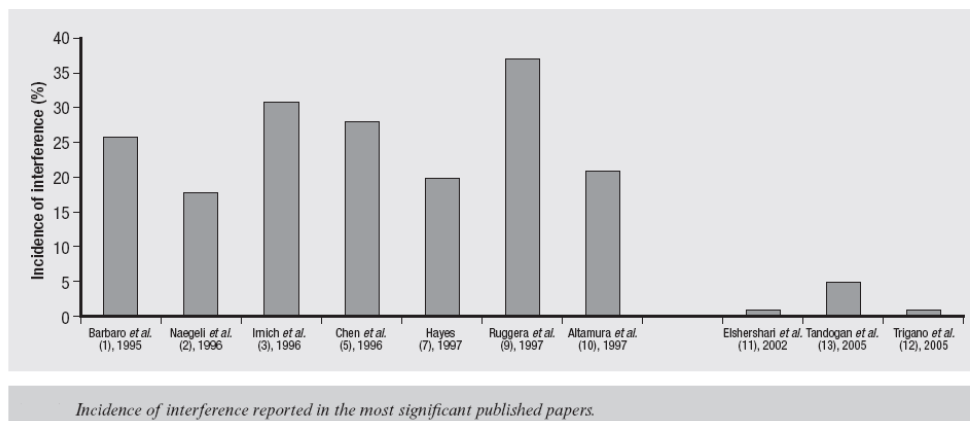
to respond appropriately to stimuli and be a contributory factor to many cellphone-related automobile accidents". 6121 Finns returned a questionnaire looking at mobile phone use and accidents or close calls (Korpinen & Pääkkönen 2012). Altogether 13.7% of respondents had close call situations and 2.4% had accidents when at leisure, in which the mobile phone had a partial effect, and at work the amounts were 4.5% and 0.4% respectively, during the last 12 months. The concluded that 1) men tend to have more close calls and accidents while on a mobile phone, 2) younger people tend to have more accidents and close calls while on a mobile phone 3) employed people tend to have more problems with mobile phone usage and accidents/close calls, and 4) there was a slight increase in mobile phone-related accidents/close calls if the respondent also reported sleep disturbances and minor aches and pains.

Andrew Goldsworthy continues "Electromagnetic fields of the right amplitude and frequency selectively remove structural calcium from cell membranes, which weakens them and makes them more prone to temporary pore formation. When this occurs in excitable nerve cells it could promote the generation of spurious action potentials by direct depolarisation and/or calcium ingress from the outside and intracellular stores. This could account for many of the symptoms of electrosensitive people from headaches to pins and needles. Calcium ingress into the cytosol in ordinary cells would interfere with cell signalling and increase the rate of specific aspects of metabolism that they are programmed to carry out. It could increase the rate of healing of injured tissues or promote the growth of cancer cells – both good and bad effects of electromagnetic exposure. For more discussion of this topic see Chapter 11 of "Plant Electrophysiology – theory and Methods" ed. A Volkov.

He also says that exposure to the ion cyclotron resonance frequency for calcium (32 Hz in the Earth's magnetic field) gives opposite biological effects to 16 Hz (the potassium resonant frequency). If there are any adverse effects of weak electromagnetic fields on human or animal health, it should be possible to reverse them by simultaneous exposure to 32 Hz. Where people are particularly sensitive to mobile phone pulse frequencies near 16 Hz (e.g. TETRA at 17.6 Hz) it should in theory be possible to partially mitigate these effects by attaching a strong permanent magnet to the handset. This would shift the resonant frequency of the potassium ions in the brain to a higher value (the resonant frequency is directly proportional to the strength of the local DC field) and make them no worse than regular mobile phones.

British police forces are being equipped with smartphones. These will enable them to identify residents in a particular street of interest to them, and other information relevant to them. There may be problems with inadequate mobile bandwidth and security. The take up rate has been about 85%.

Newer pacemakers are equipped with RF feed-through filters incorporated into the internal circuitry, which Censi (2007) believes as a result of a literature review (see bar graph below), gives the pacemaker protection from interference.



A personal communication reported that mobile phones can affect baby monitoring equipment and drips in hospitals. In a study looking at patients' heart rates when using exercise test equipment, electromagnetic interference from a charging mobile phone connected to the same socket as the exercise machine changed the recording of one patient to that of pseudosinus tachycardia at approximately twice the rate of actual basal heart rate (Aliyev [2010](#)).

In 2010, the Cohort Study on Mobile Communications (COSMOS) was launched looking at more than 250,000 people aged 18 to 69 in Britain, Finland, the Netherlands, Sweden and Denmark. The study will work with mobile operators to examine a participant's mobile phone use whether making calls, sending texts or downloading data. It will also look at how users carry their phone, such as in a trouser or chest pocket and whether they use hands-free kits. Participants who agree to take part in the study will fill in an ongoing online questionnaire about their mobile phone use, health and lifestyle. The professors said many of the studies into mobile phone use had only looked for a link to cancer, whereas the COSMOS study will examine all health developments and look for links to neurological diseases such as Alzheimer's and Parkinson's. The large selection of participants will also include those who use mobile phones more than others, allowing the scientists to examine what impact increased use has.

As long ago as 1948, the US reported a possible link between microwaves and testicular degeneration in dogs. In 1953 a study of workers at Hughes Aircraft Corporation found excessive amounts of internal bleeding, leukaemia, cataracts, headaches, brain tumours, heart conditions, etc. in those employees working with radar. In 1976, Soviet military research into microwave radiation at modern mobile phone frequencies, found brain damage in rats subjected to less than 1 / 100th of the radiation emitted by mobile phones; higher risk of heart disease in men exposed to microwave radiation; pre-cancerous cells linked with leukaemia and Hodgkin's disease in exposed workers; memory loss and headaches identical to those reported by mobile phone users; and damage to the immune system. In 2005 it was admitted that a new British army radio produced levels of radiation higher than those allowed by the HPA-RPD. Soldiers are being issued with health guidelines warning them not to stand nearby when the radio is in use for fear of cancer. Mobile phone users expose their brains to higher mean intensities than military personnel are allowed to be exposed to when repairing radar (Cherry 2001).

In the 1990s, according to the Cancer Atlas of the United Kingdom and Ireland [1991-2000](#), brain cancer and lymphomas increased all across the UK. Figures from the Office of National Statistics (ONS) show a 50% increase in frontal and temporal lobe tumours between 1999 and 2011.

Leukaemia, testicular, laryngeal, prostate and uterine cancer rates have gone up nearly exponentially. The tissue in the larynx is particularly sensitive to microwave radiation (Goldberg 2006), as are the testicles. Goldberg says *"Regardless of the type of exposure, the effects of the radiation are cumulative. That is if you received a large exposure over a short period of time, or if you received a low dose exposure over a longer period of time, the results are the same. The total exposure is cumulative; in essence there is no safe dose."* Certainly some of the phone use reported by Hardell (see section 3) as resulting in an increased risk of brain tumour, consists of very small numbers of hours indeed over a long period of time. Interestingly, there seems to be less evidence of problems with a short, high, exposure. We have wondered if perhaps the body's own defence mechanisms kick in if high levels are detected, whereas this mechanism is not triggered by low levels which 'get under' the body's natural defences.

Dr John Holt, an oncologist, in Australia has shown repeatedly that a few minutes exposure to cell phone type radiation can transform a 5% active cancer into a 95% active cancer for the duration of the exposure and for a short time afterwards. Dr Ross Adey ([1999](#)) exposed pregnant rats and their offspring to a modulated RF signal such as would be emitted from a mobile phone. He found an increased incidence of tumours of the central nervous system among rats which had

been given a carcinogen, suggesting that the RF exposure triggered the carcinogen to become an active cancer.

Some users can develop quite serious health consequences immediately after a call, which can persist for up to an hour or so after they stop using the phone. Other people experience similar symptoms but it takes longer for them to appear. Thomas (2008) measured mobile phone use in a randomly selected group and found no association between exposure and acute or chronic symptoms. The measurements for the acute symptom group were only over 24 hours, so it may be that the people did not react immediately.

An analysis of published scientific studies of mobile phone use and brain tumour incidence by Lloyd Morgan, Director of a USA Cancer Registry, shows very concerning results and a definite association with mobile or cordless phone use and some sorts of brain cancer. A study by Redmayne (2010) found a high correlation between mobile phone and cordless phones among Australian young people, with cordless phone use being higher, which may affect the results of some studies into mobile phone use, underestimating both cases' and controls' exposure to RF radiation. Most worryingly is the fact that brain tumours are usually only diagnosed 10 to 25 years after they were initiated. We are only just reaching the period when many people have been using their mobile phone for ten years, and to already see a significant trend is concerning.

In a review of 23 studies, involving 37, 916 people, Myung (2009) concluded that there is evidence linking mobile phone use to an increased risk of tumours, especially if the phone had been used for 10 years or more.

Given that treatment for a single case of brain cancer can cost between \$100,000 for radiation therapy alone and up to \$1 million depending on drug costs, resources to address this illness are already in short supply and not universally available in either developing or developed countries (Davis 2013). If the increased brain cancer risk found in young users in recent studies does apply globally, the gap between supply and demand for oncology services will continue to widen. It is worth noting that brain cancer is the proverbial 'tip of the iceberg', as the rest of the body is also showing effects other than cancers.

As early as 1995, the late Dr Ross Adey, one of the world's most respected and senior research scientists stated "*The laboratory evidence for non-thermal effects of both ELF (power-frequency) and RF/microwave fields now constitutes a major body of scientific literature in peer-reviewed journals. It is my personal view that to continue to ignore this work in the course of standard setting is irresponsible to the point of being a public scandal.*"

The Royal Society of Canada's report in 1999 said, "there are documented biological effects of RF even at low, non-thermal exposure levels including a) blood-brain barrier permeability changes, b) DNA damage, and c) increased cancer in rats". Jerry Phillips, Director of the Science Learning Centre at the University of Colorado, suggests that mobile phone radiation may indirectly lead to cancer by preventing DNA repair mechanisms from working properly, and by producing free radicals, highly reactive molecules that can interact with DNA in cancer-causing ways. It may be that mobile phones don't initiate tumours, but promote or accelerate the growth of existing ones. Some animal studies will investigate only whether healthy rats and mice exposed to mobile phone radiation develop brain cancer - and they may not, if mobile phones are only tumour promoters. It may be that mobile phone RF acts synergistically with other substances to create DNA damage (Tiwari 2008).

At short exposure times (2-12 h), 900 MHz EMF induced DNA breaks in leukaemia cells while longer exposure (24-48 h) affected cell-death (apoptosis), allowing the cells to survive and proliferate (Marinelli 2004).

In March 2001, the Chairman of the Independent Expert Group on Mobile Phones (IEGMP), Sir William Stewart, gave oral evidence to a Trade and Industry Select Committee Inquiry [Trade & Industry 2001, HC330], that included: "*Overall the balance of evidence to date - this is a carefully constructed phrase - suggests that exposure to RF emissions below the national guidelines do not cause adverse health effects to the general population. However, we went on to say that there was now scientific evidence that there may be biological effects occurring at exposures below those guidelines. Biological effects do not necessarily translate into health effects, but neither do they necessarily **not** translate.*"

In August 2002, Professor Michael Kundi and colleagues at the University of Vienna collaborated on producing an information booklet on Mobile Phones and Children, discouraging their use. He emphasised an aspect of cellular biology that he believes has been omitted in discussions of RF radiation and its effect on developing brains "*A child's skull is not only thinner and surely has different dielectric properties because it has more blood vessels - it also contains many more stem cells which can form blood cells. Hence, if RF-MW radiation has an influence on the development of cancer, its effects will be greater for two reasons. First the most vulnerable cells are only millimetres from the antenna. (To my knowledge, nobody has calculated the SAR within the bone marrow of the skull.) And second, the earlier in life a malign transformation occurs, the more likely it will result in a clinical malignancy*".

In May 2010, the US President's cancer Panel reported that "the true burden of environmentally induced cancers has been grossly underestimated" and named cell phones and other wireless technologies as potential causes of cancer that demand further research and precaution. In May 2011, after reviewing 21 scientific studies from 14 countries, the World Health Organisation (WHO) warned for the first time that mobile phones may cause cancer (Baan [2011](#)). Many organisations have suggested that educating people about potential health effect at a time of perceived uncertainty would induce unnecessary fear or anxiety. A study by Boehmert ([2017](#)) challenges this statement. This could well suggest that there may be other, potentially political or financial motives underlying the reluctance to educate.

Even the evidence we now have can only tell us about the damage that is being done today. For more slowly developing illnesses such as leukaemia, other cancers, Alzheimer's and other dementias we will have to look for the results in 5, 10, or even 30 years hence, as is the case with asbestos exposure and cancer diagnosis. UK deaths from mesothelioma (an asbestos-induced cancer) are due to peak between 2020 and 2030 despite the use of asbestos having been banned in the UK for many years.

Roger Coghill, an independent UK scientist, has shown that at field strengths commonly found near mobile phones, and in fact, near other appliances, at any frequencies, RF fields "*cause nitrites to form in virtually any aerated aqueous solution, and with chronic exposure (say 48 hours) achieve concentrations shown by a number of competent studies to de-aminates DNA and impair oxidative phosphorylation.*" He says "*this demonstrates how tumours might derive from such non thermal exposures.*"

Not all studies find effects; Prisco ([2008](#)) found no effect of RF on bone marrow precursor cells which would have an impact on carcinogenesis, neither did Smith ([2007](#)) find increased incidence of cancers in rats exposed to GSM and DCS wireless signals.

In 2002, the German Interdisciplinary Association for Environmental Medicine (IGUMED), said that some of the medical conditions they saw as a consequence of the technology were: learning, concentration and Attention Deficit Disorder; extreme fluctuations in blood pressure, which are harder to influence with medications; heart rhythm disorders; heart attacks and strokes among an increasingly younger population; brain-degenerative diseases (such as Alzheimer's); epilepsy, leukaemia and brain tumours. Some of these are covered in Sections 3-6 of this article.

Dr Michael Repacholi, who used to be Head of the WHO EMF Project said "*Mobile phones have only been around for less than 10 years now and the incubation period for cancer is at least 10, maybe 15 years. So we need to set up the studies so that if there is an impact, it can be found in a reasonable time. With a large study looking at mobile phone users we would see if there is anything we do not yet know about their impact on health.*" In view of what Dr Repacholi said about the time scale for cancer development we wonder whether a few years (the time scale of most longitudinal studies) is long enough to make the 'definitive statement' that WHO believes is possible.

Carl Blackman, past president of the Bioelectromagnetics Society, concluded in a paper published in March 2009, "*the international reviews of the research area since the 1986 report [National Council for Radiation Protection and Measurements, Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields, National Council for Radiation protection and Measurements 1986, 400 pages], have not included scientists with expertise in non-thermal effects (NTE), or given appropriate attention to their requests to include NTE in the establishment of public-health-based radiation exposure standards. Thus, those standards are limited because they are not comprehensive.*"

In October 2007, it was reported that Lloyd's of London was preparing for the next big liability action - for personal injury damages based on the use of cell phone technology. The questions exercising their corporate minds are "*What would happen if, say in 20 years time, the link between the electromagnetic fields (EMF) generated by mobiles is proven to be linked with a high susceptibility to illness? How are London's underwriters protecting themselves from opening the floodgates to future claims without prejudicing policyholders?*"

The Australian Sydney Morning Herald (January 2002), reported the latest research at St Vincent's Hospital on live human brain cells that are being used to test the long-term effects of mobile phone radiation. The team, led by Dr Peter French is testing the centre's hypothesis that mobile phone radiation could cause cancer in habitual, long-term users. The cells are exposed to four daily one-hour time slots of radiation. As the tests were for three to six months, is this really a long-term effect?

It is accepted that short term exposure of mice, or isolated cells, is not conclusive in determining potential risk factors in human cancer development. Cancer is being increasingly recognised as an 'organisational systems' problem, *and no short term speeded up animal experiments are likely to give the same results as extended chronic exposure to humans.* Neither are the number of studies that are investigating static fields.

In a review of studies of the risks of carcinogenesis from mobile phones and their infrastructure, Yakymenko (2010) concluded "*The lack of generally accepted mechanism of biological effects of low-intensive non-ionizing radiation doesn't permit to disregard the obvious epidemiological and experimental data of its biological activity. Practical steps must be done for reasonable limitation of excessive EMR exposure, along with the implementation of new safety limits of mobile telephony devices radiation, and new technological decisions, which would take out the source of radiation from human brain.*"