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 3
Brain tumours and other cancers

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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Brain tumours and other cancers

Data from 3 major cancer registries demonstrate increased incidences of glioblastoma multiforme (a very aggressive form of brain tumour) in the frontal lobe, temporal lobe, and cerebellum, despite decreased incidences in other brain regions. Although this may represent an effect of diagnostic bias, the incidence of both large and small tumours increased in these regions. The cause of these observed trends is unknown. So said Zada (2012); maybe it has something to do with mobile phone use? Dobes had found a significant increasing incidence of primary brain tumours between 2000 and 2008 (2011), including glioblastoma multiforme (2011) particularly after 2006. De Vocht reported (2016) that malignant neoplasms of the temporal lobe had increased faster than expected. A latency period of 10 years reflected the earliest latency period when this was measurable and related to mobile phone penetration rates, and indicated an additional increase of 35% during 2005-2014. Bortkiewicz (2017) carried out a meta-analysis of twenty four studies (26 846 cases, 50 013 controls) reported up to March 2014. A significantly higher risk of an intracranial tumour (all types) was noted for the period of mobile phone use over 10 years.

A major series of studies was carried out internationally from the beginning of the 2000s, looking at cancers and mobile phone. The studies had different results and were exposed to criticisms for a variety of different flaws in study protocol. We produce some of the results below, including other results where they seem to be relevant.

13-nation Interphone study findings, and others

The Interphone studies have been highly criticised for inconsistency. A paper by Lloyd Morgan (2009) states *"The Interphone studies have 11 flaws, and the Swedish studies have 3 flaws"*. The 11 flaws are: selection bias; insufficient latency time; definition of 'regular' phone use; exclusion of young children and adults; no investigation of brain tumour risk from cell phones radiating higher power levels in rural areas; exclusion of exposure to other transmitting sources; exclusion of some brain tumour types; exclusion of tumours outside the cell phone radiation plume; exclusion of brain tumour cases because of death or illness; recall of accuracy of cell phone use; and funding bias. Although the Interphone studies are being held up by industry and governments as the ultimate word on the health effects of mobile phones, it is difficult to see how this position can be maintained in view of the flaws they clearly possess, though Swerdlow (2011) manages it! He does not mention DECT as a confounder, though they did gather the data, and the Cardis paper is not mentioned, neither are De Vocht, the later Hardell studies, Khurana, Myung, nor Kundi. It is tempting to think of this paper as being rather hard spun. However, many of them show increased risk of different types of brain tumours that are concerning, especially if the risk is underestimated.

Here are some of the findings:

- In 2005, Schoemaker's study including 5 countries, found almost a doubling in risk of developing acoustic neuromas after 10 years of mobile phone use. Hardell (2005) found the risk of acoustic neuroma increased over 4 times with analogue phone use or over 8 times if used for more than 15 years; digital phones doubled the risk. Schüz did not find this effect (2011), in fact, he found that using a mobile phone had a slightly protective effect. We have come to expect that Schüz often finds no effect when compared with other researchers' results, however, he did conclude that because of the usually slow growth of acoustic neuromas and possible diagnostic delay, the situation needs to be monitored carefully.

- In 2006, in a UK study by Hepworth, and a re-analysis of the INTERPHONE data by Grell (2016), a significant increase in the risk of developing gliomas on the same side of the head

as the patient said they most often held the phone was found. This finding was despite the fact that the researchers excluded half the people who developed gliomas because they died before they could be interviewed. Carlberg & Hardell (2014) found a decreased survival time for glioma patients who were long-term users of mobile and cordless phones. In 2009, Hartikka found a doubling in incidence of gliomas in phone users. Hours (2007, Hardell 2015b) found an increased risk of glioma among the heaviest users: long-term users, heavy users, users with the largest numbers of telephones. The use of mobile phone for 3 or more hours a day showed a consistent pattern of increased risk for the mutant type of p53 gene expression in the peripheral zone of the glioblastoma, and that this increase was significantly correlated with shorter overall survival time (Akhavan-Sigari 2014). Gong (2014) and Wang & Guo (2016) in a review and meta-analysis of mobile phone use and glioma incidence found an increased risk with long-term mobile phone use, including a doubling of incidence of low-grade glioma with long-term use.

Barchana (2012) found the high-grade glioma incidence increased significantly from 1980-2009 but in the period after mobile phones were introduced (1994-2009) a lower, non-significant rate of increase was observed in males and a lower significant increase in females. A shift towards left-sided tumour location for all adult gliomas combined and separately for low grade gliomas and high grade gliomas was noted from 1995 onward. The shift was more marked for those who were diagnosed in ages 20-49.

- Schüz, who led the German team (2006), found a doubling in risk for gliomas after 10 years mobile phone use. A further German study was published in the BMJ in June 2008, stating that *"mobile phones, cordless phones, and cordless base stations next to beds are safe, pose no risk of cancer to adult users and do not cause headaches or sleeping problems."* This turned out to be a grossly misleading summary of the study which ***actually*** concluded *"High frequency electromagnetic fields such as those found, for example, near transmitters (e.g. radio frequency towers and mobile telephone base stations) or when using mobile end devices (cell phones) are suspected of having adverse health effects on man."* The misleading BMJ summary ***did*** mention that genetic activity changed after irradiation, and that the study authors could not say whether exposure for more than 10 years posed any risks to health. Little (2012) found that the modest increase in glioma risk in the USA was consistent with the Interphone findings.

- In 2007, a group led by Lahkola studying cases of glioma from 5 North European countries, found that regular mobile phone use for 10 years or more was associated with an increased risk of developing this type of brain tumour. The increased risk was found despite the fact that 'regular' was defined as 'on average once a week during at least 6 months.' This definition is likely to dilute the findings, including, as it will, people who hardly ever use their phones. Therefore the actual increased risk may well be higher. They found a significantly increased risk of developing a tumour on the side of the head that the phone is used. In 2002 Auvinen found a weak association between glioma incidence and the use of analog phones, though this was based on subscriber, rather than user information.

- The Israeli study (Sadetzki 2008) found a 50% increased risk of developing salivary gland tumours (PGTs), both benign and malignant. A study by the Israeli Dental Association between 1970 and 2006 reports a large increase in cancers of the salivary gland in Israel which may be related to the use of mobile phones (Haaretz daily paper July 2009). *"Between 1980 and 2002, the number of parotid salivary tumours has remained stable at 25 per year, whereas this figure rose to 75 during the next 5 years"* said Avi Zini, Hadassah School of Dental Medicine. Every fifth patient was under the age of 20. The risk increases by 34% if you are a regular mobile phone user and have used a phone for 5 years; 58% if you have

had more than 5,479 calls in your life-time; 50% if you have used a mobile phone for 5 years or more and have spoken on the phone for more than 266.3 hours. If you live in a rural area your risk increases by 81% if you have made more than 18,996 calls in your life-time and 96% if you have a life-time exposure of more than 1,035 hours. They concluded *"Based on the largest number of benign PGT patients reported to date, our results suggest an association between cellular phone use and PGTs."* Cigarette smoking was significantly more common among the cases and may indicate a synergistic effect. The authors recommended a precautionary approach to mobile phone use, as their results suggested a relationship between long-term and heavy cellular phone use and parotid gland tumours, as also did Duan (2011) and Al-Qahtani (2016). Söderqvist (2012) concludes that *"our data add to the evidence against there being an increased risk for parotid gland tumours associated with light-to-moderate use of wireless phones and for less than 10 years of use but offers little information on risk related to more prolonged and/or heavy use"*.

- The studies by Deltour (2009) and Ahlbom (2009) looking at the incidence of glioma and meningioma between 1974 and 2003 reported no significant increase. This is not really surprising as the time scale is too short to identify an increased risk for mobile phone use as they have not been in widespread use for long enough even at the latter end of the research data. Carlberg (2013) found an increased risk of meningioma in those with the highest cumulative use of a mobile or cordless phone. Hardell (2005) found an increased risk of meningioma with the use of analogue, digital and cordless phones. Dr Alison Ross, Cancer Research UK's senior science information officer said *"Overall, the scientific evidence tells us that using mobile phones for less than 10 years does not increase the risk of cancer. However, brain tumours often take a very long time to develop so we will need to look for any future changes in incidence rates to see if mobile phones could pose any longer-term risks."*

- Cardis (2010) reported a greater incidence of brain tumours on the same side of the head as the side they habitually used to make phone calls. This was reported after relatively short-term use compared with brain tumour latency periods, and the authors concluded that "*The possible effects of long-term heavy use* [about 3 hours a week] *of mobile phones require further investigation."* This suggestion was supported by Saracci & Samet (2010).

- Cardis (2011) found increased risk for gliomas in the most exposed part of the brain in those with 10+ years of mobile phone use.

- Cardis (2011), in a further Interphone paper, commented "*While amount and duration of use are important determinants of RF dose in the brain, their impact can be substantially modified by communication system, frequency band and location in the brain. It is important to take these into account in analyses of risk of brain tumours from RF exposure from mobile phones"*.

In 2010, The Interphone Study group finally reported an increased risk of glioma and, to a certain extent, meningioma at the highest exposure levels, for ipsilateral exposures, and for glioma, for tumours in the temporal lobe. They did not separate out users aged 20-29, the age group that Hardell has found particularly susceptible to developing brain tumours (2004). In a meta-analysis by Hardell (2009), he re-iterated a consistent pattern of an increased risk for glioma and acoustic neuroma after more than 10 years of mobile phone use. Cardis (2011) reported a slightly greater risk of acoustic neuroma in the heaviest users, but concluded that it was a bit early to be definitive, as acoustic neuromas grow slowly.

Papers do not usually address, or even discuss, the real ELF magnetic field pulses that surround handsets, especially GSM ones, that result from time-varying currents taken from the battery. ELF magnetic fields have been classified as IARC 2B (possibly carcinogenic) since 2002. The levels close to the handset can exceed 50 microteslas and the levels through most of the user's head by

more than 1 microtesla. Morgan recommended in 2015 that the classification be changed to 2A **probable** carcinogen due to the increased research since the previous classification.

Brain tumours

The 737 minutes per month that US mobile phone users talk on their phones, on average, make current users indistinguishable from the heavy user of 10 years ago. This certainly has implications for the conclusions of many of the research studies showing increased risk of cancer, for heavy users of mobile phones.

Whether mobile phone use causes brain tumours or not is difficult to establish for certain. This is possibly because:

a) it can take 5 -15 years from initiation to the clinical diagnosis of a brain tumour (though some researchers (Abdus-salam 2008) have suggested we need to allow up to 40 years when analysing brain tumour risk), or

b) people may not be equally susceptible to RF-induced brain cancer, possibly in absolute numbers or in the way it develops. It may be that brain cancers occur not directly as a result of RF exposure, but via an intermediary condition such as a reduction in the immune response, or multi-causal factors (genetic predisposition, chemical DNA damage, virus infections, occupational exposure, lifestyle, etc) or off-setting factors.

A paper by French (2001) develops a theoretical mechanism by which radiofrequency radiation from mobile phones could induce cancer, via the chronic activation of the heat shock response. Upregulation of heat shock proteins (Hsps) is a normal defence response to a cellular stress. However, chronic expression of Hsps is known to induce or promote oncogenesis, metastasis and/or resistance to anticancer drugs. The authors propose that repeated exposure to mobile phone radiation acts as a repetitive stress leading to continuous expression of Hsps in exposed cells and tissues, which in turn affects their normal regulation, and cancer results. This hypothesis provides the possibility of a direct association between mobile phone use and cancer, and thus provides an important focus for future experimentation. An example of an off-setting factor could be that brain cancer rates might be much higher in those people who have easy RF breaches of the blood-brain barrier. These susceptible people may experience symptoms from mobile phone use that result in their significantly reducing their usage times. Sirav & Seyhan in their study (2016) conclude that exposure of rats to electromagnetic fields of 900 MHz or 1800 MHz might increase the permeability of the blood brain barrier with sex-specific differences, with females being less affected by 1800 MHz emissions.

Dariusz Leszczynski, professor of biochemistry, University of Helsinki, Finland said in 2016 that it could be possible that mobile phone radiation itself does not cause cancer but that long-term exposure increases the risk of developing cancer when other causes are part of the picture; that mobile phone radiation might not cause cancer in and of itself. Instead, it might activate regulatory processes and accelerate development of the disease, he speculated. This hypothesis of cocarcinogenicity may explain the apparent discrepancy that has been seen in previous studies. Findings from the experimental models that were evaluated by IARC experts in 2011 suggested that mobile phone radiation alone does not cause cancer, but there may be "cocarcinogenic" properties.

Epidemiologic case-control studies show an increase in the risk for brain cancer not because mobile phone radiation causes it but because it accelerates the development of brain cancers caused by other carcinogens or that occur because of spontaneous gene mutations. This may explain why the incidence of brain cancer in the population is low compared with the high rate of mobile phone use because the increases are solely due to cocarcinogenic effects of mobile phone

radiation. Not all users are in danger of developing brain cancer, only those who have other carcinogenic or genetic factors.

Liu (2012) found that exposure to 1950-MHz TD-SCDMA may not promote tumour formation, but continuous exposure damaged the mitochondria of astrocytes and induced apoptosis.

Joel M. Moskowitz, PhD, director, Center for Family and Community Health, School of Public Health, University of California, Berkeley is not convinced. "I think he overstates the case for tumour promotion and understates the role of tumour initiation," he commented.

What happens if it does both? Perhaps some types of tumour, exposure and genetic inheritance can result in the initiation of a tumour, whereas other factors can promote a pre-existing tumour, and other factors do not involve tumour development at all. It certainly could explain the lack of consensus emerging from the research.

Massachusetts senator Edward Kennedy's brain cancer has been linked to habitual mobile phone use. The neurosurgeon who treated US Attorney Johnnie Cochrane's brain tumour in 2005 said he would not rule out a link between mobile phones and cancer.

Lloyd Morgan, Director of the Central Brain Tumour Registry of the United States, said that based on a 30 year latency time for brain tumours, he projects that there could be up to 1.6 million mobile phone brain tumours in the USA by 2019. At a treatment cost of $250, 000 per patient, this would cost $400 billion. It would also require significantly more neurosurgeons and support staff by then.

New Zealand's Dr Neil Cherry found 66 epidemiological studies showing that electromagnetic radiation (EMR) across the spectrum increases brain tumours in human populations. "*I am expecting, because these cell phone exposures of the head are far higher than even the highest military exposures for which we find very large increases in cancer, that cell phone users will be showing these symptoms. But the latency of cancer is decades. And so we need to study a large population for about two to three decades using these cell phones for a large increase in brain tumours to be observed*".

In 2004 a review of cell phone research by Michael Kundi and colleagues in Vienna revealed that nine published studies showed an enhanced cancer risk from cell phones with increasing risk for longer duration of phone use. In a later paper Kundi looked at 33 epidemiologic studies in the peer-reviewed literature about mobile phone use and cancer, 25 of which were about brain tumours (2009). He concluded there was an increased risk, but it was difficult to quantify because of insufficient information on long-term use.

In a meta-analysis by Lagorio & Röösli (2014), they say estimates of glioma and acoustic neuroma risk in long term users were consistent but not for meningioma.

Repacholi (2011) was also cautious about making statements about the risk of long-term risks of brain or other head tumours at this time, after a review of papers available.

Khurana (2009) also reviewed 11 papers and concluded that *"there is adequate epidemiologic evidence to suggest a link between prolonged cell phone usage and the development of an ipsilateral brain tumor"*. Larjavaara (2011) found that gliomas were located in the part of the brain closest to the source of RF exposure from a mobile phone. Ali Kahn (2003) found right sided gliomas in right handed people, but the results were not statistically significant. The study was quite early to detect cancer incidence.

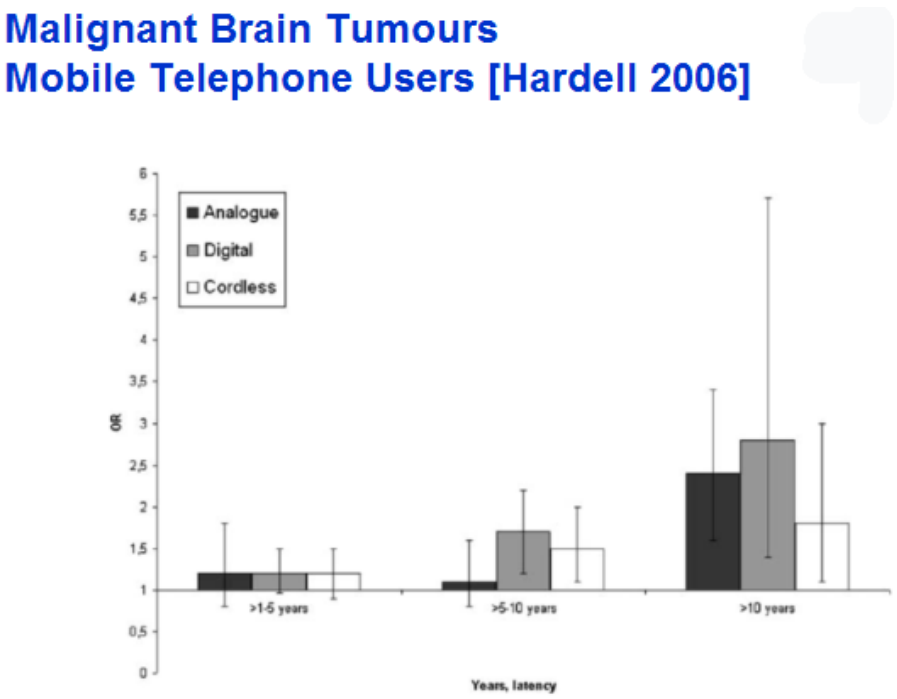
Takebeyashi (2006) found only a very slight increase in the risk of acoustic neuromas 5 years after mobile phone use started. They only recruited people between 2000 and 2004, so maybe we wait and see, until the data is more up to date with respect to current phone use.

Mobile phone use may not cause brain tumours but may influence the speed of development of the tumour. There has been an unexplained 40% increase in brain tumours in Australia in the last 20 years.

- A team at the Duke Comprehensive Cancer Center in North Carolina is heating up tumours with microwaves. This opens up the pores in blood vessels, and allows the liposomes used in chemotherapy to enter the tumours. It is uncertain what may be allowed into the brains of healthy people when exposed to microwaves.

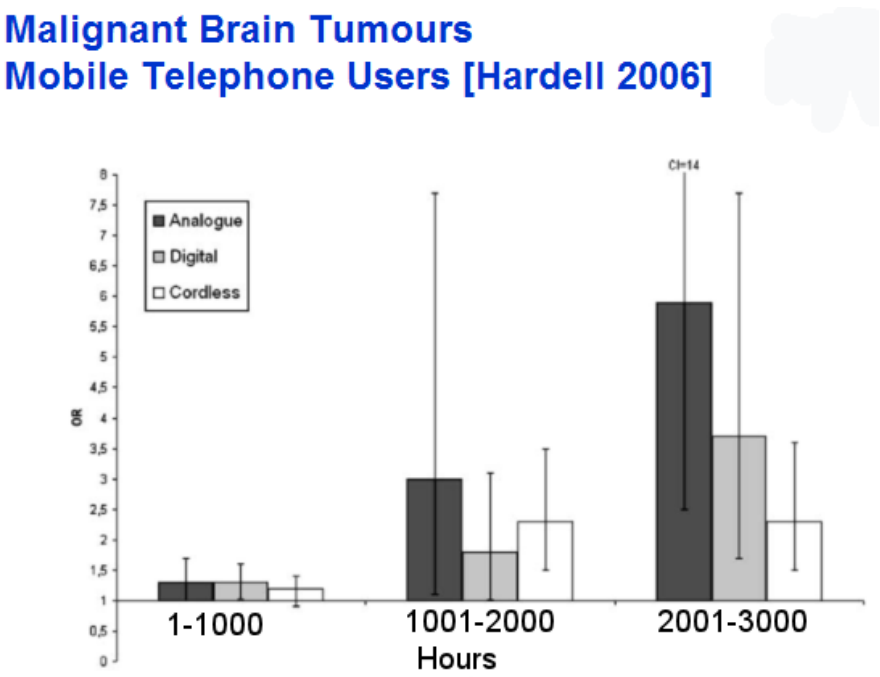
- Dr George Carlo found that the rate of death from brain cancer is higher among mobile phone users, and the risk of their contracting a rare brain tumour is more than double. There was a correlation between brain tumours on the right side of the head and use of the phone on the right side of the head (2001). His laboratory studies found that radiation caused genetic damage.
- A study by Cardis (2008) examined the distribution of energy within the brain as a result of mobile phone use. She found that over 97% of the radiation was absorbed in the brain hemisphere where the phone is used, more than 50% in the temporal lobe. She concluded *"Analyses of risk by location of tumour are therefore important for the interpretation of results of studies of brain tumours in relation to mobile phone use."* What cannot always be determined is the percentage of time spent holding the phone to the other side of the head as symptoms attributable to tumour growth (before diagnosis) make holding the phone on the original side uncomfortable.
- Coureau (2014) found in a study carried out in four areas of France between 2004 and 2006 (CERENAT) that there was a possible association between heavy mobile phone use and brain tumours. Risks were higher for gliomas, temporal tumours, occupational and urban mobile phone use.
- In Sweden, Lennart Hardell, a cancer specialist, and colleagues (2000, 2001, 2002, 2002, 2003, 2009) found the risk of getting brain cancer was at least 2.5 times higher for people who used mobile phones and DECT cordless phones frequently for more than 5 years (especially in rural areas 2005), or 3.4 times higher after having used a phone for 2,000 hours or more (Hardell 2010). In 2002, from what is claimed to be the largest case-control epidemiology study in the world (1,617 cases and a similar number of controls), he published 3 papers reporting significant increases in risk of benign brain tumours (Hardell 2006), malignant astrocytomas, and acoustic neuromas amongst mobile phone users.

In 2006, Hardell and colleagues found that the risk of developing malignant brain tumours and acoustic neuromas increased with time, and the cumulative number of hours the phone was used. This was true of analogue and digital mobile phones. Using a cordless telephone for 98 hours in 5 years (e.g. 98 minutes a month or 3 minutes a day) increased the risk by a half. Using it for 5 more years doubled the risk, and more than 10 years nearly tripled the risk (Hardell 2006). Professor Hardell commented *"The health risks from a DECT phone are the same as for a regularly used mobile. They are usually in rooms where people spend a lot of time and people tend to spend longer on them than they do on a mobile."*



In 2013, Hardell looked at the data from two periods, 1997-2003 and 2007-2009. His conclusions were that use of analogue phones tripled the risk of developing an acoustic neuroma (also Hardell 2003) and this became nearly 8 times more likely with 20 years or more use. Hardell (2015) suggests that the Swedish Cancer Register is not the best place for obtaining data about brain tumours as a large part of brain tumours of unknown type are never reported to it. Also, the frequency of diagnosis based on autopsy has declined substantially due to a general decline of autopsies in Sweden. Using the Inpatient Register during 2007-2013, tumours of unknown type in the brain or CNS increased by over 4% per year. Digital 2G phone use made the chance of developing acoustic neuromas 1 and a half times more likely, which became nearly twice as likely with 15 years use or more. 2G and 3G increased to more than 8 times the risk with 20 years or more use. Ipsilateral use resulted in a higher risk than contralateral use and the risk increased per 100 hours cumulative use and per year of use. The percentage tumour volume increased per year of use and per 100 hours of cumulative use. 100 hours is not much use cumulatively, and the evidence for tumour promotion by phones over time is becoming unquestionable. Moon (2014) also found that acoustic neuromas were found more often on the side a mobile phone was used and that tumour size was strongly linked to the amount the phone had been used.

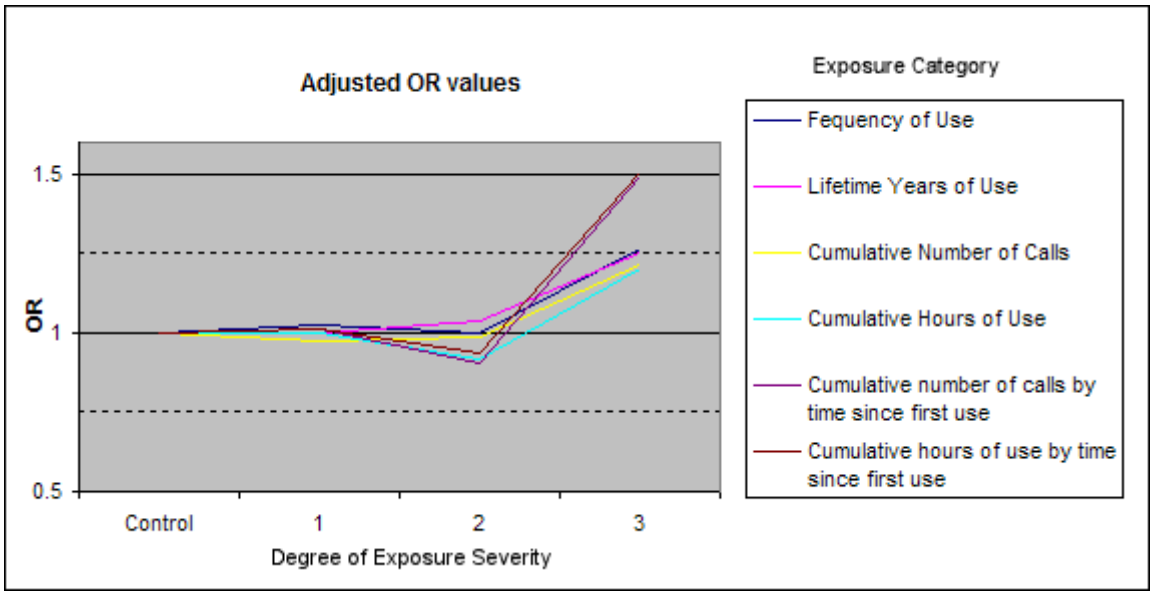
Another study by Hardell (2013c) found confirmation of previous results of an association between mobile and cordless phone use and malignant brain tumours. This provides support for the hypothesis that RF-EMFs play a role both in the initiation and promotion stages of carcinogenesis.



Hardell found that people under the age of 20 years were almost 4 times more likely to develop a malignant brain tumour if they used a digital mobile phone (Hardell 2006b, 2011). They were twice as likely to do so if they used a digital cordless phone.

- Lönn from the Karolinska Institute in Sweden (2004) found a doubling of risk for acoustic neuroma after 10 years and a quadrupling of risk for a tumour on the same side of the head as a phone was used. They found no increased risk for parotid gland tumours (2006).

Of the most severe points on the graph below, two are now fully statistically significant and three are marginally statistically significant, all for increased brain tumour risk.



For further commentary on these findings see:

http://www.powerwatch.org.uk/news/20070124_mobile_phone_glioma.asp

- In April 2002, Dr Joshua Muscat (New York University), published a study in the journal Neurology, in which they "*found no link between mobile phone use and acoustic neuromas*". There was a time-scale problem with this study in that Dr Muscat said that their study focused on short-term mobile phone use and recommended more studies on longer-term use. He did, in fact, find a slightly elevated risk for subjects with three or more years of phone use. This seems to support Hardell's findings. In 2011, Sato found a tripling in risk of acoustic neuroma with the use of a mobile phone for more than 20 minutes per day on average.

Earlier (2000), Dr Muscat had reported a doubling in risk of neuroepithelial tumours, a rare form of soft brain-tissue cancer, and in 2006, he reported that mobile phone use is unrelated to the risk of neuronal cancers. There is quite a discussion about Muscat's results and spin - see: http://www.powerwatch.org.uk/news/20000602_vodafone.asp

- Salahaldin & Bener (2006) found that the newly developed country, Qatar, had a higher incidence of acoustic neuromas than in other countries. Mobile phone use in tumour patients averaged at 14 times per day (8-20 range) for more than 5 years.

In September 2007, Lawrie Challis, (chair of the Mobile Telephony Health Research group) said there was a "*slight hint*" of increased risk of brain tumours among long-term mobile phone users. Because children have been shown to react differently to environmental stimuli, he felt it "*possible that they were at greater risk*". He also commented, with respect to the research findings that there seemed to be little evidence of increased risk among people who had used their mobile phones for less than 10 years, that "*knowing what happens in the short term tells you nothing about what happens in the long term.*" Indeed, of thirteen epidemiological studies published since 1999 on mobile phone use for more than 10 years, eight suggest a 2-3 fold risk increase.

In 2008, Hardell evaluated 10 studies on gliomas, 9 studies on acoustic neuromas, and 7 studies reporting on meningiomas. He concluded that the meta-analysis gave a consistent pattern of an association between mobile phone use and ipsilateral (same side of the head that the phone is used) glioma and acoustic neuroma when the phones had been used for 10 years or more. An overview of his studies showed a doubling in glioma incidence in the temporal lobe after 10 years, and an increase in meningioma and acoustic neuroma incidence (over twice as likely for ipsilateral use (Hardell 2013). Takebayashi (2008) found a non-significant increase in risk for glioma in people in the heavily exposed group of mobile phone users. Another two meta-analyses by Levis (2011) and Bielsa-Fernández & Rodríguez-Martín (2018) found an increase in risk of head tumours (especially ipsilateral) induced by long-term mobile phone use.

A study from Denmark by Schüz (2006) found no evidence of increased risk of developing a tumour with short or long-term use of a mobile phone. This was hardly surprising, as, amongst other shortcomings, the study ignored all mobile phone users that started their contracts after 1995 (most mobile phone users in the country now fit into this category) and ignored all non-contract usage (pay as you go). As a result, the control group will include at least as many mobile phone users as the supposedly exposed group, and probably considerably more unless it is really true that less than 16% of the Danish population use a mobile phone. Another study by Schüz et al found no effect (Christensen 2005). A study by Lehrer (2010) found a significant correlation between the number of mobile phone subscriptions and brain tumours in nineteen US states.

Eye cancer

Stang (2001) found a 4-fold increase in risk of developing uveal melanoma, a cancer of the eye, as a result of exposure to mobile phones, though a subsequent study (2009) found no such association.

Leukaemia

Cooke (2010) found a non-significantly raised risk of leukaemia in people who first used a mobile phone 15 or more years ago.

Trivino Pardo (2012) evaluated the effect of high-frequency EMF on gene expression in acute T-lymphoblastoid leukaemia cells and identified functional pathways influenced by 900 MHz MW-EMF exposure, which could have adverse health effects.

Melanoma

Johansen (2002) found no increase in the incidence of malignant melanomas with the growth of mobile phone use in Denmark, neither did Frei find an increase in CNS tumours (2011), though the study is seriously flawed. Hardell (2011) reported that the incidence of cutaneous malignant melanomas has increased in Sweden. In the most exposed areas, temporal area, cheek and ear cumulative use of a mobile or cordless phone of more than 365 hours doubled the risk of melanoma in the group using the phone for more than 1-5 years, and highest risk was for first use no matter where the melanoma occurred.

Personal experiences

AH, aged 43 (reported in the Mirror November 2009), is convinced the rare ameloblastoma tumour in his jaw was caused by his heavy phone use – 6 hours a day, and then he slept with it next to him. NW, aged 52, developed a near-fatal acoustic neuroma in 2001 and believes (as does his consultant) that it was a direct consequence of years of heavy mobile phone use (Wigan Evening Post, November 2009).

Pituitary tumours

An increased risk for pituitary tumours was observed with mobile phone use (nearly 8 times) and duration (more than 8 times) of mobile phone use (Leng & Zhang 2016).

Prostate

Şimşek (2003) found that mobile phone use did not significantly affect prostate-specific antigens (PSA) values (high levels indicate a greater likelihood of the presence of cancer), at least in the short-term.

Salivary gland tumours

In a meta-analysis by de Siqueira (2017) mobile phone use was associated with greater odds of developing a salivary gland tumour.

Skin tumours

Low-level GSM radiofrequency radiation seemed to accelerate tumour development in a study by Heikkinen (2003).

Stem cells

In a discussion paper by Belyaev & Grigoriev (2007), they concluded that "*It has been shown that non-thermal microwaves affect cells of various types including stem cells and reproductive organs. Stem cells represent especially important cellular model because recent data suggest that different cancer types, including leukemia, have a fundamentally common basis that is grounded on epigenetic changes in stem cells.*"

Thyroid cancer

There have been large increases in thyroid cancer in the USA since the 1980s (Chen 2009). Thyroid cancer is known to be caused by exposure to ionising radiation, but there has been no evidence of an increase in exposure to such radiation among Americans. Another cause is felt to be responsible. Primary tumours under 1 centimetre have increased almost 10 % per year in men and 8.6% per year in women. Larger ones exceeding 4 centimetres increased 3.7% per year in men and 5.7% per year for women. Cancers that had spread are also increasing at a similar rate.

The rate of thyroid tumor incidence increase is alarming: 9.9% per year for men and 9.6% for women (1997-2005). An annual 9% increase per year doubles the incidence rate every 8 years.

Carlberg (2016) believes that the increase of thyroid cancer cannot be attributed to better diagnostic procedures. Increasing exposure to ionizing radiation (e.g. computed tomography) and to non-ionizing radiofrequency radiation should be further studied. Non-ionizing radiation includes mobile phone frequencies.

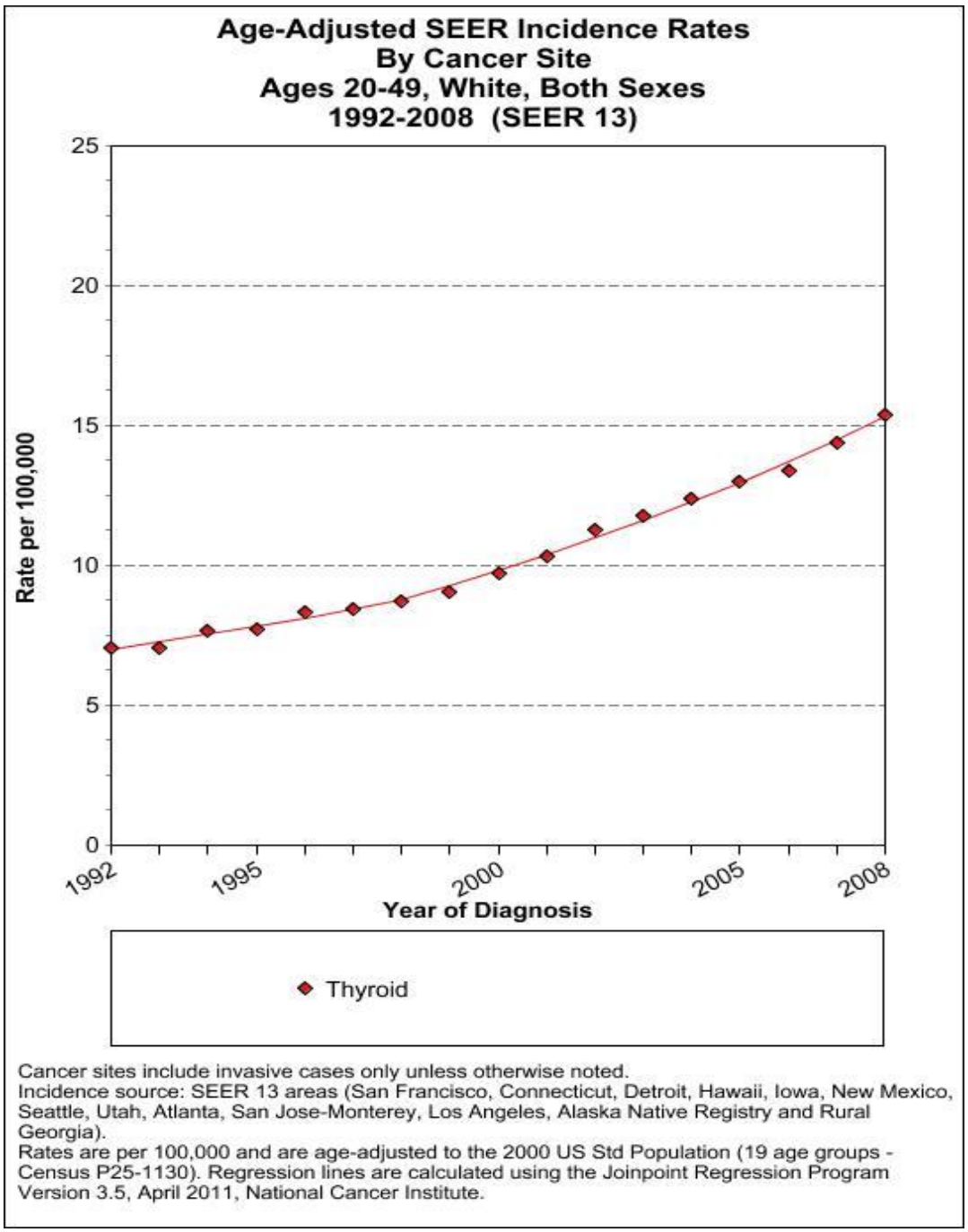
Of course, the thyroid gland is in the neck, close to where a mobile phone is held. DNA damage here could cause thyroid cancer, and it could also result in a partial loss of thyroid activity in some people, causing hypothyroidism, one symptom of which is obesity. People have wondered whether this might add to the possible causes of the obesity problems faced by society.

Other cancers

Lerchl (2015) found that tumours of the lungs and livers and lymphomas were significantly higher in exposed animals even at levels of 0.04 and 0.4 W/kg SAR. He hypothesised that the tumour-promoting effects may be caused by metabolic changes due to the RF exposure.

Tumour cells

A study by Yang (2012) found that microwave radiation can promote tumour transformation of NIH/3T3cells.



Milham (2008) found a 13 times higher risk of thyroid cancer among teachers exposed to dirty electricity in the schools where they worked, with a much shorter latency time (3 years) compared with other cancers (10 years). One of the authors (Lloyd Morgan) suggests that thyroid tissue may therefore be particularly vulnerable to non-ionising as well as ionising radiation.

The Interphone feasibility study initially was expected to investigate the incidence of head and neck tumors; but this study never happened. There is no question that electromagnetic fields coupled to the human body will result in electrical currents that concentrate in the neck because of the neck's smaller cross-sectional area.

The latency period for thyroid tumors has been considered to be about 20-38 years after exposure to ionizing radiation, although this is not accepted by everybody. The average latency time for the two thyroid tumors we found at the La Quinta Middle School was 3.0 years, and a study of Estonian and Latvian workers who were part of the Chernobyl nuclear reactor clean-up effort,

had a significant risk of thyroid cancer with a study period from 1993-1997. This indicates a thyroid cancer latency time of between 7 and 11 years (the reactor was destroyed in 1986).

Implications

There was a noticeable drop in the value of mobile telecoms industry shares when IARC ruled that RF was 'possibly carcinogenic' on 31st May 2011. Matthew Lynn's "City View" in MoneyWeek 13th June 2011 includes: *"If a link is ever proved beyond a doubt, you don't want to be holding the shares or bonds of the main players in the industry."* In 2013, Hardell and Carlberg produced a paper in which they concluded *"Based on the Hill criteria, glioma and acoustic neuroma should be considered to be caused by RF-EMF emissions from wireless phones and regarded as carcinogenic to humans, classifying it as group 1 according to the IARC classification. Current guidelines for exposure need to be urgently revised."*

Legal Viewpoints?

In May 2005, Sharesa Price was awarded $30,000 to pay her medical bills and other expenses, when a judge was convinced her brain tumour was caused by radio-frequency radiation from her occupational mobile phone use several hours a day.

In December 2009, as a result of the evidence put forward by Hardell, a judge on a Labour Tribunal recognised the occupational origin of National Public Insurance Institute employee Innocenzo Marcolini who developed a tumour on his trigeminal nerve, having worked for long hours using a mobile phone and a cordless phone. He is now 80% disabled as a result of this (Reuters). The employer is to pay all court costs. This judgement makes it possible for employees in Italy to insist on the supply of a corded phone and to advise their employer that they are legally liable for future damages should they insist on the use of a cordless phone. This ruling, if challenged in court, may apply to other EU countries. The Consumer Centre in South Tirol advises everyone to insist on a written declaration regarding the use of telecommunication equipment which expressly states that the employer takes all responsibility for any future medium or long term consequences.

The legal departments of mobile phone manufacturers have inserted a warning about holding the phone against your head or body into the fine print of the slip inside the phone packaging. The chances are that this will be thrown away with the rest of the packaging. Iphones are to be kept at least 5/8 inch away from the head and Blackberrys should approach no closer than an inch.

In April 2017, The Italian court, in Ivrea, agreed that a man's brain tumour was linked to his mobile phone use. It awarded Robert Romero 500 euros (£418) a month in compensation. He had claimed that using his business mobile phone for three or four hours a day, over a period of 15 years, led to the growth of the benign tumour. His lawyer, Stefano Bertone added that the firm has other cases in other parts of Italy. *"We have also been approached by an interesting number of people in the last 24 hours saying they have experienced the same kind of thing. And they can show they have accumulative use of mobile phones that's exceeding 1,000 hours,"* he said.
http://www.bbc.co.uk/news/technology-39666822