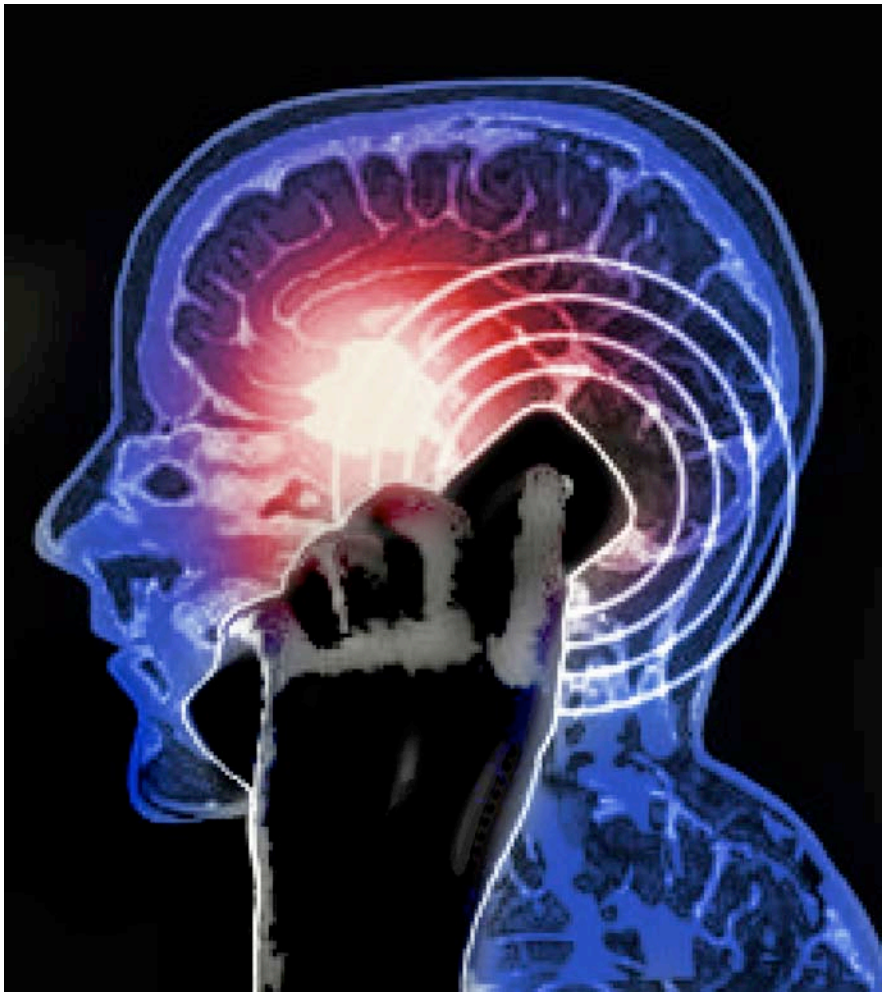

# Cellphones and Brain Tumors

# 15 Reasons for Concern

*Science, Spin and the Truth Behind Interphone*

*August 7, 2009*

*"Today, more that ever before, science holds the key to our survival as a planet and our security and prosperity as a nation. It's time we once again put science at the top of our agenda and work to restore America's place as the world leader in science and technology. It's about listening to what our scientists have to say, even when it's inconvenient—especially when it's inconvenient."*

**—President Barack Obama**

# The Precautionary Principle

*"Better Safe Than Sorry"*

*When an exposure raises the possibility of harm to human health, and low or no cost solutions are available, then the Precautionary Principle action should be taken.*

# *Endorsements*

We the undersigned believe it is essential governments and the media understand the independent science regarding cellphone use and brain tumors, as well as the design flaws of the 13 country Interphone study. The widespread nature of wireless telecommunication systems requires that society understand any potential risks, and that this understanding be as current as possible with the latest evidence-based science. We endorse both the message and urgency of this report.

*Awaiting confirmation from those invited to endorse the document.*

# *Editors*

The following have been responsible for the creation and editing of the document into its current form:

**Primary Author**

*L. Lloyd Morgan, USA, Powerwatch, Electronics Engineer (retired)*

**Co-Authors**

*Elizabeth Barris, USA, Consultant*

*Janet Newton, USA, EMR Policy Institute, President*

*Eileen O'Connor, UK, Radiation Research Trust, Director*

*Alasdair Philips, UK, Powerwatch, Director; Electronics Engineer & EMF Consultant*

*Graham Philips, UK, Powerwatch, Technical Manager (ICT Systems)*

*Camilla Rees, USA, ElectromagneticHealth.org, Founder*

*Brian Stein, UK, Radiation Research Trust, Chairman*

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# Cellphones and Brain Tumors

# 15 Reasons For Concern

## *Science, Spin and the Truth Behind Interphone*

## Introduction

***Cellphones and Brain Tumors: 15 Reasons for Concern*** has been prepared to enable balanced reporting on this important subject. It provides information on scientific findings from studies, independent of industry funding, as well as information on telecommunication industry-funded studies, on the risk of brain tumors from cellphone use. Further, it includes background information on the soon to be published, Telecom-funded Interphone study.

In particular, the report's purpose is to inform journalists and government officials of the independent scientific findings that raise red flags, and also to address the design flaws in the Interphone study protocol that results in an underestimation of the risk of brain tumors from cellphone use. This report is fully referenced to enable further investigations and for detailed fact checking.

We urge all readers to review the results from *independent* studies on the risk of brain tumors from cellphone use discussed in this report, and to become familiar with the Interphone study's design flaws (see Appendix 1, *A Description of Interphone Study's Design Flaws*). We also urge readers to learn about the Precautionary Principle actions (commonly referred to as the "Better Safe Than Sorry" approach) that can be implemented by governments and by individuals to greatly reduce cellphone radiation exposure (see Appendix 2, *The Precautionary Principle Applied to Cellphone Use*).

## Major Points

- **Studies, independent of industry, consistently show there is a "significant"[1] risk of brain tumors from cellphone use.**

[1] Significant as used throughout this document, is a shorthand term-of-art for "statistically significant" which means there is a 95% or greater probability that the finding is not due to a chance finding. Conversely, "non-significant" is short hand for "statistically non-significant" meaning that there is less than a 95% confidence that the finding is due to chance. Also see the footnote in Concern 2.

- **The electromagnetic field (EMF) exposure limits, advocated by industry, and used by governments, are based on a false premise that the cellphone's electromagnetic radiation has no biological effects except for heating.**

  There are thousands of studies showing biological effects from electromagnetic radiation at exposure levels far below where heating occurs (non-thermal effects). The BioInitiative Report provides extensive documentation of studies that show that there are non-thermal effects. We urge readers to review this report. It can be found online at www.bioinitiative.org.

- **The names of the persons responsible for these design flaws have not been made public so they could be questioned about why these design choices were made.**

  In no profession, and in particular for a public health matter, are the responsible people not held accountable for the product of their work.

- **In aggregate, the Interphone study's design flaws substantially reduce the reported risk of brain tumors from cellphone use.**

  These flaws are discussed in detail in Appendix 1. The flaws that result in an underestimation of the risk of brain tumors include:

  - selection bias,
  - exclusion of people who had died, or were too ill to be interviewed, as a consequence of their brain tumor,
  - insufficient latency time to expect a tumor diagnosis,
  - unrealistic definition of a "regular" cellphone user,
  - exclusion of children and young adults from the study,
  - exclusion of many types of brain tumors, and
  - treating study subjects who used a cordless phone as "unexposed" to microwave radiation.

# Interphone Study Background

In the interest of truth in science, and fair reporting, this document ***"Cellphones and Brain Tumors: 15 Reasons for Concern"***, has been prepared to provide journalists and government officials access to additional information, independent of industry, in order to enable a better understanding and balanced reporting of all sides of this important topic.

The multi-million dollar, 13-country Interphone study was implemented to determine whether there is a risk from cellphone use and 3 types of brain tumors: glioma (brain cancer in the brain's glial cells), acoustic neuroma (a tumor of the auditory nerve in the brain), and meningioma (a tumor of the meninges—the lining of the brain and spinal cord). The Interphone study included the risk of other tumors (e.g., salivary gland) but the results of these studies are outside the scope of this document.

Delayed by four years since first promised [1], the combined 13-country, but still incomplete, Interphone brain tumor results, will soon be published. Though the Telecom-funded Interphone data collection was completed in 2004, publication has been repeatedly delayed; and delayed again, to such a point that the European Parliament declared the delay was 'deplorable.' [2] Here we highlight what were the possible causes of these delays.

Much is not known. Certainly, for considerable time we have known there has been internal squabbling, with the Interphone researchers divided into 3 warring camps: those who believe "there is no risk"; those who believe that "higher tumor risks are showing up and precautionary measures are called for," and those who believe in just not saying (publishing?) anything. [3] As will be explained below, another reason for this four-year delay may be embarrassment.

Though the combined results from all 13 countries has yet to be published there have been 14 Interphone studies with partial results published. Three studies have combined results from 5 countries (Denmark, Finland, Norway, Sweden, and the UK), [4-6] and the 11 other studies have reported results from individual countries [Denmark (AN);[2] Denmark (G & M); France (AN, G & M); Germany (AN); Germany (G & M); Japan (AN); Japan (G & M); Norway (AN, G & M); Sweden (AN); Sweden (G & M), and; UK (G)]. [7-17]

Surprisingly, the dominant finding of all 14 studies was that use of a cellphone *protects* the user from a brain tumor! There are 2 possible conclusions that can be drawn from this unlikely finding:

1) either using a cellphone does provide protection from a brain tumor, or

2) the study design is fundamentally flawed.

[2] AN: Acoustic Neuroma; G: Glioma; M: Meningioma.

Many epidemiologists believe such a finding is *prima facie* evidence of a deeply flawed study. With the identification of 11 design flaws, [18] there is good evidence to support the second of the 2 possible conclusions, as the most likely. These flaws create a systemic-protective-skew that underestimates the risk to such an extent that it creates the *appearance* that using a cellphone *protects* the user from a brain tumor.

The 11 flaws, and the resultant systemic-protective-skew may be a source of embarrassment to Interphone study authors. For example, Professor Bruce Armstrong, Principle Investigator of the Australian Interphone study, stated during his keynote address at an ACRBR[3] annual meeting in November 2008,

> "For meningioma you can see the upper 95% confidence bound is *well below* one. Which means this is a highly significant *reduction*, an apparent reduction, in risk of meningioma with ever having used a mobile phone. [pause] Does anyone here know why mobile use *protects* against brain tumors, [laughter], particularly meningioma? Does that sound plausible? Do you think it is at all likely, particularly to that extent? *No!* So, immediately it tells you there something wrong here, there's a problem here." [Italics indicates tonal emphasis during the talk] [19]

Appendix 1, *A Description of the Interphone Study's Design Flaws,* provides the details of each flaw.

It is also important to point out that in 2004, the second Interphone study to be published raised considerable alarm when it reported a nearly 300% increased risk of acoustic neuroma. [7] When a cellphone is held to the ear, it is the acoustic nerve that receives the highest exposure. When results from all 13 countries are finally published, they will be incomplete because acoustic neuroma results will not be included as "a complete set of the raw Interphone data on acoustic neuromas has yet to be circulated." [20] Five years has gone by since the full set of acoustic neuroma data has been available, but it has "yet to be circulated."

Finally, after a delay of 4 years, the 13-country combined Interphone study results, though still missing the acoustic neuroma results, has been submitted for publication. We are concerned that the "media statement" (AKA press release) accompanying the publication will mislead the public into thinking there are no concerns.

[3] Australian Centre for Radiofrequency Bioeffects Research

# Recommendations in Brief

It is our considered view that there are reasons to be concerned about cellphones and brain tumors. We believe scientists, physicians, health advocates and concerned citizens should call on their national governments to take a strong public health stand on this issue. Immediate actions are available and are described in Appendix 2, *The Precautionary Principle Applied to Cellphone Use*. We wholeheartedly echo the European Parliament's recent call for actions. In brief they are:

- Review the scientific basis and adequacy of existing exposure limits
- Keep certain establishments free of wireless device radiation, including schools, child day care centers, retirement homes and health care institutions.
- Fund a wide-ranging awareness campaigned aimed at young people and children
- Increase communications to the public about the potential health hazards of wireless devices
- Create yearly reports on electromagnetic radiation exposures, describing the sources and actions taken to protect public health.

*See Recommendations on page 24 for a more extensive list of recommendations.*

# 15 Reasons for Concern

## **Concern 1:** *Industry's own research showed cellphones caused brain tumors.*

Dr. George Carlo, leader of the Cellular Telecommunications Industry Association's (CTIA) $25M research project held 3 successive meetings in February 1999: first with the executives of the CTIA, second with the Food and Drug Administration's (FDA) Interagency Working Group chartered with determining the safety of cellphones, and third with the CTIA Board of Directors. At each meeting Dr. Carlo presented the results of CTIA's own studies, which found cellphone use was causing brain tumors. [21, p 211] Among the findings Dr. Carlo presented were:

- a statistically significant doubling of brain cancer risk;
- a statistically significant dose-response[4] risk of acoustic neuroma with more that 6 years of cellphone risk, and;
- findings of genetic damage in human blood when exposed to cellphone radiation. [21, pp 205-206]

## **Concern 2:** *Subsequent industry-funded research also showed that using a cellphone elevated the risk of brain tumors (2000-2002).*

Even though 3 of these 5 subsequent studies on the risk of brain tumors from cellphone use, published between 2000 and 2002, had Telecom industry funding, all 5 studies

[4] Dose-response, an important credibility factor in epidemiology. In this context dose-response means, the longer the use of a cellphone, the higher the risk.

found "non-significant"[5] *elevated risks* for brain tumors (from 64% to 94.7% confidence that the result was not due to chance) including a "significant" 20% increased risk of brain tumor for every year of cellphone use. [22-26][6]

## **Concern 3:** *Interphone studies, published to date, consistently show use of a cellphone for less than 10 years protects the user from a brain tumor.*

All 14 Telecom industry-funded Interphone studies published to date have found use of a cellphone for less than 10 years *protects* a cellphone user from a brain tumor. As Professor Armstrong said, commenting on his Australian Interphone study's finding of protection, "So, immediately it tells you there something wrong here, there's a problem here." As noted above, either this is due to a genuine protective effect from cellphone use, or it is because the Interphone study is riddled with design flaws that underestimate the risk of brain tumors. [18] The effect of these design flaws is that there was systemic-protective-skewing of *all results*. That is, the true risk is larger than the published risk. For an explanation of these flaws, see Appendix 1, *A Description of the Interphone Study's Design Flaws*.

A similar example of results from another Telecom industry-funded study on the risk of cancer among Danish cellphone subscribers found that cellphone use resulted in *significant protection from cancer*, and also found for use of a cellphone for 10 or more years, *significant protection from brain tumors*. [27]

In both the Interphone studies and the Danish study, the authors disguised their statistically significant protective results, by stating there was "no risk" of brain tumor, or cancer, from cellphone use instead of communicating the actual results obtained.

The phenomenon that studies funded by an agency with a financial interest in the results reports results favorable to their financial interest is, not surprisingly, common. It occurs across many industries and is known as funding bias.

Dr. Henry Lai, Research Professor, Dept. of Bioengineering, University of Washington, has analyzed studies investigating effects from exposure to electromagnetic fields (EMFs). EMF industry-funded studies found effects from EMF exposures 28% of the time, and independent studies found effects from EMF exposures, 67% of the time. [18]

For more information see Flaw 11: *Funding Bias* in Appendix 1, *A Description of the Interphone Study Design Flaws.*

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[5] Clearly the use of a threshold 95% confidence level to define "significance" in science papers is an arbitrary convention. Statistical Process Control (SPS), used in factories throughout the world, uses 63% confidence as a threshold to investigate process problems. Statistical significance is a continuum, not a threshold. To illustrate: is 94.999% confidence "non-significant," while 95.000% confidence is "significant"?

[6] Brain tumor risk with confidence intervals, p-value, and percent confidence are listed with the references.

## **Concern 4:** *Independent research, shows there is risk of brain tumors from cellphone use.*

Studies led by Professor Lennart Hardell[7] in Sweden found significantly increased risk of brain tumors from 10 or more years of cellphone or cordless phone use. Among their many significant findings are the following:

- For every 100 hours of cellphone use, the risk of brain cancer increases by 5%; [28]
- For every year of cellphone use, the risk of brain cancer increases by 8%; [28]
- After 10 or more years of digital cellphone use, there was a 280% increased risk of brain cancer; [29]
- For digital cellphone users who were teenagers or younger when they first starting using a cellphone, there was a 420% increased risk of brain cancer. [30]

## **Concern 5:** *Despite the systemic-protective-skewing of all results in the Interphone studies, significant risk for brain tumors from cellphone use was still found.*

The Telecom-funded Interphone study *always* finds a significant increased risk, or in one study, [14] a near-significant[8] increased risk (91% confidence), of brain tumors when cellphone use is for 10 or more years on the same side of the head where the brain tumor was diagnosed. [18] Because the systemic-protective-skew remains, the true risk is greater that the reported risk for *every* Odds Ratio[9] reported in any of the Interphone studies. [18, 31]

This suggests that when the 2 highest risks are combined:

1) 10 or more years of cellphone use, and

2) the cellphone was held on the same side of the head where the tumor was diagnosed, that the true risk overwhelms the systemic-protective-skew such that a significant *increased risk* is reported. Nevertheless, even in this case the true risk is still greater than the reported increased risk.

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[7] Professor Oncology and Cancer Epidemiology, Orebro University, Orebro, Sweden

[8] Near-significant means, $\geq$90% confidence, $p \leq 0.10$ (the probability of a chance finding).

[9] Odds Ratio: The relative risk of brain tumors in cellphone users when compared to non-cellphone users.

## **Concern 6:** *Studies independent of industry funding show what would be expected if wireless phones[10] cause brain tumors.*

We would expect:

- The higher the cumulative hours of wireless phone use, the higher the risk; [28]
- The higher the number of years since first wireless phone use, the higher the risk; [28]
- The higher the radiated power from wireless phone use, the higher the risk; [32]
- The higher the exposure (use on the same side of head as the brain tumor), the higher the risk, [29,33] and;
- The younger the user, the higher the risk. [34]

Indeed, Professor Hardell's Swedish studies, which were not funded by industry are consistent with what would be expected if cellphone use caused brain tumors. Such consistency increases the credibility of any epidemiological study.

Besides the Hardell studies, tellingly, there has been only one other Telecom industry-independent study. Published in January 2001, this early (data collection was from June 94 to August 98) study reported a 70% increased, though non-significant, risk (75% confidence), of acoustic neuroma. [24]

*Why are there no other independent studies?* The $4-trillion-a-year industry [35] has provided large sums of money for studies on the risk of tumors from cellphone use. Before the Interphone study existed the Telecom industry groups went to various national governments saying they would provide funds for such studies if these governments would do the same. Many of these governments agreed to participate with the Telecom industry groups, and thus these governments were effectively pre-empted from funding studies independent of the Telecom industry.

And, these governments' attitudes towards the Telecom industry are certainly not immune from the influence of the billions of dollars in annual revenues received from this industry.

[10] Wireless phones: cellphones or cordless phones

## **Concern 7:** *The danger of brain tumors from cellphone use is highest in children, and the younger a child is when he/she starts using a cellphone, the higher the risk.*

"In [2005 in] the United States, studies show that over fifty percent of children own their own personal cell phones." [36] Since 2005, the percentage of children using cellphone is much higher.

Since "texting" became popular it is common that children sleep with their cellphones underneath their pillows. The cellphones are in vibrate-mode so their parents won't hear the phone ring. When a message arrives, the child wakes up, and sends a text message reply (so the parents won't hear them talking). Because cellphones are always radiating unless turned off, and irrespective of sleep deprivation, even though the cellphone beneath the pillow is radiating far less average power than when a phone call is being made, sleeping with a cellphone beneath a pillow results in a night-long exposure, every night.

An Israeli study of brain tumors resulting from scalp irradiation of children (average 7 years of age) with X-rays found *40 years later*, that the children who were exposed when they were younger than 5 years had the highest risk (a 356% increased risk of a brain tumor), children who were irradiated between 5 and 10 years of age had a 224% increased risk, and those who were irradiated at over 10 years of age, had a 47% increased risk of a brain tumor. [37]

Brain tumor risk increases as the age of an exposed child decreases. But the age at exposure has no effect on latency time. Whether children or adults, the latency time between first exposure and brain tumor diagnosis remains the same (~30 years).

If the risk of brain tumors is still increasing after 40 years from a single X-ray to the scalp, could it also be that risk of brain tumors would still be increasing 40 years after children first started using cellphones? In response to this question the appropriate thing to do would be to take precautionary measures now instead of taking no action and waiting to see what may happen. See Appendix 2, *The Precautionary Principle Applied to Cellphone Use* for a description of appropriate actions.

Compounding this concern is a recently published Swedish study reporting a 420% increased risk of brain tumors from cellphone use, and a 340% increase risk from cordless phone use when wireless phone use began as teenagers or younger. [30]

For more details including numerous graphs see Appendix 1, A Description of the Interphone Study's Design Flaws, Flaw 4: *Exclusion of young adults and children from studies.*

## **Concern 8:** *There have been numerous governmental warnings about children's use of cellphones.*

"France is nearing the point where it will make it illegal to market cell phones to children and recently banned cellphones in elementary schools. Russian officials have recommended that children under the age of 18 years not use cell phones at all. Similarly, the United Kingdom, Israel, Belgium, Germany and India have discouraged use of cell phones by children. In Finland, the Radiation and Nuclear Power Authority has urged parents to err on the side of caution." [Underlines added] [39]

The *French* government has become the first European government to publicly announce a proposal for an outright ban on some aspects of mobile phone usage based exclusively on potential risks to health. The proposed bill could lead to a ban on advertising of mobile phones to children under 12. It will also be illegal for sales of phones that are intended for use by children under the age of 6, and it will be compulsory for all handsets to be sold with accompanying earphones. While similar to the recommendation of other countries, this is the first recommendation to have made its way into proposed national legislation. [40]

*France* is also requiring manufacturers to come up with a new kind of phone for children—it would only allow sending and receiving of text messages and thus does not allow children to place the cellphone to the side of their heads. [40]

*Toronto*'s Department of Public Health has advised that children under eight should only use mobile phones in emergencies and teenagers should limit calls to less than 10 minutes, and *Israel*'s Health Ministry has also advised caution. [39]

In January 2009, the *Finnish* Radiation and Nuclear Safety Authority (STUK) also issued a position paper stating, "With children, we have reason to be especially careful," and recommended children's mobile phone use should be restricted to text messages, parental limitation of the number and duration of calls, use of hands-free devices, avoidance of calls from a moving car or train, and calls from rural areas (where the cellphone radiates more power in order to connect to a distant cellphone base station. [41] Appendix 2, *The Precautionary Principle Applied to Cellphone Use* describes in some detail these same actions.

On July 9, 2009 the *Korean* Times reported, "The Seoul Metropolitan Council plans to draw up draft regulations next week to ban the use of cell phones at primary and secondary schools. For elementary schools, the rules would mean that students can't come to school with phones. Middle and high schools would collect cell phones and return them after school. 'Cellular phones could harm the study atmosphere at schools and could cause health risks for kids. It is desirable to prohibit students from using cell phones at schools,' said Lee Jong-eun, head of the city council for education and culture." [42]

Even the head of the Interphone studies, Dr. Elizabeth Cardis, stated in an interview with the French newspaper *Le Monde*, "I am therefore globally in agreement with the idea of restricting the use [of cellphones by] children." [43]

For additional details why children are at higher risk of brain tumors from cellphone use see Appendix 1, A Description of the Interphone Study's Design Flaws, Flaw 4: *Exclusion of young adults and children from study*.

## **Concern 9:** *Exposure limits for cellphones are based only on the danger from heating.*

Cellphones radiate microwaves, as do microwave ovens. The exposure limits set by the Federal Communications Commission (FCC) in the United States, and by the International Commission on Non-Ionizing Radiation Protecting (ICNIRP) for most countries in the European Union, assume the only danger from microwave radiation would come from temperature increases in our brains, or from temperature increases to any other part of our bodies. Short and long-term non-thermal effects are not considered.

If there are no non-thermal biological effects, why does medicine use these fields for healing bone fractures that did not previously heal with a cast, and the military use them to discourage the enemy? *The BioInitiative Report: A Rationale for a Biologically-Based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*, presents the irrationality of the existing exposure limits, which do not consider non-thermal effects, in great depth. [44]

## **Concern 10:** *An overwhelming majority of the European Parliament has voted for a set of changes based on "health concerns associated with electromagnetic fields."*

In April 2009 the European Parliament by a vote of 559 to 22 (8 abstentions) called for a set of changes. Among the actions called for were: [45]

- "To review of the scientific basis and adequacy of the EMF [exposure] limits."
- To consider "biological effects when accessing the potential health impacts of electromagnetic radiation" and for "research to address potential health problems by developing solutions that negate or reduce the pulsating and amplitude modulation" used in transmission.
- "Member States to make available … maps showing exposure to high-voltage power lines, radio frequency and microwaves …telecommunication masts, radio repeaters and telephone antennas."
- Publish "a yearly report on the level of electromagnetic radiation by the EU."

- Finance "a wide ranging awareness campaign" aimed at young people to minimize their exposures to cellphone radiation. See Appendix 2, for similar methods.

- "Member States to increase research funding" to evaluate "long-term adverse effects" from cellphones for an "investigation of harmful effects … [from] different sources of EMF, particularly where children are concerned."

- Condemnation of "marketing campaigns" for the "sale of mobile phones designed solely for children."

- Imposition of "labeling requirements" for transmitted powers on all "wireless operated devices."

- "Greatly concerned" that "insurance companies are tending to exclude coverage for the risk associated with EMFs [from] liability insurance."

- Member States "to recognize persons with electrohypersensitivity [EHS] …as being disabled" so as to assure their protection and equal opportunity under law.

## **Concern 11:** *Cellphone radiation damages DNA, an undisputed cause of cancer.*

Concern 11 not only describes studies that have shown that electromagnetic fields cause DNA damage, but also describes the role of Telecom industry-funded studies that repeatedly contradict independent studies. What follows is a kind of call & response used to illustrate both the concerns raised by an independent paper and industry's attempt to nullify the concern (Paper with concern & Industry response).

### A) Paper with concern

In a March 2009 paper, "Electromagnetic fields and DNA damage," Dr. Jerry Phillips, Director, Science/Health Science Learning Center, University of Colorado, along with Dr. Singh and Dr. Lai from the University of Washington in Seattle, reviewed all the studies, from exposure to radio frequency radiation (RFR), with significant cellular DNA damage and studies with no significant cellular DNA damage. [46] Their paper cites 14 studies showing significant effects and 17 studies that did not find significant effects.

### A) Industry response

Motorola funded Professor Joseph Roti Roti from Washington University in St. Louis. Dr. Roti Roti is an author on 8 of the 17 "no significant effect" papers.

### B) Paper with concern

Most of the 17 "no effect" studies, used a "comet assay" to determine the extent of DNA damage. Commenting on the "no significant effect" papers, the authors of the

"Electromagnetic fields and DNA damage," study stated, "Different versions of the assay have been developed. These versions have different detection sensitivities and can be used to measure different aspects of DNA strand breaks. A comparison of data from experiments using different versions of the assay could be misleading. Another concern is that most of the comet assay studies were carried out by experimenters who had no prior experience with this technique and mistakes were made." [46]

Dr. Roti Roti used a variation of the comet assay referred to as the Olive assay. In this context, the comet assay used by Drs. Singh and Lai is referred to as the Singh variant. At a Bioelectromagnetics Society (BEMS) meeting, with Dr. Roti Roti in attendance, a presentation was made showing that the Olive variant's sensitivity was far less than the sensitivity of the Singh variant.

## B) Industry response

Very soon after the BEMS presentation, a Motorola funded study was published (Dr. Roti Roti was an author) that purported to show that the Olive variant of the Comet assay "*is as sensitive as* other modifications of the comet assay reported in literature." [Italics added] [47] However, this paper failed to mention that in using human fibroblast cells instead of the human lymphocytes cells, the "sensitivity" was an artificial result because, "Fibroblasts in culture have higher background DNA damage than lymphocytes. Therefore, it is more difficult to detect low levels of DNA damages in fibroblasts. Their paper [Malyapa et al. 1998] [47] said that the Olive method is at least as sensitive as the Singh method. It actually would mean that the Olive method is more sensitive because they determined sensitivity using fibroblasts, instead of lymphocytes." [48]

## C) Paper with concern

When the BEMS presentation was published it reported, "The Singh and Olive methods are identical in principle and similar in practice, but the Singh method appears to be at least one- or two-orders of magnitude [10 to 100 times] more sensitive." [49]

Non-technical readers may not understand the import of this seemingly endless debate. Even those who understand the import are fatigued by the debate. However, the true measure is which of these Comet assay variants dominate? The table below answers this question. It shows the number of times each variant has been cited in the peer-reviewed science literature, providing the answer.

| Results as of July 1st, 2009 | Google Scholar Citations | Scopus Citations | Web of Science Citations |
|---|---|---|---|
| Singh et al., 1988 | 2,956 | 2,717 | 2,760 |
| Olive et al., 1990 | 595 | 526 | 571 |

For additional details, see Appendix 1, *"A Description of the Interphone Study Design Flaws"*, Flaw 11: *Funding bias.*

The above discussion illustrates how industry responds to independent studies by casting doubt on the validity of the independent studies. When the independent studies show results not favorable to those with a financial interest, an industry study quickly follows casting doubt on the original study. The back & forth (call & response) of independent studies followed by industry studies adds to the sense of doubt. It is a highly successful technique used to neutralize alarming findings by independent science. It fatigues the mind to such an extent that few pay attention to what is going on. Yet, as seen in the above table, the big picture is that the overwhelming conclusion of science favors the independent science.

## **Concern 12:** *Cellphone radiation has been shown to cause the blood-brain barrier to leak.*

Strictly speaking this concern is not about cellphones and brain tumors, but is about a problem with known and unknown consequences from Blood-Brain Barrier (BBB) leakage resulting from cellphone use, including the possibility of brain tumors.

The BBB protects the brain from many molecules that are toxic to the brain (e.g., albumin). Professor Leif Salford, of the Department of Neurosurgery, from Lund University in Sweden has shown cellphone radiation results in leakage of the BBB. The highest BBB leakage occurs at lower exposure levels and decreases for higher exposure levels.

Of considerable alarm, these results show that a Specific Absorption Rate (SAR)[11] of 1 Watt of power deposited per kilogram (1W/kg) of brain tissue results in significantly increased leakage of albumin across the BBB, and the highest leakage occurs at 100 times lower SAR levels (0.010 W/kg). [50]

[11] In the United States the exposure limit for SAR is 1.6W/kg, and 2.0W/kg in most other countries.

Professor Salford's study clearly showed BBB leakage killed neurons in the brain of exposed rats. His findings are of major concern because one of many potential outcomes of BBB leakage is dementia. As a measure of this concern Section 6 of BioInitiative Report, *Evidence For Genotoxic Effects*, cites 23 papers about Blood-Brain Barrier leakage. [44]

## **Concern 13:** *Cellphone user manuals warn customers to keep the cellphone away from the body even when the cellphone is not in use.*

In order to insure "safe" operation, many cellphone User Manuals state that the phone must be kept a certain distance from the user's body to insure "safe" operation. For example, the Apple iPhone warns the user, "Tested for use at the ear and for body worn operation (with iPhone positioned 15 mm (5/8 inch) from the body)." [51] This means that even the existing exposure limits (based on a false premise), will be violated if the cellphone is less than 15 mm from the body (e.g., held to the ear, in a shirt pocket, in a your pants/trousers pocket, etc.)

Other warnings include:

- Nokia 1100 warns, "This product meets RF exposure guidelines…when positioned at least 1.5 cm (~1/4 inch) away from the body…and should position the product at least 1.5 cm away from your body." [52]

- Motorola V195 GSM warns, "keep the mobile device and its antenna at least 2.5 centimeters (1 inch) from your body." [53]

- BlackBerry 8300 warns, "When using any data feature of the BlackBerry device, with or without a USB cable, keep the device at least 0.98 inches (25 mm) from your body," and "SHOULD NOT be worn or carried on the body." [CAPITALIZATION in the original] [54]

Since these manuals are rarely read, the devices will likely be placed against the body. As a result our so-called "safety" agencies should require that such products be manufactured such that it would not be possible to place it closer that the stated "safe" limits, if they were truly concerned about safety. At minimum, the warnings in the user manuals should be on a warning label prominently displayed on the cellphones or on similar products.

## **Concern 14:** *Federal Communications Commission (FCC) warning for cordless phones.*

The FCC warning label attached to the most common cordless phone technology, Digitally Enhanced Cordless Technology (DECT), warns, "This equipment should be installed and operated with a minimum distance of 20 centimeters [almost 8 inches]

between the radiator and your body." [51] Unlike previous cordless phone technology, DECT base stations are continuously radiating 24 hours a day, 7 days a week.

DECT phone radiation, based on GSM cellphone technology, is similar to cellphone radiation.

## **Concern 15:** *Male fertility is damaged by cellphone radiation.*

This concern also is not about brain tumors per se, but is of such potential consequence that it is discussed here.

Men, and particularly teenage boys, place their cellphone in the pants/trousers pockets when they are not holding it to their heads in conversation. There are multiple studies showing deleterious effects on sperm including decreased sperm counts and reduced sperm motility. [55-57] One study found a highly significant (99.99% confidence) 59% decline in sperm count in men who used cell phones for 4 or more hours per day as compared with those who did not use cell phones at all. [56]

Another study reported an 80% increased near-significant risk (93.9% confidence) of testicular cancer when the cellphone was kept in the left pocket, then the left testicle developed cancer; kept in the right pocket, then the right testicle developed cancer. [58]

Because there have been no cellphone studies on female fertility it is unknown if there are deleterious effects. And, it is also a truism, if you don't look for an effect, you will not find an effect.

# Summary

In conclusion, Telecom-funded studies have been reporting highly questionable results in comparison with independent studies. Studies independent of industry consistently show there is a significant risk of brain tumors from cellphone use.

The existing ICNIRP and FCC exposure limits are based on a false premise that only thermal effects cause harm. In this regard the European Parliament has voted overwhelmingly for a review of the existing exposure limits.

The risk to children is far greater than to adults, and though some government recommendations or guidelines have been published, no mandatory actions have been taken.

Soon, after years of delays, for the first time, *partial* results from all 13 countries of the Interphone study will be published.

**Whatever these results show, they must be interpreted with the understanding that the Interphone Protocol's design flaws result in a systemic-protective-skewing of *all reported* results.**

The Telecom industry "media statement" (AKA press release) and similar messages will do their best to cast doubt about the risk of brain tumors from wireless phone use. But the facts remain. We encourage journalists to report on the independent science, make the dangers of cellphone use known to the public, and to thoroughly investigate who was responsible for the Interphone design protocol—particularly who decided to create the most egregious of all flaws, Flaw 6 that excludes cordless phone users from the analysis. This had the effect of underestimating risk by contrasting cell phone users' incidence of brain cancer with a group of "unexposed" people that had high radiation exposure from cordless phone use, the more common form of wireless phone used at that time.

# Recommendations

We the Endorsers and the editors of ***Cellphones and Brain Tumors: 15 Reasons To Be Concerned*** support the full set of actions called for by the European Parliament as a result of the "Health Concerns Associated With Electromagnetic Fields" vote. We call on our respective governments to give the highest priority to this list of actions:

- Ban marketing campaigns of cellphones designed solely for children.
- Require proof of liability insurance coverage for potential health risks associated with cellphones and similar wireless devices prior to their being offered for sale.
- Review the scientific basis and adequacy of the EMF exposure limits.
- Allocate research funding, independent of industry funds and influence, to evaluate long-term adverse effects from cellphones and other harmful effects from different sources of EMF, particularly where children are concerned.
- Finance a wide-ranging awareness campaign aimed at young people to minimize their exposures to cellphone radiation.
- Require warning labels on all wireless devices.
- Make available maps showing exposure to high-voltage power lines, radio frequency and microwaves from telecommunication masts (cell towers), radio repeaters and telephone antennas.
- Publish a yearly report on the level of electromagnetic radiation in our respective nations.

And, we the Endorsers and editors call for these additional actions by our respective governments:

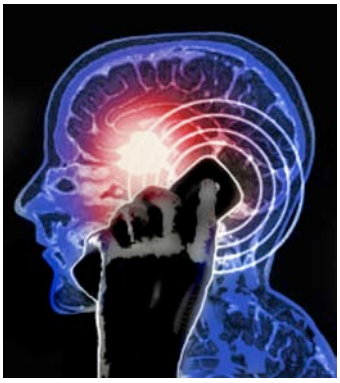
1. Fund comprehensive research, independent of industry influence and funds, into the biological effects from exposure to electromagnetic fields from all sources.

2. Pass legislation that rewards whistle-blowers who produce cellphone industry documentation that acknowledges harmful effects from their products.

3. Adoption of "biologically based" exposure limits, meaning limits based on non-thermal electromagnetic field exposure effects, in contrast to use of the false premise that the only effects from electromagnetic field exposures are from heating.

4. Call on all governments that provided funding to the Interphone study that the Interphone study expedite release of the complete results from the Interphone study including, but not limited to, the risk of acoustic neuroma, and the risk by tumor location (e.g., temporal lobe tumor on the side of the head where there cellphone was used) from cellphone use. If the complete results are not published by a date certain, then government funding of the Interphone study shall be paid back by the Telecom industry funders of the Interphone study.

5. Finally, call for all Interphone studies previously published to be revised by treating subjects who used a cordless phone as 'exposed' subjects, and the revised results published by a date certain, correcting for a serious design flaw (See Flaw #6 in Appendix 1) As above, if not published by a date certain, the funds provided by the governments are to be paid back to these governments.



# The science is here.

# The problem exists.

# Action is required.

# Appendix 1

# A Description of the Interphone Study Design Flaws

## **Flaw 1:** *Selection Bias*

In a case–control cellphone study both brain tumor cases and controls without a brain tumor are asked if they would like to participate in a "cellphone study." It is reasonable to assume controls who use a cellphone are more likely to participate than controls who do not use a cellphone. This would result in selection bias. And, such selection bias would result in an underestimation of risk.

The impact of selection bias increases as the percentage of controls that refuse to participate increases. The Interphone weighted-average refusal rate for controls was a remarkably high 41%. [1] Dr. Sam Milham, an occupational epidemiologist with over 100 published papers, states that in the past, science journals would not accept a study with such a high refusal rate. [2]

One Interphone study investigated the possibility of selection bias by asking controls that refused participation if they used a cellphone; 34% said they used a cellphone and 59% said they did not use a cellphone, confirming selection bias in that Interphone study. [3]

## **Flaw 2:** *Insufficient Latency Time*

The known latency time (the time between exposure and diagnosis) for brain tumors is 30+ years [4], similar to lung cancer from smoking, [5] and mesothelioma from asbestos exposure. [6]

An ICNIRP study states, "Most types of cancer occur many years, or even decades, after initial exposure to known carcinogens." [7] Yet, they also note, "However, the important issue is not how long it takes for maximum risk to occur, but how long before detectable risk is present. Even for asbestos, a carcinogen that has a notoriously long induction period, detectable elevations in risk occur 10–14 years after first exposure," [7]

Ten or more years was the longest cellphone use time reported in the Interphone studies. Three of the 11 single country Interphone studies had no brain tumors cases that had used a cellphone for 10 or more years, and 3 of the remaining 8 studies had less

than 10 cases. Not including sufficient numbers of longer-term cellphone users results in an underestimation of risk.

## **Flaw 3:** *Definition of "Regular" Cellphone User*

The Interphone Protocol defines "regular" cellphone use, as use for at least once a week, for 6 months or more, with any cellphone use 1 year prior to diagnosis (Dx) excluded. Based on UK cellphone subscriber data, [8] and the UK study's Dx eligibility dates [9], the rapid rise of cellphone subscribers finds 85% of "regular" UK users had used a cellphone for less than 5 years; 98% of "regular" UK users had used a cellphone for less than 10 years (all Interphone countries had similar rapid increases in cellphone users). See Figure 1: UK Cellphone Subscribers by Year.

Given known latency times how could any risk of brain tumors be expected for "regular" users? Inclusion of such a large proportion of short-term users (use for at least once a week, for 6 months or more) underestimates the risk of brain tumors.

Dr. Elizabeth Cardis, the head of the Interphone study stated, "Reporting 'regular' user [data] was not intended to be a risk factor." [10] Yet, the abstract of every Interphone brain tumor study highlights that there is "no risk" of brain tumors from "regular" cellphone use.

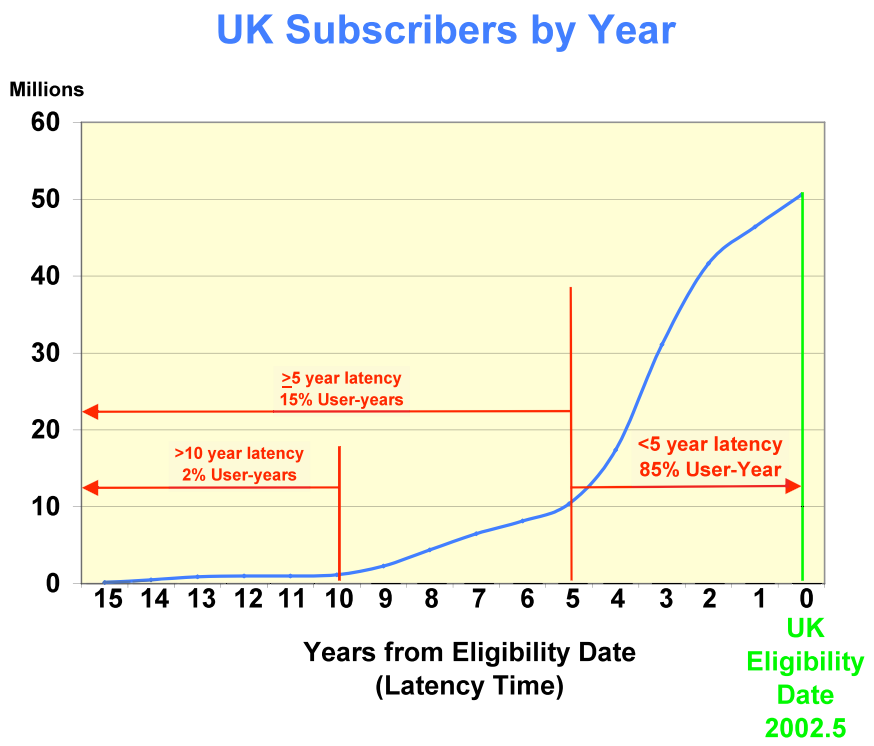



**Figure 1: UK Cellphone Subscribers by Year**

*Figure 1 provides a picture showing the number of UK cellphone subscribers who have used a cellphone for a particular length of time in years (latency time). Clearly, the vast majority of "regular" cellphone users had used a cellphone for a relatively short period of time. Given known latency times for brain tumors, risk of brain tumors in the Interphone studies would not be expected to be diagnosed given the definition of "regular" cellphone users.*

## **Flaw 4:** *Exclusion of Young Adults and Children from the Interphone Study*

The Interphone Protocol requires subjects to be between 30 and 59 years of age (some studies have included ages as low as 20). There is strong evidence that the young adults and children are at greater risk from exposure to carcinogens than mature adults suggesting that the young, with greater cell growth, are more vulnerable to genetic mutations.

Two cellphone studies report higher brain tumor risks in young adults (20–29 years of age) compared to mature adults. The first study found a 717% increased risk of brain tumor compared to a 35% increased risk for all adults using an analog cellphone [11] (see Figure 2: Increased Risk of Brain Tumor in Young Adults Compared to All Adults), and the second study found a 217% increased risk of brain tumor [12] compared to 26% to 84% increased risk in older adults (see Figure 3: Increased Risk of Brain Tumor in Young Adults Compared to All Adults). An ionizing radiation brain tumor study of children found the younger a child's age, the greater the increased risk of brain tumors (356% increased risk/Gy[12] of brain tumors for children less than 5 years of age; 224%% increased risk/Gy for children 5 to 9 years of age, and; 47% increased/Gy risk for children 10 or more years (See Figure 4 Increased Risk of Brain Tumors in Children by Age at Exposure). [4]

Exclusion of children and young adults underestimates the risk of brain tumor.

[12] Gy, abbreviations for Gray, a unit of measure for an X-ray dose. The average dose in this study was 1.5Gy.

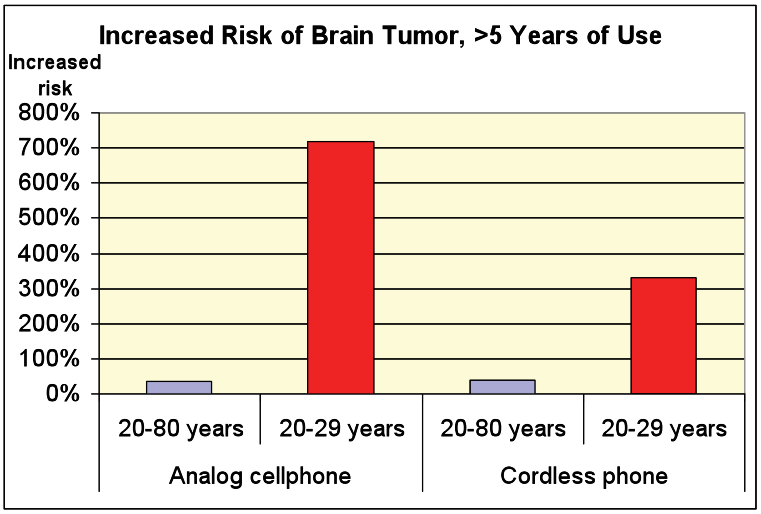



**Figure 2: Increased Risk of Brain Tumor in Young Adults Compared to All Adults**

*Figure 2 shows a dramatic difference in the increased risk of brain tumor from use of either an analog cellphone or a cordless phone exists in young adults (red column) when compared to all adults (blue column).*

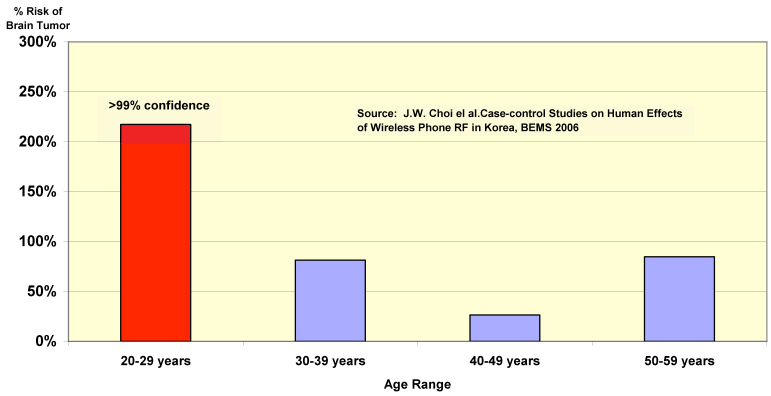



**Figure 3:** Increased Risk of Brain Tumor in Young Adults Compared to Older Adults

*Figure 3 demonstrates how the risk for brain tumors from cellphone use is much higher in young adults (red column) when compared to older adults (blue columns).*

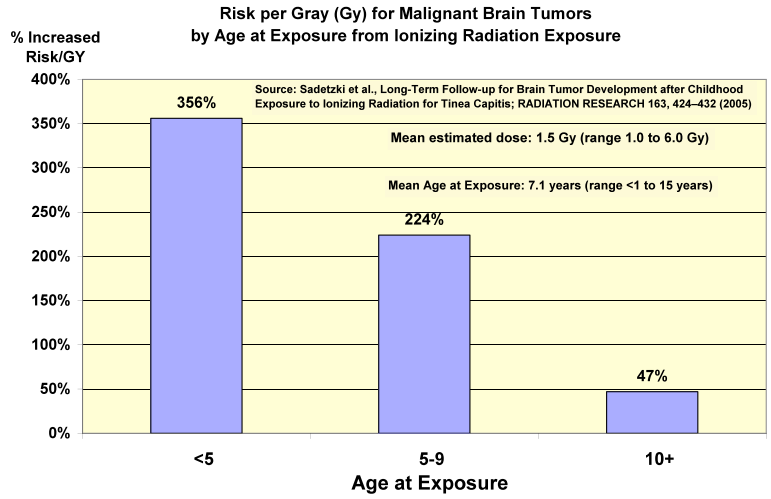



**Figure 4:** Increased Risk of Brain Tumor in Children by Age at Exposure

*Figure 4 demonstrates that the younger the age of a child when the head is exposed to ionizing radiation, the higher the risk of brain tumor.*

Children's heads and brains are not miniature adult heads. Their skulls are thinner, the proportion of water is higher, myelin (thought to be like wire insulation for neurons) is still developing, etc. As a result, as shown in Figure 5, the cellphone radiation penetrates a far larger proportion of the brain. [13]

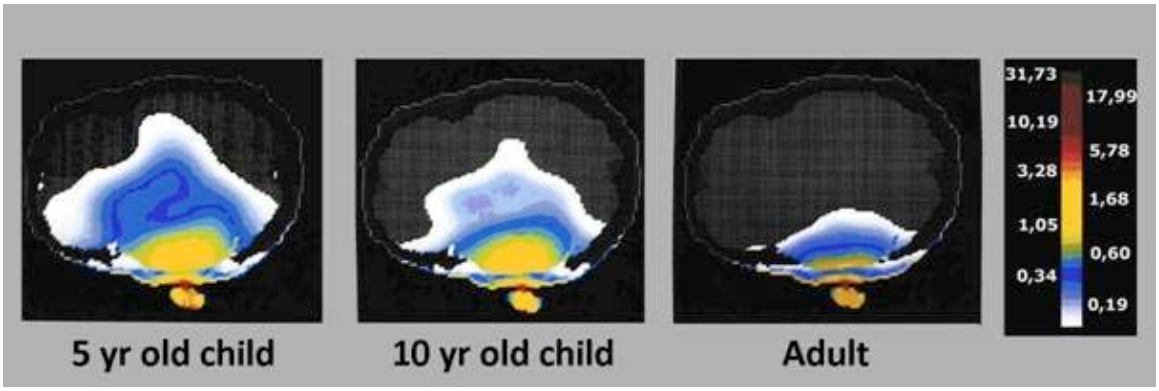



**Figure 5:** Estimation of the absorption of electromagnetic radiation from a cell phone based on age (Frequency GSM 900 MHz) (On the right, color scale showing the Specific Absorption Rate in W/kg) [13]

*Figure 5 demonstrates how much greater the cellphone's radiation plume penetrates a 5 year old child's head, and a 10 year old child's head as compared to an adult's head.*

Perhaps Figure 5 explains why in Figure 4, the younger the child when first exposed, the higher the risk of being diagnosed with a brain tumor?

## **Flaw 5:** *Brain Tumor Risk from Cellphones Radiating Higher Power in Rural Areas Were Not Investigated*

Because rural users are farther away from the cell towers (base stations or masts) compared to urban users, the cellphone's radiated power is higher. [14] Unfortunately the Interphone studies selected mostly metropolitan areas to locate brain tumor cases. When higher radiated power is not included there is an underestimation of risk.

## **Flaw 6:** *Exposure to Other Transmitting Sources Are Not Considered*

Subjects who used cordless phones, walkie-talkies, Ham radio transmitters, etc., and who did not use a cellphone, are treated as unexposed in the Interphone study when in fact they are exposed to radiation quite similar to cellphone radiation. Further, during the period when the Interphone investigation was underway, far more people used cordless phones that used cellphones. So arguably there were greater exposures from cordless phone use than for cellphone use.

It is important to note that two independently funded cellphone studies found that use of a cordless phone results in an increased risk of brain tumors. [15,16] Treating exposed subjects as unexposed, once again, underestimates the risk of brain tumors.

The existence of Flaw 6 is perhaps the most egregious example of either incompetence by the authors of the Interphone Protocol,[13] or a conscious attempt to downplay a discovery of a risk. DECT cordless phones are based on GSM cellphone technology. The unpublished portion of the Interphone Protocol requires asking subjects if they use a cordless phone. Yet cordless phone use was not analyzed. Since cordless phone use data exists, a re-analysis, treating cordless phone user as an exposed user, and publication of the results, is in order.

## **Flaw 7:** *Exclusion of Brain Tumor Types*

The Interphone study includes three brain tumor types: acoustic neuroma, glioma and meningioma, but excludes all other types of brain tumors (e.g. brain lymphoma, neuroepithelial brain tumors, etc.). Exclusion of these other tumors underestimates the risk of brain tumors. Interestingly, as noted above in **"Cellphones and Brain Tumors: 15 Key Reasons for Serious Concern, Science, Spin and the Truth Behind Interphone"**, another Telecom-funded study reported a 2.1-fold risk of a neuroepithelial brain tumor, [17] and a Telecom-funded cellphone study showed an excess risk of lymphoma in mice exposed to cellphone radiation. [18] Given this prior knowledge of these tumors resulting

[13] Interphone investigators must follow the Interphone Protocol, and thus are not responsible, per se, for the systemic-protective-skew. The Interphone Protocol is partially the published version[20], though substantial portions of the Interphone Protocol remain unpublished.

in an increased risk of tumors from cellphone radiation, it is surprising that these brain tumors were not included, much less that all brain tumor types were not included.

## **Flaw 8:** *Tumors Outside the Cellphone's Radiation Plume Are Treated as Exposed*

The cellphone's radiation plume's volume is a small proportion of the brain's volume. Treating tumors outside the radiation plume as exposed tumors results in an overestimation of risk (the only flaw that overestimates risk), while at the same time creating a hidden underestimation of risk. Instead, if the risk of brain tumors within the cellphones' radiation plume were analyzed, the existing data suggests that this risk would be greatly increased above what has been reported in the Interphone study.

The adult brain absorbs the cellphone's radiation almost entirely on the side of the head where the cellphone is held (ipsilateral); almost no radiation is deposited on the opposite side of the head (contralateral). In adults the ipsilateral temporal lobe absorbs 50–60% of the total radiation and is ~15% of the brain's volume. The ipsilateral cerebellum absorbs 12–25% of the total radiation and is ~5% of the brain's volume. Thus, 62–85% of the cellphone's radiation is absorbed by ~20% of an adult's brain's volume (see Adult Head in Figure 5). [19]

Because a child's brain absorbs far more radiation than an adult's brain, these data are not applicable for a child's brain.

## **Flaw 9:** *Exclusion of Brain Tumor Cases Because of Death or Too Ill to Respond*

A large number of brain cancer (glioma) cases died before they could be interviewed or were too ill to be interviewed. Common practice would be to interview a proxy (e.g., a spouse). The published portion of the Interphone Protocol requires use of proxies in case of death. [20] Yet, 3 of the 7 glioma studies excluded deceased, or too ill to be interviewed cases from their studies [21-23] and a 4th did not use proxies for all of the cases who were too ill to be interviewed or who had died. [24] The weighted average of these exclusions was 23% of all glioma cases. This flaw limits determining the risks, if any, from the most deadly and debilitating brain tumors from cellphone use.

Another study found significant risks for high-grade glioma (the most deadly), but not for low-grade glioma (less deadly). [25]

## **Flaw 10:** *Recall Accuracy of Cellphone Use*

Memory accuracy, particular in the distant past, is limited at best. An Interphone validation study investigated this problem by asking cellphone users to recall their cellphone use, and then compared their recall to billing records.

The validation study reported that light cellphone users tend to underestimate their use, and heavy users tend to overestimate their use. This results in an underestimation of risk. [26] Thus, though recall accuracy is a genuine problem, its effect would be to underestimate the risk. In other words, because of the effects of inaccurate recall the true risk is larger than the published risk.

Accurate data for the Interphone study could have been obtained by accessing subjects' cellphone-billing records as was done in the validation study of recall bias. [26] An August 2005 magazine article describing the Interphone study with the head of the Interphone study, Dr. Elizabeth Cardis, reported, "… the researchers carried out personalized and in-depth interviews of the control groups to assess for how long and how frequently they used mobile phones. Important details were recorded carefully – including which ear the mobile phone is usually held against. … These recall data were then compared with the invoicing data available from the service operators, the network technical characteristics and the phones used." [27] Yet, none of 14 Interphone studies reported use of invoice data, and instead stated they relied solely on the subjects' memory. This raises the question whether the magazine report was wrong, or was the invoice data that was collected never used.

## **Flaw 11:** *Funding Bias*

If studies are funded by an entity with a financial interest in the findings, it has been shown, more often than not, the findings of such a study are favorable to the financial interest compared to studies where the funding has no financial interest.

Dr. Henry Lai at the University of Washington in Seattle maintains a database of cellphone biological studies. The results (Table 1) from his database (July 2007) report the magnitude of funding bias. The EMF industry-funded studies found an effect from EMF exposures in 28% of the studies, and the independently funded EMF studies found an effect from EMF exposures 67% of the time. The probability that this is a chance finding is extraordinarily minute ($p = 2.3\times10^{-9}$).[14]

A study on the source of funding of cellphone studies and the reported results reported, "We found that the studies funded exclusively by industry were indeed substantially less likely to report statistically significant effects on a range of end points that may be relevant to health." [28]

[14] p is the probability of a finding being due to chance alone.

| Cellphone Biological Studies | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Effect Found | | No Effect Found | | | |
| | | Studies | % All Studies | Studies | % All Studies | Studies | % All Studies |
| Industry Funded | No. | 27 | 8.3% | 69 | 21.2% | 96 | 29.4% |
| | % | 28.1% | | 71.9% | | | |
| Independently Funded | No. | 154 | 47.5% | 76 | 23.5% | 230 | 70.6% |
| | % | 67.0% | | 33.0% | | | |
| Totals | | 181 | 55.5% | 145 | 44.5% | 326 | 100.0% |

$Chi^2 = 39.8$ ($p = 2.3 \times 10^{-9}$) 11 July 2006 [1]

**Table 1:** Industry-Funded and Independently-Funded Cellphone Biological Studies

Financial bias is pervasive across all fields of science. It is sufficiently pervasive that books have been written on the subject and science journals have brought it to the attention of their readers. A search for books about "Funding Bias in Science" at Amazon.com found 86 titles. [29]

In a review of a book by Sheldon Krimsky, "Science in the Private Interest: Has the Lure of Its Profits Corrupted Biomedical Research?", Dr. Roger Porter wrote, "The major theme of this superb book, therefore, is the degradation of the academic scientist, who is lured to the pecuniary gains offered by industry and now asks the scientific questions posed by industry instead of independently pursuing scientific investigation of public needs." [30]

A substantial portion of the Interphone study funding comes from the cellphone industry. For European studies, industry has provided more than €3.2 million ($4.5M), [31] another $1 million came from the Canadian Wireless Telecommunications Association [32] and it is unknown if industry funding has been provided for studies in Japan, Australia and New Zealand.

In addition to the €3.2 million, the Interphone Exposure Assessment Committee received an unknown amount of funding from the UK Network Operators (O2, Orange, T-Mobile, Vodafone, '3') and French Network Operators (Orange, SFR, Bouygues). [20] A cellphone company employed at least one member of the Exposure Assessment Committee: Dr. Joe Wiart from France Telecom. [20]

Beyond the €3.2 million available to the European Interphone studies, the French study [22] received an unknown amount of funding from "Orange, SFR, Bouygues Télécom." [33]; the UK study received an unknown amount of funding from O2, Orange, T-Mobile,

and Vodafone, and [9]; the Danish study received an unknown amount of funds from the for-profit International Epidemiology Institute (IEI). The source of the IEI funds is not stated. [21]

## Conclusion

The 11 Interphone study design flaws, taken together, greatly distort the true risk of brain tumors from cellphone use. Any consideration of Interphone study conclusions must weigh an understanding of these design flaws so as not to mislead the public about risks of cell phone use. It is the view of the editors and endorsers of this report that there is a far greater risk of brain tumors from cellphone use than has been reported in the Telecom-funded Danish cellphone subscriber study or in the Telecom-funded Interphone study.

# Appendix 2

# The Precautionary Principle Applied to Cellphone Use

Simply put the Precautionary Principle is a policy that says if there is some evidence that a problem may exist, and low or no-cost actions are available, then these actions should be undertaken. Colloquially, we say, "Better safe than sorry." If cellphones induce brain tumors the potential public health costs are enormous. There is a simple action that can reduce the absorbed cellphone radiation by several orders-of-magnitude (factors-of-10) for virtually no cost.

Cellphone radiation decreases as the square of the distance from the phone. As a result even small changes in distance have a dramatic effect. For example, say when the speaker on the cellphone is placed to the ear, the cellphone is 0.1 inch (2.5 mm) from the head, and if the cellphone is held 10 inches (25 cm) it is 100 times farther from the head. The square of 100 is 10,000. Because of the inverse square decrease of radiation with distance, this increase in distance would result in a 10,000-fold reduction in the radiation absorbed by the head.

With use of a headset (not a wireless headset) connected to a cellphone, the cellphone is not held directly against the ear and thus the absorbed cellphone radiation could be reduced by several orders-of-magnitude.

## Government Mandated Action

1. An appropriate Precautionary Principle action would be for governments to mandate cellphone manufacturers remove the existing cellphone speaker that is placed to the ear and replace it with a headset directly connected to the cellphone. The cost would be near zero (potentially a net cost savings): remove one cellphone speaker—add another speaker (AKA headset).

2. Given the greater vulnerability of younger people to cellphone radiation, governments should mandate that schools post warnings about the potential health risks of microwave radiation from cellphones.

## Personal Actions

Here are 8 simple steps you can take to substantially reduce your, or your children's, exposure to cellphone radiation:

1. When on a call, use a wired headset (not a wireless headset such as a BlueTooth), or use in speaker-phone mode, or send text messages. [7]

2. Keep the cellphone away from your body (particularly pant/trouser or shirt pockets) or use a belt holster designed to shield the body from cellphone radiation, when not in use (stand-by mode).

3. Avoid use in a moving car, train, bus, or in rural areas at some distance from a cell tower (AKA mast or base station) as any of these uses will increase the power of the cellphone's radiation. [7]

4. Use the cellphone like an answering machine. Keep it off until you want to see who has called. Then, return calls using step 1.

5. Use a land-line phone, if available, instead of a cellphone.

6. Avoid use inside of buildings, particularly with steel structures.

7. Do not allow your children to sleep with a cellphone beneath their pillow or at the bedside.

8. Do not allow your children under 18 to use a cellphone except in emergencies.

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## Cellphones and Brain Tumors - 15 Reasons for Concern


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## Appendices 1 and 2 - A Description of the Interphone Study Design Flaws and the Precautionary Principle Applied to Cellphone Use


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## For further information contact:

**U.K.:**
**Graham Philips**
**E-Mail:** graham@powerwatch.org.uk
**Tel.** +44 (0)1353 778422

**U.S.A.:**
**L. Lloyd Morgan**
**E-Mail: bilovsky@aol.com**
**Tel.** +510 841-4362
**Tel.** +510 528-5302 (prior to August 16th use this)