

***Statement
Of
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***Domestic Policy Subcommittee
Oversight and Government Reform Committee
Thursday, September 25, 2008
2154 Rayburn HOB
11:00 a.m.***

“Tumors and Cell Phone use: What the Science Says”

Thank you for inviting me to speak with you today about the important matter of cell phones and our health. I have served as the Founding Director of the University of Pittsburgh Cancer Institute (UPCI) since 1985, and as the Founding Director of University of Pittsburgh Medical Center (UPMC) Cancer Centers since 2001. The organizations that I lead employ more than 660 oncologists, other cancer experts and research faculty and more than 2,000 other staff members. In addition to the cutting edge cancer research performed at UPCI, our cancer centers, located throughout western Pennsylvania and adjacent states, annually treat more than 27,000 new cancer patients each year.

The UPCI is a National Cancer Institute (NCI)-designated comprehensive cancer center, and is one of the top ranked cancer research facilities in the nation. In fact, in 2007, UPCI was ranked 10th nationally in its level of NCI funding for cancer research. During the past two decades, UPCI has recruited some of the world's top scientists.

At UPCI, I am the Hillman Professor of Oncology, Professor of Medicine and Associate Vice Chancellor for Cancer Research at the University of Pittsburgh. I also was the founding Chairman of the Board of Directors, and I currently am the President, of the Pennsylvania Cancer Control Consortium, a state-wide cancer control organization. I am a longstanding member and Chairman of the Research and Clinical Trials Team, of C-Change, a national cancer organization, that has President George H.W. Bush, First Lady Barbara Bush, and Sen. Dianne Feinstein as the honorary co-chairs. For the past few years, C-change has focused mainly on innovative strategies to reduce smoking and other personal risk factors for cancer, and to facilitate medical interventions to protect people at increased risk for cancer.

I also served from 1999-2001 as the President of the Association of American Cancer Institutes, an organization that includes almost all of the major academic cancer centers in the US. All of the organizations that I am associated with are focused on eliminating cancer as a public health problem, a commitment that I take very seriously.

As a cancer researcher, I have published more than 700 peer-reviewed articles in major biomedical journals, and for two decades my scientific publications placed me as among the 100 most cited biomedical scientists. In addition, I have served as an associate editor on more than 10 major, peer-reviewed journals, including Cancer Research, the Journal of the National Cancer Institute (JNCI), and the Journal of Immunology, and I have been a peer reviewer for over 1,000 manuscripts submitted for publication. For nearly two decades before I was recruited to Pittsburgh to found the UPCI, I led research teams at the NCI that focused mainly on characterizing the cellular basis for human anti-tumor immunity and utilizing the insights derived from those studies to develop innovative approaches to use immunotherapy to improve the treatment of cancer. The work of my research team at NCI resulted in the initial identification and then extensive characterization of natural killer (NK) cells. Research by my team at NCI and then at UPCI, along with other leading researchers around the world, have shown that NK cells are a key component of our natural defense against the development and metastatic spread of cancer.

In addition to world class studies in cancer immunology and immunotherapy at UPCI, other programs at our institute are developing prognostic indicators of response to treatment. UPCI also includes experts working on strategies for cancer prevention, early detection, and treatment and approaches for cancer control. Through our innovative Center for Environmental Oncology, we are carrying out studies to better define the role of environmental exposures on cancer risk, coupled with measures to reduce cancer risk by reducing exposure to environmental carcinogens, or using nutritional and other interventions to protect people who have been exposed to environmental hazards.

As part of our overall efforts, we are also working to identify important policy changes that should be developed to reduce the burden of cancer. After years of protracted delays, our nation has finally made progress against smoking by getting individuals to stop smoking. But, smoking control policies proved difficult to implement for many years, because of complex strategies to manipulate information on its dangers. Analogous efforts to identify and then effectively implement actions for other controllable causes of cancer have been fairly limited.

Now, to turn to the issues of direct interest to this committee, I first want to point out that, in contrast to several of the other speakers at this important hearing, who are longstanding experts on some aspects of radiofrequency (RF) radiation associated with cell phones or on the design and implementation of population-based studies, I have only recently become involved in the issue of the possible health risks of cell phones, by issuing a precautionary message to the faculty and staff of the UPCI and the UPMC Cancer Centers. For you to understand why a non-expert in the field took this action, I

believe it is important to explain the process that led up to the issuance of the advisory to reduce direct cell phone exposures to the head and body.

Last year, as she was finalizing her well-researched book, *The Secret History of the War on Cancer*, my colleague, Dr. Devra Davis, Director of the UPCI's Center for Environmental Oncology and an internationally acclaimed expert in environmentally-induced health risks, shared with me the growing scientific literature on the possible association between extensive cell phone and increased risk of malignant and benign brain tumors. My attention was directed to a large body of evidence, including expert analyses showing absorption of RF into the brain and the comprehensive Bioinitiative Report, review of experimental and public health studies pointing to potential adverse biologic effects of RF signals, including brain tumors, associated with long-term and frequent use of cell phones held to the ear. I also learned of a recent series of similar precautionary advisories from international experts and various governments in Europe and Canada. I reacted to this information in the same fashion as I do with other reports of claims of biologically and/or clinically important findings, namely I first carefully reviewed the reports and consulted with a variety of relevant experts.

My evaluation of the scientific and technical information indicating the potential hazards of cell phones was built on the foundation of my extensive experience in cancer research and critical evaluations of reports being submitted for peer-reviewed publications. I recognized that there was sufficient evidence to justify the precautionary advisories that had been issued in other countries, to alert people about the possibility of harm from long-term, frequent cell phone use, especially by young children. Then, Dr. Davis and I consulted with international experts in the biology of radiofrequency (RF) effects and the epidemiology of brain tumors, and with experts in neurology, oncology and neurosurgery at UPCI. . Without exception, all of the experts contacted confirmed my impression that there was a sound basis to make the case for precaution, especially since there are simple and practical measures that can be taken, to be able to continue to use cell phones while substantially reducing the potential hazards.

Another factor influencing my decision was my growing conviction that substantially more attention should be devoted to promoting a range of strategies to reduce the future burden of cancer. Of course, I appreciate the tremendous progress that the US has made in treating cancer, some of which was achieved by studies at the University of Pittsburgh, on melanoma, breast, brain, and colorectal cancer. I also recognize that approaches that aim to prevent new cases from occurring are the most likely ways to more effectively and efficiently reduce the overall burden of cancer. Accordingly, I decided to act, consistent with my responsibilities as the leader of a major US cancer institute, by informing my colleagues about my concerns that cell phone use may be a substantial risk to public health. I also wanted to stimulate broader awareness and discussion of the evidence that I came to be familiar with, and to encourage changes in the behavior of some of my colleagues and by extension, also their families and friends.

Summary of review of the published scientific evidence for an association between cell phone use and brain tumors

Obviously, scientific research plays a central role in identifying exposures that may affect our health. In public health research, scientists generally rely on two major types of evidence to evaluate potential risks. First, a combination of laboratory-based experimental studies using animals, cell cultures, and computer models can be used to examine mechanisms, identify biological effects and predict the potential impact for humans. Then, population-based human studies can also be used to determine if observed patterns of disease can be correlated with specific exposures, and other more detailed studies of people with a particular disease in comparison with healthy controls, so-called case-control studies, can be carried out to determine if there are different health patterns in those with and without certain exposures..

Although in some cases a clear association between an exposure and health effect can be demonstrated, often methodological differences among studies can introduce subtle differences in the way data are evaluated, and in some cases can lead to very different conclusions. This is especially true for human population-based cancer epidemiology studies where it is sometimes very difficult to select non-exposed controls, where the critical timing of exposure is not precisely known, where the mechanism by which an exposure might cause cancer is not well defined or understood, or where the characteristics of the exposure change over time. A critical review of the literature on the biological effects of cell phones exemplifies this point. Despite the lack of consistency in outcomes in all the cell phone publications, there are several well-designed studies that suggest that long-term (10 years or more) use of wireless phone devices is associated with a significant increase in risk for glioblastoma (glioma), a very aggressive and fatal brain tumor, and acoustic neuroma, a benign tumor of the auditory nerve that is responsible for our hearing.

For more than eight years, the World Health Organization has been conducting a combined effort to study cell phones and brain cancer in thirteen countries, called the Interphone study. No results synthesizing this overall effort have been published yet. But, several reports from countries participating in the Interphone study have appeared. Some analyses have found no increased risk of cell phones, while others, from countries where study participants used cell phones for a decade or longer, have found increased risks for brain tumors. But, even in these negative studies, when the subset of long-term users are examined separately, there is evidence of increased risk of brain tumors.

Clearly, not all of the published cell phone studies have reached the same conclusion. What are some of the characteristics of study design that can explain the differences among cell phone use studies generally and between the Interphone-related studies and the independent, non-Interphone-related studies?

To address this question, in 2008, Dr. Lennart Hardell, a distinguished oncologist and senior author on several cell phone studies in Sweden that have shown increases in brain tumor risk with long-term use, published a combined analysis (also called a meta-

analysis) of published case-control studies that evaluated the effects of cell phone use on brain tumor risk. For gliomas, a malignant tumor of the supporting tissue of the brain, he and his colleagues found 10 studies, 7 were part of the Interphone Study, one was partly based on Interphone participation and partly independent, and 2 were not part of Interphone (one was a Swedish study from Hardell's team. and the second was a Finnish study). In contrast to the Interphone-related studies which found no increased risk for glioma, both of the independent studies found an increased risk of 40-50%. Since 8 of these 10 studies were Interphone-related, and these studies all showed no effect of cell phone use on glioma risk, the combined data result (meta-analysis) also showed no effect. It should be noted, however, that most of these studies included as cell phone users those who only made a single phone call a week and did so over a limited duration.

In contrast, focusing on those who had used cell phones for a decade provided a different story. Of these 10 studies, 6 evaluated long-term exposure effects, resulting from 10 or more years of cell phone use. Of these 6 studies, all showed an increase risk for developing a glioma on the same side of the head where the phone was used, and this increased risk ranged from a low of 20% increased risk for low grade (less aggressive) glioma to more than 400% increase risk of high grade (very aggressive) glioma. The meta-analysis for the combined data indicated that those who regularly used cell phones had twice the risk of malignant brain tumors overall, and four times the risk if they were high users of phones.

For acoustic neuroma, 9 case-control studies have been published that have compared the reported history of cell phone use of persons with and without this benign tumor on the hearing nerve. Eight of these studies are Interphone study-related and one, by Hardell's group, was independent. Whereas six of the 7 Interphone studies showed that no increased risk with regular cell phone use, Hardell found that regular cell phone users had a 70% greater risk. What struck me as especially relevant, and to possibly account for the divergent reports, is one simple fact: all three studies that looked at cell phone users for at least a decade, found a significantly increased risk. In long term users, acoustic neuromas are twice as frequent in regular, long-term users. .

Within the last month, as also noted by Dr. David Carpenter in this hearing, Dr. Hardell reported at a meeting of the Royal Society of London that very frequent and long term users of cell phones by teenagers that started before age 20, resulted in a five times higher rate of brain cancer by the age of 29, when compared with non-cell phone users.

Brain cancer, which is one of the health effects of very serious concern, is believed to develop in adults over a period of at least one decade and in some cases, up to several decades. Among the known causes of brain cancer is ionizing radiation, such as x-rays. RF radiation is not ionizing, but it is absorbed into the brain, according to modeling studies that have been produced by the cell phone industry, in particular by French Telecom. There is no debate that radiation emitted by cell phones is absorbed into the brain -- dramatically more so in children than in adults.

In summary, my review of the literature suggests that most studies claiming that there is no link between cell phones and brain tumors are outdated, had methodological

concerns, and did not include sufficient numbers of long-term cell phone users to find an effect, since most of these negative studies primarily examined people with only a few years of phone use and did not inquire about cordless phone use. In addition, many studies defined regular cell phone use as “once a week.”

One major negative study, published by the Danish Cancer Society and supported by the cell phone industry, started with nearly three quarters of a million cell phone users during the period between 1982 and 1995. This study excluded more than 200, 000 business users, who were most likely to be the most frequent users during that time period. Recall bias was a problem with all of these studies as solid data such as cell phone records were not used to document usage and people were simply asked, often the day after surgery, whether or not they had used a cell phone and for how long.

Scientists appreciate that diseases like brain cancer can take decades to develop. This means that even well conducted studies of those who have used phones for only a few years, as most of us have, cannot tell us whether or not there are hazards from long-term use.

In contrast, some recent studies in Nordic countries, where phones have been used longest, find that persons who have used cell phones for at least a decade have 30% to more than 200% more brain tumors than do those without such use, and only on the side of the head where the user holds his or her phone. To put these numbers in context, this is at least as high an increase as the added risk of breast cancer that women face from long-term use of hormone replacement therapy. Based on these findings and the increased absorption into the brains of the young, the French Ministry of Health advised that children should be discouraged from using cell phones, a position also taken by British, German and other authorities.

Precautionary advisory based on review of the published reports and consideration of the precautionary advisories from several countries in Europe and elsewhere

While those issues are being debated and resolved, and as we eagerly await the results, my review of the available published evidence suggesting some increased brain tumor risk following long-term cell phone use, combined with the current near ubiquity of exposure to cell phones and cordless phone RF fields (more than 90% of the population in the Western European countries and about 90% of the population in the USA use cellular phones), led me to work with both international experts and experts at UPCI to develop a set of prudent and simple precautions that I felt could reduce potential risk, while awaiting more definitive evidence. . Certainly, if it turns out that long-term use of cell phones does increase brain tumor risk, the public health implications of not taking action are obvious.

On July 21, 2008, I issued the advisory on the safe use of cell phones to the physicians, researchers and staff at UPCI and UPMC Cancer Centers. Before its issuance, this document was reviewed by UPCI experts in neuro-oncology, epidemiology, environmental oncology, and neurosurgery as well as national and international scientific and engineering experts. A copy can be found at the end of my

testimony (Appendix A). My sole goal in issuing the cell phone advisory was to suggest simple precautions that would reduce exposure to cell phone electromagnetic radiation. The advisory clearly indicated that the human evidence on the potential hazard of cell phones is still evolving, but it pointed out that there are some studies using experimental and population-based approaches that suggest an association between long-term cell phone use and development of brain tumors. It also pointed out that modeling studies suggest the possibility that there may be additional differences in susceptibility between young children and adults. Based on my review of the data, I felt that there was sufficient evidence for possible human health risks, to warrant providing precautionary advice on cell phone use, especially by children.

What are the main points of the advisory? Adults can reduce direct exposure of the head and bone marrow to radiofrequency radiation by using ear pieces or the speaker phone mode whenever possible. Cell phone use by children should be restricted. Here we advised, as do a number of governments, that cell phone use by children be limited to emergencies calls and for older children, text messaging. In circulating this warning, I joined with an international expert panel of pathologists, oncologists and public health specialists, who recently declared that RF radiation emitted by cell phones should be considered a potential human health risk.(Appendix B)¹ In fact, shortly before I sent my precautionary message to faculty and staff at UPCI and UPMC Cancer Centers, a number of countries including France, Germany and India, and the province of Ontario, Canada, issued similar advice, suggesting that exposure to RF radiation from cell phones be limited. Very soon after the UPCI advisory was issued, Israel's Health Ministry endorsed my recommendations, and Toronto's Department of Public Health advised that teenagers and young children limit their use of cell phones, to avoid potential health risks (Appendix C).

I appreciate the interest of this committee in exploring the current state of the scientific evidence on the potential hazards of cell phones. I have provided appendices that include links and references to reviews and advisories that have been issued within the past few years by other authorities. In addition, the web site for UPCI's Center for Environmental Oncology (www.preventingcancernow.org) includes the actual papers as pdf files for all major studies published over the past two years. In addition, the Bioinitatives Report (www.bioinitativereport.org) provides comprehensive, critical review, that includes references to the more than 4,000 relevant studies that have been published to date on this subject.

Most people throughout the developed world are using cell phones. Cell phones save lives and have revolutionized our world in many positive ways. Without doubt, the most immediate danger from the use of cell phones is that of traffic crashes. But, the longer term spectre of harm cannot easily be dismissed at this point. The absence of definitive positive studies should not be confused with proof that there is no association. Rather, it reflects the difficulties of assembling definitive proof and the absence of well-conducted, large-scale independent studies on the problem.

¹ *The Case for Precaution in the Use of Cell Phones Advice from University of Pittsburgh Cancer Institute Based on Advice from an International Expert Panel*, available at www.preventingcancernow.org

Throughout my career I have witnessed the tremendously important discoveries that have improved cancer care. I also recognize that cancer professionals and physicians in general have failed to pay adequate attention to the need to identify and then promptly and effectively control avoidable causes of cancer. Nowhere is our failure more evident than in the protracted and prolonged debate that played out over the hazards of tobacco. By all accounts, we have also missed the boat with respect to our national policies on known workplace cancer causes such as exposure to asbestos, and we waited far too long before acting to reduce dangers associated with hormone replacement therapy.

It is worth noting that in the case of tobacco and lung cancer, debates over whether there was a true increase in lung cancer associated with smoking raged far longer than they should have, fomented by an active disinformation campaign of which this Congress is well aware. The dilemma of public policy when it comes to controlling and identifying the causes of cancer is profound. If we insist we must be certain of human harm and wait for definitive evidence of such damage, we are effectively saying that we can only act to prevent future cancers, once past ones have become evident. Recalling the 70 years that it took to remove lead from paint and gasoline and the 50 years that it took to convincingly establish the link between smoking and lung cancer, I argue that we must learn from our past to do a better job of interpreting evidence of potential risk. In failing to act quickly, we subject ourselves, our children and our grandchildren to the possibility of grave harm and to living with the knowledge that with more rapid action that harm could have been averted.

I do not envy policy makers and regulators as they do not always have adequate solid data on which to base standards. In the present case, the link between cell phones and health effects is suggestive but not solidly established. From my careful review of the evidence, I cannot tell you conclusively that phones cause cancer or other diseases. But, I can tell you that there are published peer reviewed studies that have led me to suspect that long term cell phone use may cause cancer. . It should be noted in this regard that worldwide, there are three billion regular cell phone users, including a rapidly growing number of children. If we wait until the human evidence is irrefutable and then act, an extraordinarily large number of people will have been exposed to a technology that has never really been shown to be safe. In my opinion, for public health, when there is some evidence of harm and the exposed group is very large, it makes sense to urge caution. This is why I issued advice to our faculty and staff, especially to take precautions to reduce cell phone RF exposures to children

Now that the issue of a possible association of long-term cell phone with increased brain tumor risk has reached national and international attention, the central question is where we go from here. Should we simply wait and watch? Or, should we take some actions now? I am not sufficiently expert to comment on possible new regulations to affect cell phone usage. Rather, from my perspective as a scientist and cancer center director, I want to do all that I can to see that the matter of cell phones and our health is resolved. I believe that we should undertake additional, more definitive research that will tell the whole story. Many of my colleagues at UPCI, Rutgers

University, University of California, San Francisco and a number of senior faculty at M.D. Anderson Cancer Institute are joining with me in calling for an independent scientific investigation, avoiding as many of the limitations of the prior studies as possible, to determine if long-term, frequent use of cell phones and cordless phones increases brain tumor risk We will urge that these studies engage both university and NIH experts and also the full cooperation of the cell phone industry, which will be asked to provide solid usage data in the form of access to billing records and substantial contribution to the funding of the study but without any direct review or control of the results, in order to clearly settle this issue in the not too distant future.

In the meantime, while we continue to conduct progressively better research on this question, I believe it makes sense to urge caution: it's better to be safe than sorry.

List of Appendices to Testimony of Ronald B. Herberman, MD

September 25, 2008

Subcommittee on Domestic Policy

Government Oversight and Reform Committee

U.S. House of Representatives

Appendix A: Advisory to UPCI Staff on Cell Phones

Appendix B: International Expert Advisories

Appendix C: Overview of Biological Impacts of Radio Frequency

Appendix D: Cell phone- related biological and health risks

Appendix E: Lloyd Morgan critique of INTERPHONE Study

Physical Exhibit: Three Dimensional Model of Brain Showing Radio-absorption

1) Electromagnetic fields from cell phones are estimated to penetrate the brain especially in children. (Figure 1.) [1, 2]

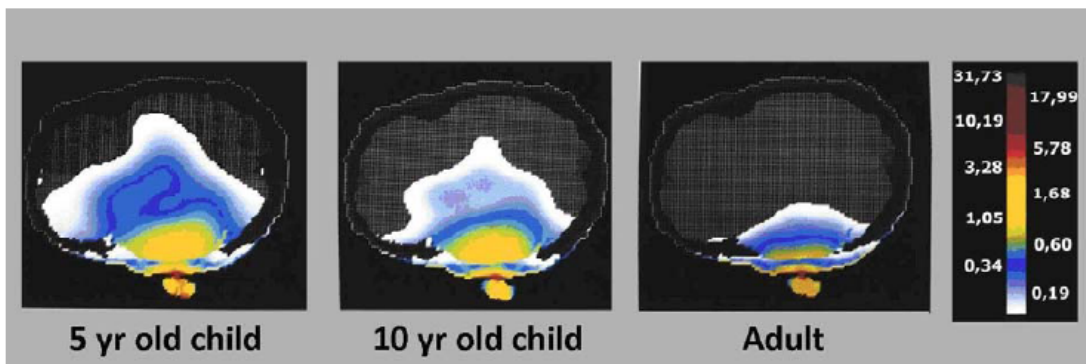


Figure 1. Estimation of the penetration of electromagnetic radiation from a cell phone based on age (Frequency GSM 900 Mhz) (On the right, a scale showing the *Specific Absorption Rate* at different depths, in W/kg) [1]

OR High quality color reproduction of Gandhi imaging studies of brain absorption.

Appendix A: Advisory to UPCI Staff on Cell Phones

MEMORANDUM

TO: UPCI Faculty and Staff

FROM: Ronald B. Herberman, MD

SUBJECT: Important Precautionary Advice Regarding Cell Phone Use

DATE: July 21, 2008

Recently I have become aware of the growing body of literature linking long-term cell phone use to possible adverse health effects including cancer. Although the evidence is still controversial, I am convinced that there are sufficient data to warrant issuing an advisory to share some precautionary advice on cell phone use.

An international expert panel of pathologists, oncologists and public health specialists, recently declared that electromagnetic fields emitted by cell phones should be considered a potential human health risk.¹ To date, a number of countries including France, Germany and India have issued recommendations that exposure to electromagnetic fields should be limited. In addition, Toronto's Department of Public Health is advising teenagers and young children to limit their use of cell phones, to avoid potential health risks.

More definitive data that cover the health effects from prolonged cell phone use have been compiled by the World Health Organization, International Agency for Research on Cancer. However, publication has been delayed for two years. In anticipation of release of the WHO report, the following prudent and simple precautions, intended to promote precautionary efforts to reduce exposures to cell phone electromagnetic radiation, have been reviewed by UPCI experts in neuro-oncology, epidemiology, neurosurgery and the Center for Environmental Oncology

Practical Advice to Limit Exposure to Electromagnetic Radiation Emitted from Cell Phones

1. Do not allow children to use a cell phone, except for emergencies. The developing organs of a fetus or child are the most likely to be sensitive to any possible effects of exposure to electromagnetic fields.

¹ *The Case for Precaution in the Use of Cell Phones Advice from University of Pittsburgh Cancer Institute Based on Advice from an International Expert Panel*, available at www.preventingcancer.org

2. While communicating using your cell phone, try to keep the cell phone away from the body as much as possible. The amplitude of the electromagnetic field is one fourth the strength at a distance of two inches and fifty times lower at three feet.

Whenever possible, use the speaker-phone mode or a wireless Bluetooth headset, which has less than 1/100th of the electromagnetic emission of a normal cell phone. Use of a hands-free headset may also reduce exposures.

3. Avoid using your cell phone in places, like a bus, where you can passively expose others to your phone's electromagnetic fields.
4. Avoid carrying your cell phone on your body at all times. Do not keep it near your body at night such as under the pillow or on a bedside table, particularly if pregnant. You can also put it on "flight" or "off-line" mode, which stops electromagnetic emissions.
5. If you must carry your cell phone on you, it is preferable that the keypad is positioned toward your body and the back is positioned toward the outside of your body. Depending on the thickness of the phone this may provide a minimal reduction of exposure.
6. Only use your cell phone to establish contact or for conversations lasting a few minutes, as the biological effects are directly related to the duration of exposure. For longer conversations, use a land line with a corded phone, not a cordless phone, which uses electromagnetic emitting technology similar to that of cell phones.
7. Switch sides regularly while communicating on your cell phone to spread out your exposure. Before putting your cell phone to the ear, wait until your correspondent has picked up. This limits the power of the electromagnetic field emitted near your ear and the duration of your exposure.
8. Avoid using your cell phone when the signal is weak or when moving at high speed, such as in a car or train, as this automatically increases power to a maximum as the phone repeatedly attempts to connect to a new relay antenna.
9. When possible, communicate via text messaging rather than making a call, limiting the duration of exposure and the proximity to the body.
10. Choose a device with the lowest SAR possible (SAR = Specific Absorption Rate, which is a measure of the strength of the magnetic field absorbed by the body). SAR ratings of contemporary phones by different manufacturers are available by searching for "sar ratings cell phones" on the internet.

Appendix B: International Expert Advisories

The Case for Precaution in the Use of Cell Phones

Advice from University of Pittsburgh Cancer Institute Based on Advice from an International Expert Panel

ANALYSIS OF RECENT STUDIES

Electromagnetic fields generated by cell phones should be considered a potential human health risk. Sufficient time has not elapsed in order for us to have conclusive data on the biological effects of cell phones and other cordless phones—a technology that is now universal.

Studies in humans do not indicate that cell phones are safe, nor do they yet clearly show that they are dangerous. But, growing evidence indicates that we should reduce exposures, while research continues on this important question.

Manufacturers report that cell and wireless phones emit electromagnetic radiation. Electromagnetic fields are likely to penetrate the brain more deeply for children than for adults. Modeling in the diagram below estimates that young children are more susceptible to electromagnetic fields due to smaller sized brains and softer brain tissue.

1) Electromagnetic fields from cell phones are estimated to penetrate the brain especially in children. (Figure 1) [1, 2]

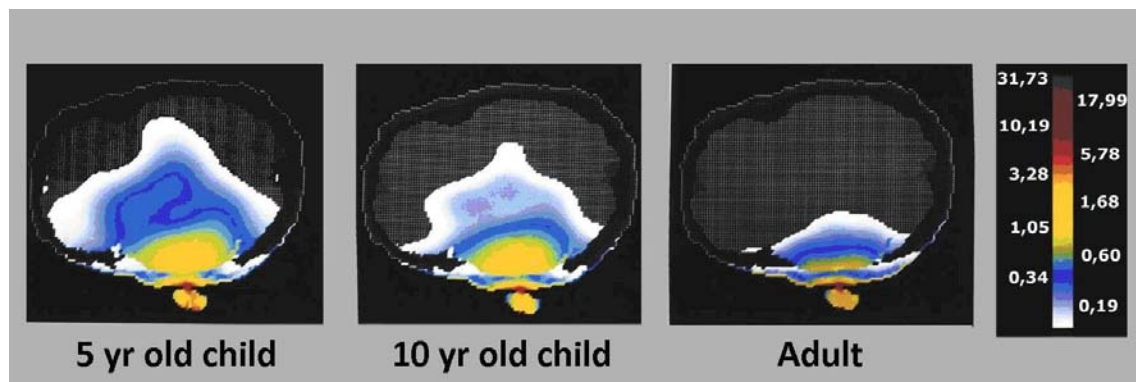


Figure 1 Model estimate of the absorption of electromagnetic radiation from a cell phone based on age (Frequency GSM 900 Mhz) (On the right, color scale showing the *Specific Absorption Rate* in W/kg)[1]

2) Living tissue is vulnerable to electromagnetic fields within the frequency bands used by cell phones (from 800 to 2200 MHz) even below the threshold of power imposed by most safety standards (1.6 W/Kg for 1g of tissue), notably an increase in the permeability of the blood-brain barrier and an increased synthesis of stress proteins. [3, 4, 5, 6]

The most recent studies, which include subjects with a history of cell phone usage for a duration of at least 10 years, show a possible association between certain benign tumors (acoustic neuromas) and some brain cancers on the side the device is used.[6, 7, 8, 9]

However, human epidemiological studies on cell phones conducted to date cannot be conclusive. Due to their recently increased use, we are not yet able to evaluate their long term impact on health. Even where an association between exposure and cancer is well established

and the risk very high -- as with tobacco and lung cancer -- under similar study conditions (in other words with people who smoked for less than 10 years) it would be difficult, if not impossible, to identify an increased risk of cancer, as the risk appears mostly 15 to 35 years later. [7].

THE TEN PRECAUTIONS

Given the absence of definitive proof in humans of the carcinogenic effects of electromagnetic fields of cell phones, we cannot speak about the necessity of *preventative* measures (as for tobacco or asbestos). In anticipation of more definitive data covering prolonged periods of observation, the existing data press us to share important prudent and simple measures of *precaution* for cell phone users, as have been variously suggested by several national and international reports. [6, 9, 10, 11, 12]

These measures are also likely to be important for people who are already suffering from cancer and who must avoid any external influence that may contribute to disease progression.

1. Do not allow children to use a cell phone except for emergencies. The developing organs of a fetus or child are the most likely to be sensitive to any possible effects of exposure to electromagnetic fields.
2. While communicating using your cell phone, try to keep the cell phone away from the body as much as possible. The amplitude of the electromagnetic field is one fourth the strength at a distance of two inches and fifty times lower at three feet.

Whenever possible, use the speaker-phone mode or a wireless Bluetooth headset, which has less than 1/100th of the electromagnetic emission of a normal cell phone. Use of a headset attachment may also reduce exposure.

3. Avoid using your cell phone in places, like a bus, where you can passively expose others to your phone's electromagnetic fields.
4. Avoid carrying your cell phone on your body at all times. Do not keep it near your body at night such as under the pillow or on a bedside table, particularly if pregnant. You can also put it on "flight" or "off-line" mode, which stops electromagnetic emissions.
5. If you must carry your cell phone on you, it is preferable that the keypad is positioned toward your body and the back is positioned toward the outside of your body. Depending on the thickness of the phone this may provide a minimal reduction of exposure.
6. Only use your cell phone to establish contact or for conversations lasting a few minutes as the biological effects are directly related to the duration of exposure. For longer conversations, use a land line with a corded phone, not a cordless phone, which uses electromagnetic emitting technology similar to that of cell phones.
7. Switch sides regularly while communicating on your cell phone to spread out your exposure. Before putting your cell phone to the ear, wait until your correspondent has picked up. This limits the power of the electromagnetic field emitted near your ear and the duration of your exposure.

8. Avoid using your cell phone when the signal is weak or when moving at high speed, such as in a car or train, as this automatically increases power to a maximum as the phone repeatedly attempts to connect to a new relay antenna.
9. When possible, communicate via text messaging rather than making a call, limiting the duration of exposure and the proximity to the body.
10. Choose a device with the lowest SAR possible (SAR = Specific Absorption Rate, which is a measure of the strength of the magnetic field absorbed by the body). SAR ratings of contemporary phones by different manufacturers are available by searching for “sar ratings cell phones” on the internet.

CONCLUSION

The cell phone is a remarkable invention and a breakthrough of great social importance. Our society will no longer do without cell phones. None of the members on the expert committee has stopped or intends to stop using cell telephones. This includes Dr. David Servan-Schreiber, a 16 year survivor of brain cancer. However, we, the users, must all take precautionary measures in view of recent scientific data on the biological effects of cell phone use, especially those who already have cancer.

In addition, manufacturers and service providers must also assume responsibility. It is their responsibility to provide appliances and equipment with the lowest possible risk and to constantly evolve their technology in this direction. They should also encourage consumers to use their devices in a way that is most compatible with preserving their health.

In the early 1980's, the owners of asbestos mines were reduced to bankruptcy as a result of lawsuits brought by the families of deceased exposed workers. A few years later, a key executive of Johns Manville, the most prominent company, drew lessons from the years of struggle of his industry against medical data and the scientists who were drawing attention to the risks of asbestos. He concluded with regret that greater warnings for the public, the establishment of more effective precautions, and *more extensive* medical research "could have saved lives, and probably also shareholders, the industry, and the benefits of its product." [14, 15]

We call on the cell phone companies to provide independent access to records of use so that appropriate studies can be carried out.

That is what we wish for today's cell phone industry. We do not need to ban this technology, but to adapt it – to harness it – so that it never becomes a major cause of illness.

INTERNATIONAL EXPERT COMMITTEE

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APPEL DE 20 EXPERTS INTERNATIONAUX CONCERNANT L'UTILISATION DES TÉLÉPHONES PORTABLES

- ANALYSE DES ÉTUDES RÉCENTES
- LES 10 PRECAUTIONS A PRENDRE

ANALYSE DES ÉTUDES RÉCENTES

Les champs magnétiques émis par les téléphones portables doivent être pris en compte en matière de santé. Il est important de s'en protéger. Dix mesures simples de précaution peuvent y aider.

A ce jour, les études épidémiologiques existantes sont insuffisantes pour conclure de façon définitive que l'utilisation des téléphones portables est associée à un risque accru de tumeurs et autres problèmes de santé.

Toutefois, il existe un consensus scientifique existe pour conclure que les études disponibles mettent en évidence :

1/ **une pénétration significative des champs électromagnétiques des téléphones portables dans le corps humain**, particulièrement au niveau du cerveau, et plus encore chez les enfants du fait de leur plus petite taille. (Figure 1.)

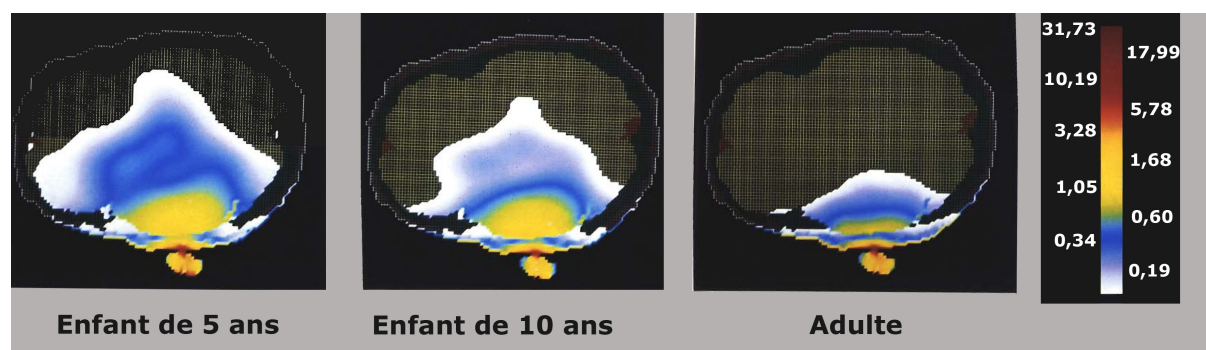


Figure 1. Estimation de la pénétration du rayonnement électromagnétique d'un téléphone portable en fonction de l'âge (Fréquence GSM 900 Mhz) (A droite, échelle du *Débit d'Absorption Spécifique* à différentes profondeurs, en W/kg) *

* Les chercheurs de l'étude INTERPHONE ont obtenu des résultats comparables avec 129 téléphones portables récents (fréquences 800 à 1800 MHz, PDC et GSM) sur les modèles de cerveau adulte mais n'ont pas évalué l'absorption des cerveaux d'enfants.

2/ divers effets biologiques des champs électromagnétiques dans les bandes de fréquence des téléphones portables (de 800 à 2200 Mhz) même en dessous des seuils de puissance imposés par les normes de sécurité européennes (2 W/kg pour 10g de tissu) sur les tissus vivants, notamment une augmentation de la perméabilité de la barrière hémato-encéphalique et une synthèse accrue des protéines de stress.

Du fait de la rareté de l'utilisation des portables jusqu'à ces dernières années, nous notons que les études épidémiologiques humaines réalisées jusqu'à ce jour ne peuvent avoir comporté un nombre suffisant de personnes ayant utilisé leur téléphone pendant plus de 10 ans de façon intensive (plusieurs heures par semaine).

Et l'on sait que même dans le cas où l'association d'une exposition avec un cancer est parfaitement prouvée et le risque très fort (comme pour le tabac et le cancer du poumon), des études dans des conditions similaires, à savoir sur des personnes ayant fumé pendant moins de 10 ans auraient du mal à mettre en évidence un risque augmenté de cancer du poumon : le risque apparaît surtout 15 à 35 ans plus tard. .

Les études les plus récentes qui incluent des utilisations de téléphone portable pendant plus de 10 ans montrent une association probable avec certaines tumeurs bénignes (neurinomes du nerf acoustique) et certains cancers du cerveau, plus marquée *du côté d'utilisation de l'appareil*.*

LES 10 PRECAUTIONS A PRENDRE

Compte tenu de l'absence de preuve absolue chez l'être humain d'un effet cancérigène des ondes électromagnétiques émises par les téléphones portables nous ne pouvons pas parler de la nécessité de mesures de *prévention* (comme pour le tabac ou l'amiante). Dans l'attente de données définitives portant sur des périodes d'observations prolongées, les résultats existants imposent que l'on fasse part aux utilisateurs des mesures les plus importantes de *précaution* comme l'ont aussi suggéré plusieurs rapports nationaux et internationaux **

Ces mesures sont aussi importantes pour les personnes qui sont déjà atteintes d'un cancer afin d'éviter toute influence extérieure qui pourrait contribuer à la progression de leur maladie.

1. N'autorisez pas **les enfants de moins de 12 ans** à utiliser un téléphone portable sauf en cas d'urgence. En effet, les organes en développement (du fœtus ou de l'enfant) sont les plus sensibles à l'influence possible de l'exposition aux champs électromagnétiques.
2. Lors de vos communications, essayez autant que possible de **maintenir le téléphone à plus d'1 m du corps** (l'amplitude du champ baisse de quatre fois à 10 cm, et elle est cinquante fois inférieure à 1 m de distance – voir figure 2).

* Le risque pour ces personnes pourrait être près de deux fois celui des non-utilisateurs, voire plus.

** Les rayonnements électromagnétiques des antennes relais et des émetteurs WIFI sont beaucoup plus faibles que ceux des téléphones portables. Nous limitons pour cette raison nos recommandations actuelles à l'utilisation des téléphones.

Dès que possible, utilisez le **mode « haut-parleur »**, ou un **kit mains libres équipé d'un tube à air** dans ses derniers 20 cm qui semble moins conduire les ondes électromagnétiques qu'un kit mains libres filaire traditionnel,** ou une **oreillette bluetooth** (moins d'1/100^e de l'émission électromagnétique du téléphone en moyenne – mais attention de ne pas la conserver constamment à l'oreille en période de veille).

3. Restez à plus **d'un mètre de distance d'une personne en communication**, et évitez d'utiliser votre téléphone portable dans des lieux publics comme **le métro, le train ou le bus** où vous exposez passivement vos voisins proches au champ électromagnétique de votre appareil.
4. **Evitez le plus possible de porter un téléphone mobile sur vous**, même en veille. Ne pas le laisser à proximité de votre corps la nuit (sous l'oreiller ou sur la table de nuit) et particulièrement dans le cas des **femmes enceintes** – ou alors le mettre en mode « avion » ou « hors ligne/*off line* » qui a l'effet de couper les émissions électromagnétiques.
5. Si vous devez le porter sur vous, assurez-vous que la **face « clavier » soit dirigée vers votre corps** et la face « antenne » (puissance maximale du champ) vers l'extérieur.
6. N'utilisez votre téléphone portable que pour **établir le contact** ou pour **des conversations de quelques minutes seulement** (les effets biologiques sont directement liés à la durée d'exposition). Il est préférable de rappeler ensuite d'un téléphone fixe *filaire* (et non d'un téléphone sans fil --DECT)-- qui utilise une technologie à micro-ondes apparentée à celle des portables).
7. Quand vous utilisez votre téléphone portable, **changez de côté régulièrement**, et avant de mettre le téléphone portable contre l'oreille, **attendez que votre correspondant ait décroché** (baisse de la puissance du champ électromagnétique émis).
8. **Evitez d'utiliser le portable lorsque la force du signal est faible** ou lors de déplacements rapides comme **en voiture ou en train** (augmentation maximale et automatique de la puissance lors des tentatives de raccordement à une nouvelle antenne relais ou à une antenne distante)
9. **Communiquez par SMS** plutôt que par téléphone (limite la durée d'exposition et la proximité du corps).
10. **Choisissez un appareil avec le DAS le plus bas possible** par rapport à vos besoins (le « Débit d'Absorption Spécifique » mesure la puissance absorbée par le corps). Un [classement des DAS des téléphones contemporains](#) des différents fabricants est disponible sur www.guerir.fr et d'autres sites internet.

** Certains kits avec tube à air peuvent être commandés sur internet en faisant une recherche sur « *air tube headset* ». Les données sur les kits mains libres filaires sans tube à air sont encore trop imprécises pour en garantir l'efficacité. De plus, une étude récente a observé le même risque accru de tumeurs de la parotide chez les utilisateurs fréquents de téléphones portables, qu'ils utilisent ou non un kit piéton filaire traditionnel.

CONCLUSION

Le téléphone portable est une invention remarquable et une avancée sociétale importante. Nous ne nous en passerons plus. Aucun des membres du comité d'experts ci-dessous n'a renoncé à l'utilisation d'un téléphone portable. Même moi (DSS), porteur d'un cancer au cerveau, je ne m'en passerai plus. En revanche, nous, les **utilisateurs**, devons tous prendre les mesures de *précaution* qui s'imposent aux vues des données scientifiques récentes sur leurs effets biologiques, particulièrement si nous sommes déjà porteur d'un cancer avéré.

Par ailleurs, **les constructeurs et les opérateurs** doivent aussi prendre leurs responsabilités. Il leur revient de fournir aux utilisateurs des appareils et des équipements qui permettent le plus bas niveau de risque possible et de faire constamment évoluer la technologie dans ce sens. Ils doivent aussi encourager les consommateurs à utiliser leurs appareils de la façon la plus compatible avec la préservation de leur santé.

Au début des années 1980, lorsque les propriétaires des mines d'amiante se sont vus réduits à la banqueroute sous l'effet des procès des familles des personnes décédées à cause de leur exposition professionnelle, Johns Manville, le plus important d'entre eux, a tiré les leçons de ses années de lutte contre les données médicales et scientifiques qui mettaient en cause son industrie. Il concluait, avec regrets, que *davantage d'avertissements* appropriés pour le public, la mise en place de *précautions plus efficaces*, et *davantage* de recherche médicale « auraient pu sauver des vies, et probablement les actionnaires, l'industrie, et du coup les bienfaits de son produit. »

C'est ce que nous souhaitons aujourd'hui à l'industrie du téléphone portable. Il ne s'agit pas de bannir cette technologie, mais de l'adapter – de la maîtriser – afin qu'elle ne devienne *jamais* une cause majeure de maladie.

Appendix C: Overview of Biological Impacts of Radio Frequency

Overview of Biological impact of RF - Mechanisms

Effect on Genotoxic effect and DNA Damage

RF may be considered genotoxic, cause DNA damage including single and double strand breaks and cross-link, chromosome conformation and micronucleus formation. Of 28 total studies on RF exposure and DNA damage, 14 studies reported significant effects (50%). Of 29 total studies on RF radiation and micronucleation, 16 studies reported effects (55%). Of 21 total studies on chromosome and genome damage from RF radiation, 13 studies (62%) reported significant effects.

Selected Significant Study Findings

Reference

Exposed mice to 900-MHz RF radiation at a SAR of 0.09 W/kg for 7 days at 12 h per day. A significant damage to both the mitochondrial genome and the nuclear -globin locus was found.	Aitken et al., 2005
Increases in DNA strand breaks and micronucleation in lymphocytes obtained from cell phone users.	Gandhi and Anita, 2005
Human fibroblasts and rat granulosa cells were exposed to mobile phone signal (1800 MHz; SAR 1.2 or 2 W/kg; during 4, 16 and 24 h; intermittent 5 min on/10min off or continuous). Effects occurred after 16 h exposure in both cell types. The intermittent exposure showed a stronger effect than continuous exposure.	Diem et al., 2005
Increases in single and double strand DNA breaks in brain cells of rats exposed for 2 hrs to 2450-MHz field at 0.6-1.2 W/kg.	Lai and Singh,1995, 1996, 1997, 2005]; Lai et al., 1997
An increased in single strand breaks in brain cells of rats after 35 days of exposure to 2.45 and 16.5 GHz fields at 1 and 2.01 W/kg.	Paulraj and Behari, 2006
Exposed male rats to 2.45 GHz RFR fields for 2 hours daily, 7 days a week, at 5-10 mW/cm ² for up to 30 days. Erythrocyte count, haemoglobin and haematocrit were increased in peripheral blood on irradiation days 8 and 15. Anuclear cells and erythropoietic precursor cells were significantly decreased in the bone marrow on day 15, but micronucleated cells were increased.	Busljeta et al., 2004
GSM microwaves at 915 MHz did not induce DNA double stranded breaks or changes in chromatin conformation, but affected expression of genes in rat brain cells.	Belyaev et al., 2006
Human peripheral blood lymphocytes were exposed to continuous 830-MHz EMFs (1.6-8.8 W/kg for 72 hr) showed a SAR dependent chromosome aneuploidy, a major “somatic mutation leading to genomic instability and thereby to cancer. It is suggesting that epigenetic alterations are involved in the SAR dependent genetic toxicity. The effects were non-thermal.	Mashevich et al., 2003

Effect on Stress Response (Stress Proteins)

The stress response enables cells to survive environmental stressors with the aid of heat shock proteins (HSP). It is stimulated by both non-thermal power (ELF), and non-thermal RF, as well as thermal RF-EMFs. It has been shown that RF stimulates the cellular stress response and cells start to synthesize stress proteins in many different kinds of cells. Safety standards must be developed to protect against possible damage at nonthermal levels, and the standards must be defined in terms of a non-thermal biological dose.

Selected Significant Study Findings

Reference

EMF may affect electron distribution and movement in DNA, and help it to come apart to initiate protein synthesis. Charge transport through DNA depends on the DNA sequence, and there are reasons to believe that EMFs would cause the DNA to come apart at the EMF consensus sequence, nCTCTn.	Shao et al., 2005 Blank and Goodman, 2002
Genotoxic effects were produced in fibroblasts, granulosa cells and HL60 cells by RF field exposure at SARs between 0.3 and 2W/kg. The expression and phosphorylation of the stress protein hsp27 was one of the many proteins affected.	REFLEX, 2004
The stress response threshold can be stimulated in both ELF and RF frequency ranges appears to suggest that the threshold is independent of EMF energy.	Lai and Singh, 2005
The separation of thermal and non-thermal mechanisms had been shown, where chromosomal damage observed under RF in lymphocytes was not seen when the cells were exposed to elevated temperatures.	Mashevich et al., 2002
The molecular damage stimulated by non-thermal ELF fields occurs in the absence of an increase in temperature. ELF energy thresholds are estimated to be about 10-12 W/kg, over a billion times lower than the thermal stimuli that cause damage in the RF range.	Blank and Goodman, 2004a
The importance of non-thermal mechanisms was showing that both denaturation and renaturation of β -lactoglobulin are accelerated by microwave EMF. It has also been shown that microwave radiation causes protein aggregation without bulk heating.	Bohr and Bohr, 2000 de Pomerai et al., 2003
Cellular processes are unusually sensitive to non-thermal ELF frequency fields, in the range of 0.5 to 1.0 μ T, not very much higher than the environmental backgrounds of \sim 0.1 μ T. The low biological thresholds in the non-thermal ELF range undermine claims that an EMF must increase the temperature in order to cause changes in cells or cause DNA damage.	Blank et al, 1994; Daniells et al, 1998; Di Carlo et al, 2002; Caraglia et al, 2005; Diem et al, 2005.
In addition to very low thresholds, exposure durations do not have to be very long to be effective. It has been shown a full response to an occurred with ELF modulated 915MHz sine waves, when cells were exposed for only 10sec.	Litovitz et al., 1991, 1993

Effect on Immune System

Both human and animal studies reported immunological changes with exposure to environmental levels of EMFs. Measurable physiological changes (mast cells increases) that are bedrock indicators of allergic response and inflammatory conditions are stimulated by EMF exposures. It is possible that chronic provocation by exposure to EMF can lead to immune dysfunction, chronic allergic responses, inflammatory responses and ill health if they occur on a continuing basis over time.

Selected Significant Study Findings

Reference

Assessed immunoglobulin concentrations and T-lymphocyte subsets in workers of TV re-transmission and satellite communication centers, increase in IgG and IgA concentrations, increased count of lymphocytes and T8 lymphocytes, decreased count of NK cells and a lower value of T-helper/T-suppressor ratio were found.	Dmoch and Moszczynski, 1998
Mast cells occur in the brain and their presence may under the influence of EMF and/or RF radiation exposure lead to chronic inflammatory response by the mast cell degranulation.	Zhuang et al., 1999
For women exposed to EMF induced by radiotelevision broadcasting stations in residential area at least 2 years, a significant reduction of blood NK CD16+-CD56+, cytotoxic CD3(-)-CD8+, B and NK activated CD3(-)-HLA-DR+ and CD3(-)-CD25+ lymphocytes were found.	Boscol et al., 2001
Exposed mononuclear cells isolated from peripheral blood of healthy donors to 1,300 MHz pulse-modulated microwaves at 330 pps with 5 μ s pulse width and the value of SAR = 0.18 W/kg. Pulse-modulated microwaves represent the potential of immunotropic influence, stimulating preferentially the immunogenic and proinflammatory activity of monocytes at relatively low levels of exposure.	Dabrowski et al., 2003
It was estimated that the proportion of individuals in Switzerland with electrical hypersensitivity (EHS) symptoms is about 5%. Based on a study of EHS in the UK, symptoms reported by mobile phone users included headaches (85%), dizziness (27%), fatigue (24%), nausea (15%), itching (15%), redness (9%), burning 61%), and cognitive problems (42%).	Roosli et al., 2004a, 2004b Cox, 2004
It was reported that non-thermal microwave exposure from GSM mobile phones at lower levels than the International Commission for Non-Ionizing Radiation Protection (ICNIRP) safety standards affect chromatin conformation and 53BP1/ γ -H2AX foci among EHS adults.	Markova et al., 2005
It was reported that EMF from mobile phones affects the synchronization of cerebral rhythms. The finding suggested that prolonged exposure to mobile phone emissions affect cortical activity and the speed of neural synchronization by interhemispherical functional coupling of EEG rhythms.	Vecchio et al., 2007

RF and Reactive Oxidative Species (ROS)

Several factors influence the susceptibility to oxidative stress by affecting the antioxidant status or free oxygen radical generation. Radiofrequency fields of cellular phones may affect biological systems by increasing free radicals, which appear mainly to enhance lipid peroxidation, and by changing the antioxidant activities of human blood thus leading to oxidative stress. Acute exposure to RF fields of commercially available cellular phones may modulate the oxidative stress of free radicals by enhancing lipid peroxidation and reducing the activation of superoxide dismutase (SOD) and total glutathione peroxidase (GSH-Px), which are free radical scavengers (Moustafa et al., 2001)

RF and gene expression

It was found that some genes were up-regulated during the RF exposure which mainly involved in the following functional categories on the basis of reported literatures: cytoskeletal structure, signal transduction pathway, ion channel, complement activity, synapses-related genes, cell adhesion, etc., whereas oxidation and deoxidization, immediately early genes, transcription factors, proto-oncogene and connexon were down-regulated by clustering analyses. Gene expression of rat neuron could be altered after exposed to the pulsed RF EMF at a frequency of 1800 MHz modulated by 217 Hz which is commonly used in cell phone. Among 1200 candidate genes, 24 up-regulated genes and 10 down-regulated genes were identified after 24-h intermittent exposure at an average SAR of 2 W/kg (Zhao et al., 2007)

RF and Reproductive System

Animal studies indicate that EMW may have a wide range of damaging effects on the testicular function and male germ line (Dasdag et al., 1999 and Davoudi et al., 2002). Recently, decreased sperm account has been reported (Agarwal et al., 2008). Men who used their cell phones the most had significant poorer sperm quality than those who used them the least. The lowest average sperm count was found in men who had the most cell phone use (more than four hours a day).

Overview of Biological Impacts of RF - Epidemiologic Evidence

Study	Population	Period	Study type	No of cases	No of Controls	OR (95% CI)	Cell phone exposure
Inskip et al., 2001	USA	1994–1998	Case–control	22	172	1.0 (0.5 – 1.9) ¹	Regular use (at least two calls per week) ≥ 5 years of regular use > 100 hours of cumulative use
				5	31	1.9 (0.6 – 5.9) ¹	
				9	51	1.4 (0.6 – 3.5) ¹	
Muscat et al., 2002	USA	1997–1999	Case–control	11	6	1.7 (0.5 – 5.1)	3–6 years of regular use (having had a subscription to a cell phone service) > 60 total hours use
				9	12	0.7 (0.2 – 2.6)	
Christensen et al., 2004	Denmark	2000–2002	Case–control	45	97	0.9 (0.5 – 1.6)	Regular use (more than one call per week for 6 months) > 5 years (> 81.7 hours) cumulative use
				9	25	0.7 (0.3 – 1.9)	
Lönn et al., 2004	Sweden	1999–2002	Case–control	89	356	1.0 (0.6 – 1.5)	Regular use (more than one call per week for 6 months) ≥ 10 years since first regular use of ipsilateral exposure
				12	15	3.9 (1.6 – 9.5)	
Schoemaker et al., 2005	4 Nordic countries, UK	1999–2004	Case–control	360	1934	0.9 (0.7 – 1.1)	Regular use (having used a mobile phone at least 6 months more than 1 year) ≥ 10 lifetime years cell use of ipsilateral exposure
				23	72	1.8 (1.1 – 3.1)	
Hardell et al., 2002	Sweden	1997-2000	Case-Control	38	11	3.5 (1.8 – 6.8)	> 1-year latency of analogue cell phone use
Hardell et al., 2005	Sweden	2000-2003	Case-Control	20	79	2.0 (1.05 – 3.8)	> 1-year latency of digital cell use > 1-year latency of analogue cell use
				53	343	4.2 (1.8 – 10)	
Hardell et al., 2006	Sweden	1997–2003	Case–control	68	297	2.9 (2.0 – 4.3)	> 1-year latency of analogue cell phone use > 1-year latency of digital cell phone use ≥ 10-year latency of analogue cell phone use > 1000 hours cumulative any cell phone use
				105	776	1.5 (1.1 – 2.1)	
				19	84	3.1 (1.7 – 5.7)	
				36	189	2.2 (1.4 – 3.4)	
Takebayashi et al., 2006	Japan	2000–2004	Case–control	51	192	0.7 (0.4 – 1.2)	Regular mobile phone use (had used mobile phone at least 6 months) > 8 years cumulative length of use > 900 hours cumulative call time
				4	12	0.8 (0.2 – 2.7)	
				7	28	0.7 (0.3 – 1.9)	
Schüz et al., 2006	Denmark	1982–2002	Cohort	32	43.7	0.7 (0.4 – 1.03) ²	Regular use (use call per week over 6 months or more) ≥ 10 years use or more (all brain tumor combined)
				28	42.5	0.7 (0.4 – 0.95)	
Klaeboe et al., 2007	Norway	2001-2002	Case–control	22	227	0.5 (0.2 – 1.0)	Regular use (use at least once mobile phone per week for at least 6 months) > 6-year latency of cell phone use >425 hours cumulative use
				8	67	0.5 (0.2 – 1.4)	
				7	56	0.6 (0.2 – 1.8)	
Hardell et al., 2008	Sweden		Meta-analysis	824	4261	0.9 (0.7 – 1.1)	Regular cell phone use ³ Using cell phone ≥ 10 years latency period ⁴
				83	355	1.3 (0.6 – 2.8)	

1. Relative Risk 2. Standardized incidence ratio (SIR) was calculated based on observed and expected numbers; 3. Based on 9 case-control study.

4. Based on 4 case-control study (Lönn et al 2004, Christensen et al. 2004, Schoemaker et al. 2004, and Hardell et al., 2006)

Overview of Biological Impacts of RF – Epidemiologic Study (continued)

Study	Country	Period/study	Type of Tumor	No of cases	No of Controls	OR (95% CI)	Cell phone exposure
Inskip et al., 2001	USA	1994–1998 Case–Control	Glioma	172	85	0.8 (0.6 – 1.2) ¹	Regular cell phone use
				31	11	0.6 (0.3 – 1.4) ¹	≥ 5 years of regular cell phone use
			Meningioma	172	32	0.8 (0.4 – 1.3) ¹	Regular cell phone use
				31	6	0.9 (0.3 – 2.7) ¹	≥ 5 years of regular cell phone use
				172	139	0.8 (0.6 – 1.1) ¹	Regular cell phone use
All brain tumors	31	22	0.9 (0.5 – 1.6) ¹	≥ 5 years of regular cell phone use			
Hardell et al., 2002	Sweden	1997–2000 Case–Control	Meningioma	9	2	4.5 (0.9 – 20.8)	> 1-year latency of analogue cell phone use
				11	14	0.8 (0.4 – 1.7)	> 1-year latency of digital cell phone use
			All benign tumors	49	13	3.8 (2.0 – 6.9)	> 1-year latency of analogue cell phone use
				35	34	1.0 (0.6 – 1.7)	> 1-year latency of digital cell phone use
Hardell et al., 2005	Sweden	2000–2003 Case–Control	Meningioma	74	160	1.7 (1.1 – 2.6)	> 1-year latency and > 64 h of digital cell use
				20	39	2.2 (1.1 – 4.3)	> 1-year latency and > 80 h of analogue cell use
			All benign tumors	218	343	1.5 (1.1 – 2.1)	> 1-year latency and of digital cell use
				62	79	2.4 (1.5 – 3.9)	> 1-year latency and of analogue cell use
				200	305	1.5 (1.1 – 2.0)	> 1-year latency and of cordless cell use
Hardell et al., 2006	Sweden	1997–2003 Case–control	Meningioma	113	297	1.3 (0.99 – 1.7)	> 1-year latency of analogue cell phone use
				295	776	1.1 (0.9 – 1.31)	> 1-year latency of digital cell phone use
			All benign tumors	34	84	1.6 (1.02 – 2.5)	≥ 10-year latency of analogue cell phone use
				60	102	1.6 (1.1 – 2.2)	> 1000 hours cumulative cordless phone use
				199	297	1.6 (1.3 – 2.0)	> 1-year latency of analogue cell phone use
				437	776	1.2 (0.96 – 1.4)	> 1-year latency of digital cell phone use
				57	84	1.8 (1.2 – 2.6)	≥ 10-year latency of analogue cell phone use
				84	102	1.6 (1.2 – 2.2)	> 1000 hours cumulative cordless phone use
Schütz et al., 2006	Denmark	1982–2002 Cohort	Glioma	257	253.9	1.0 (0.9 – 1.1) ²	Regular cell phone use
			Meningioma	68	79.0	0.7 (0.5 – 1.0)	Regular cell phone use
Klaeboe et al., 2007	Norway	2001–2002 Case–control	Glioma	161	227	0.6 (0.4 – 0.9)	Regular cell phone use
				55	61	0.7 (0.4 – 1.2)	> 6-year latency of cell phone use
				49	54	0.7 (0.4 – 1.3)	>425 hours cumulative use
			Meningioma	96	227	0.8 (0.5 – 1.1)	Regular cell phone use
				28	50	1.2 (0.6 – 2.2)	> 6-year latency of cell phone use
				18	49	0.9 (0.4 – 1.7)	>425 hours cumulative use

1. Relative Risk 2. Standardized incidence ratio (SIR) was calculated based on observed and expected numbers

Overview of Biological Impacts of RF – Epidemiologic Study (continued)

Study	Country	Period/study	Type of Tumor	No of cases	No of Controls	OR (95% CI)	Cell phone exposure
Auvinen et al., 2002	Finland	1996 Case-Control	Gliomas	172	921	2.1 (1.3 – 3.4)	Ever use analogue cell phone
				188	938	1.0 (0.5 – 2.0)	Ever use digital cell phone
			Meningioma	121	615	1.5 (0.6 – 3.5)	Ever use analogue cell phone
				126	623	0.7 (0.2 – 2.6)	Ever use digital cell phone
				358	90	1.6 (1.1 – 2.3)	Ever use analogue cell phone
All brain tumors	382	96	0.9 (0.5 – 1.5)	Ever use digital cell phone			
Johansen et al., 2001	Denmark	1982-1995 Cohort	Glioma	66	70	0.9 (0.7 – 1.2)	Regular cell phone use
				16	18.6	0.9 (0.5 – 1.4)	Regular cell phone use
			Brain and nervous tumors	84	81	1.0 (0.8 – 1.3)	Analogue cell phone use
				20	15	1.3 (0.8 – 2.1)	Analogue and digital cell phone use
				50	56.1	0.9 (0.7 – 1.2)	Digital cell phone use
Muscat et al., 2000	USA	1994-1998 Case-Control	Brain Cancer	13	20	0.7 (0.3 – 1.4)	Frequent handheld cell phone use (>10.1h/mo)
				14	19	0.7 (0.3 – 1.4)	> 480 hours cumulative cordless phone use
Schüz et al., 2006	Germany	2000-2003 Case-Control	Glioma	138	283	0.98 (0.7 – 1.3)	Regular cell phone use
				51	91	1.1 (0.8 – 1.7)	≥ 5-year of regular cell phone use
				34	74	1.0 (0.6 – 1.6)	Lifetime duration of calls >195 hrs
			Meningioma	104	234	0.8 (0.6 – 1.1)	Regular cell phone use
				23	50	0.9 (0.5 – 1.5)	≥ 5-year of regular cell phone use
				24	44	1.0 (0.6 – 1.8)	Lifetime duration of calls >195 hrs
Hepworth et al., 2006	England	2000-2004 Case-Control	Glioma	966	1716	0.9 (0.8 – 1.1)	Regular mobile phone use
				66	112	0.9 (0.6 – 1.3)	≥ 10-year of regular mobile phone us
				278	486	1.2 (1.0 – 1.5)	Ipsilateral mobile phone use
				199	491	0.8 (0.6 – 0.9)	Contralateral mobile phone use
Lahkola et al., 2007	5 North European countries	2000-2004 Case-Control	Glioma	1496	3134	0.8 (0.7 – 0.9)	Regular mobile phone use
				629	88	0.9 (0.7 – 1.3)	≥ 10-year of regular mobile phone us
			Globlastoma	698	3134	0.8 (0.6 – 0.9)	Regular mobile phone use
				330	38	0.8 (0.5 – 1.2)	≥ 10-year of regular mobile phone us

1. Standardized incidence ratio (SIR) was calculated based on observed and expected numbers

Summary of weakness and strength of reviewed articles use of cell phone and acoustic neuroma

Study	Strength	Weakness
Inskip et al 2001	Cumulative use was calculated as the product of the duration of regular phone use. The relative risk (RR) were adjusted for several matching variables	Small sample size and inadequate power to calculate RR for AN. Limited to capture historical changes of cell phone use and heavy exposures. Misclassification of exposure.
Muscat et al. 2002	Interviews were performed in person (only one was replied by spouse). The odds ratios were adjusted for several variables including occupational categories.	Definition of regular use can't assess the long-term risk of cell phone use, not can response frequent daily uses. Lack of long-term risk measurements.
Christensen et al. 2004 ^{a,b}	The study has power of 75% to detect a doubling risk of AN with a latency 5-year or more. Standardized face-to-face interviews diminished recall bias. Lifetime cumulative use was calculated.	Definition of regular use. High rate of loss of cases due to death. Retrospective case ascertainment and possible interview bias. Lack of information on control selection.
Lönn et al 2004 ^b	Control selection was adjusted of their reference dates to ensure that control did not have a longer exposure. Use of analog and digital mobile phones was analyzed separately.	Definition of regular use. Selection bias was introduced due to lower response rate among controls. Lack of information on control selection.
Schoemaker et al. 2005 ^b	Statistical power was high in the larger case-control studies. Lifetime cumulative exposure was calculated. Excluding subjects who reported having radiotherapy.	Definition of regular use. Selection bias was introduced due to lower response rate among controls. Misclassification due to recall bias and changes of cell phone use due to hearing loss.
Hardell et al. 2002, 2005, 2006	Observational bias was reduced by blinding interviewers and data coding. Relatively higher case number and only living cases were included to obtain higher data quality. Long latency of cell phone use was available in the 2006 publication.	Recall bias and misclassification of long term exposures. Excluding death cases may underestimates risk of the deadly tumors. Statistical uncertainty due to large range of confidence interval.
Takebayashi et al. 2006 ^b	Two indices were considered including cumulative length of use and cumulative call time.	Definition of regular use. Small case number of heavy users. Participation rate is different among case and control introduced selection bias.
Schüz et al. 2006	The only one cohort study with large population. The mean time since first cell phone subscription was 8-years. Objective measure of exposure and subscription years was derived from the network provider.	Definition of regular use. Excluding business and young users who may have higher exposures. No cumulative exposure was calculated. Misclassification of exposure status.
Klaeboe et al. 2007 ^b	Any substantial change in use that longer than 6 months was reported. Cumulative use was calculated.	Definition of regular use. Small number of long-term users. Selection bias due to a 30% non-response rate from both cases and controls.

a. First result from the Danish portion of the INTERPHONE project. b. Participants of the INTERPHONE STUDY

Appendix D: Cell Phone-Related Biological and Health Risks

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Cell phone radiation poses a serious biological and health risk:

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7/5/01

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The Issue:

Thousands of people are using cell phones for hours each day. They are exposing a very sensitive organ, their brain, to higher mean intensities than military personnel are exposed to when repairing radar. The military personnel show significant increases in cancer and a wide range of illnesses. Even at the very low mean levels that people experience living within 10 km of radio and TV towers, significant increases in cancer has been observed.

Analogue cell phones emit an analogue modulated RF/MW signal similar to an FM radio or TV signal. The digital cell phones radiate a pulse RF/MW signal similar to radar. Biological and epidemiological effects from EMR exposure across the spectrum show the same or similar effects.

Many people continue to drive while talking on their cell phones. Attention deficit and neurological effects on the user's brain make accidents much more likely.

Very young children and teenagers are becoming regular to heavy users of cell phones while their brains and bodies are in a much more vulnerable state than elderly people. With cancer and neurodegenerative disease latencies of decades, the possible adverse effects will take some time to become evident. By which time it will be too late for thousands of people.

There is growing concern about cell phone interference with cardiac pacemakers. If cell phone signals can interfere with an electronic pacemaker, then it is likely to also interfere with human hearts that are arrhythmically unstable.

Biophysical Principles:

Radiant energy is absorbed into human bodies according to three main processes. The first is the Aerial Effect where bodies and body parts receive and absorb the RF/MW signal with resonant absorption that is a function of the size of the body parts and the wavelength of the RF/MW signal. For an adult male about 1.8 m tall the optimal absorption frequency is close to 70 MHz, Figure 1. This has a wavelength of 4.3m. The body acts like a half-wave dipole interacting strongly with a half wavelength close to the body size. A monkey interacts with a wavelength of 1m and a half wavelength of 0.5m. This is similar to the absorbency of a human child.

The Aerial effect also relates to body parts such as arms and heads. A typical adult head has a width of 15 cm. This is a half wavelength for a 1 GHz microwave signal, close to that used by most cell phones.

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Figure 1: Average SAR for 3 species exposed to 10 W/m^2 with E vector parallel to the long axis of the body, from Durney et al. (1978).

Cellphone-type radiation is in the 0.9 to 1.8 GHz range, i.e. 0.9×10^9 to 1.8×10^9 Hz. Hence according to Figure 1 neither children nor adults are close to the optimum absorption rate but babies and infants bodies, whose dimensions lie between "monkey" and "mouse", are close to the optimal absorption for cell phone-type radiation.

A person with a height h (m), acting as an aerial in an RF electric field E (V/m) at a carrier frequency f (MHz), has a current induced in them which flows to earth through their feet, given by, Gandhi et al. (1985):

$$I_h = 0.108 h^2 E f \text{ (mA)}$$

This induced current flows mainly through high water content organs. In flowing to ground the current passes through the ankles. These consist mainly of low conductivity bones and tendons and have an effective cross-sectional area of 9.5 cm^2 for an adult, despite the actual physical area is of the order of 40 cm^2 . The formula for I_h also allows for the effective absorption area of the person, which is somewhat greater than their actual cross-sectional area, because of the attraction of the surrounding field to an earthed conductor. These aerial considerations are more pertinent to whole-body exposures to cell sites.

Cell phone aeriels form digital phones typically occupy the length of the body of the phone and extend a few centimeters out of the top of the phone body. Cellphone radiation for the phone's aerial is quite close to the user's head and can be intense enough to cause a warming sensation.

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Figure 2: The dielectric constant and conductivity of typical biological tissue as a function of frequency, Schwan (1985).

The second mechanism involves the coupling of the signal to the tissue as the signal penetrates the tissue and interacts with the cells and layers of tissue. This process is related to the dielectric constant and conductivity of the tissue types, which vary significantly with the carrier frequency, Figure 2.

The third biophysical absorption process involves resonant absorption by biological systems in the brain and cells. Resonant absorption occurs when a system with a natural frequency is stimulated by an imposed signal of a similar frequency or harmonic frequency. Radio and TV receivers use both the aerial principle and the resonant absorption principle. The aerial resonantly absorbs the carrier frequency and carries it as an induced current to the receiver. Here a tuned circuit oscillating at the same frequency resonantly absorbs the carrier wave and uses decoding circuitry

to extract the encoded message contained in the amplitude, frequency or digital modulation imprinted on the carrier wave.

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Figure 3: Comparison of the frequency spectra of the human EEG from 260 young males showing the 5%, 50% and 95%ile bands, adapted from Gibbs and Gibbs (1951), and Schumann Resonance peaks, from Polk (1982).

Figures 4 and 5 confirm the relationship shown in Figure 3, using independently derived spectra of the daytime human EEG, Figure 4 and the Schumann Resonance spectrum, Figure 5. The figures have been aligned to have a common horizontal frequency scale.

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Figure 4: A typical EEG spectrum, with the Schumann Resonance peaks superimposed.

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Figure 5: Daytime Schumann Resonance Spectrum, Polk (1982).

Figures 3-5 show that the frequency range of the primary peaks of the Schumann Resonances coincide with the frequency range of the human EEG. Upper Schumann peaks also associated with small peaks in the EEG. This shows a resonant interaction and supports the probability of an actual use by the brain or the Schumann Resonance signal. Figure 6 shows that this occurs in a study showing a significant dose-response correlation between the intensity of the 8-10 Hz Schumann Peak and human reaction times.

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Figure 6: Human reaction times as a function of Schumann Resonance 8-10 Hz Relative Intensity, for 49,500 subjects tested during 18 days in September 1953, at the German Traffic exhibition in Munich. Derived from data in Figure 3 of König (1974b). Trend: $t = 10.414$, 2-tailed $p < 0.001$.

Cellphone radiation is shown to interact with human EEG patterns and to alter them and to change reaction times. The GSM signal has a pulse frequency of 217 Hz and a modulation at 8.34 Hz. This is in the Schumann Resonance and EEG spectral primary frequency range.

Effects shown for electromagnetic radiation, especially radio and radar signals, but also electrical occupations:

Such signals have been shown to:

Neurological Activity:

- • Alter brain activity, including EEG and reaction times, memory loss, headaches, fatigue and concentration problems, dizziness (the Microwave Syndrome), Gordon (1966), Deroche (1971), Moscovici et al. (1974), Lilienfeld et al. (1978), Shandala et al. (1979), Forman et al. (1982), Frey (1998).

- • Impair sleep and learning, Altpeter et al. (1995), Kolodynski and Kolodynska (1996)
- • Increase permeability of the blood brain barrier (a mechanism for headache), Frey et al. (1975), Alberts (1977, 1978) and Oscar and Hawkins (1977).
- • Alter GABA, Kolomytkin et al. (1994).
- • Increase neurodegenerative disease including Alzheimer's Disease, Sobel et al. (1995, 1996), Savitz et al. (1998a,b)
- • Highly significant Increased permeability of the blood brain barrier for 915 MHz radiation at SAR =0.016-0.1 (p=0.015) and SAR = 0.1-0.4 (p=0.002); Salford et al. (1994).
- • Increase the Suicide Risk, Baris and Armstrong (1990), Perry et al. (1991), Van Wijngaarden et al. (2000).

Cardiological Activity:

- • Alter blood pressure and heart rhythm (heart rate variability) Bortkiewicz et al. (1995, 1996, 1997) and Szmigielski at al (1998).
- • Increases Heart Disease and heart attack mortality, Forman et al. (1986), Hamburger, Logue and Silverman (1983), Savitz et al. (1999)

Immune System Activity:

- • Impairs the immune system Quan et al. (1992), Dmoch and Moszczynski (1998), Bruvere et al. (1998)

Reproductive Activity:

- • Reduces sperm counts in radar exposed military personnel, Weyandt et al. (1996)
- • Increases miscarriage and congenital abnormalities, Kallen et al. (1982), Larsen et al. (1991), Ouellet-Hellstrom and Stewart (1993).
- • Doubles the incidence of twins in the families of radar exposed personnel, Flaherty (1994).
- • Significantly alters the leaf structure of plants exposed to a radar, Magone (1996).
- • Significantly reduces the radial growth of pine trees, Balodis et al. (1996).

- • Reduced fertility of mice exposed to an RF field (27.12 MHz), Brown-Woodman et al. (1989).
- • Increased fetal/embryo lethality in mice exposed to 2.45 GHz microwaves, Nawrot, McRee and Galvin (1985).
- • Radio exposures completely cause complete infertility in mice over 3 to 5 generations at mean exposure levels of 1.05 and $0.17\mu\text{W}/\text{cm}^2$, respectively, Magras and Xenos (1997).

Genotoxic Activity:

- • Reduce melatonin and alter calcium ions, Abelin (1999), Burch et al. (1997, 1999) Bawin and Adey (1976), Blackman et al. (1988, 1989, 1990).
- • Enhances heat shock proteins at extremely low exposure levels in a highly reproducible manner showing that they are not stimulated by heat but in reaction to a 'toxic' protein reaction, Daniells et al. (1998), and down to $0.001\text{W}/\text{kg}$ ($0.34\mu\text{W}/\text{cm}^2$) using 750MHz microwaves, de Pomerai (2000).
- • Damages chromosomes. Heller and Teixeira-Pinto (1959), Tonascia and Tonascia (1966), Yao (1982), Garaj-Vrhovac et al. (1990, 1991, 1992, 1993, 1999), Timchenko and Ianchevskaia (1995), Balode (1996), Haider et al. (1994) and Vijayalaxmi et al. (1997) have reported significant chromosome aberrations from RF/MW exposures. In the Mar/Apr 1999 edition of Microwave News it is reported that Drs Tice, Hook and McRee
- • Alters DNA, Ali and Behari (1994).
- • Breaks DNA strands, Lai and Singh (1995, 1996, 1997).
- • Alters gene transcription activity, Phillips et al. (1992, 1993).
- • Neoplastically transform cells, Balcer-Kubiczek and Harrison (1991).
- • Enhances cell death in a dose response manner for signal intensity and exposure time, Garaj-Vrhovac et al. (1991).
- • Enhances cell proliferation in a dose-response manner for exposure time, Mattei et al. (1999).
- • Enhances Ornithine Decarboxylase (ODC) activity, a measure of cell proliferation rate, Byus et al. (1988), Litovitz et al. (1997).
- • Enhances free radicals, Phelan et al. (1992).
- • Increased cancer in rats and mice, Prausnitz and Susskind (1962), Szmigielski et al. (1988) and Chou et al. (1992)

Cancer Epidemiology:

- • Increase the incidence of many types of cancer, including leukaemia, brain tumor, testicular cancer, genitourinary and breast cancer, Robinette et al. (1980), Milham (1985, 1988), Szmigielski (1996), Hocking et al. (1996), Dolk et al. (1997 a, b), Beall et al. (1996), Grayson (1996), Thomas et al. (1987), Lilienfeld et al. (1978), Zaret (1989), Davis and Mostofl (1993), Hayes et al. (1990), Tynes et al. (1996), Cantor et al. (1995), and many others.

These biological and health effects are consistent with the biological understanding that brains, hearts and cells are sensitive to electromagnetic signals because they use electromagnetic signals for their regulation, control and natural processes, including those processes monitored by the EEG and ECG. There is overwhelming evidence that EMR is genotoxic, alters cellular ions, neurotransmitters and neurohormones, and interferes with brain and heart signals, and increases cancer.

Cell Phone Radiation Research:

For years the cell phone companies and government authorities have assured us that cell phone are perfectly safe. For example, they claim that the particular set of radiation parameter associated with cell phones are not the same as any other radio signal and therefore earlier research does not apply. They also mount biased review teams who falsely dismiss any results that indicate adverse biological and health effects and the flawed pre-assumption that the only possible effect is tissue heating. There is a very large body of scientific research that challenges this view. Now we have published research, primarily funded by governments and industry that shows that cell phone radiation causes the following effects:

Neurological Activity:

- • Alters brain activity including EEG, Von Klitzing (1995), Mann and Roschkle (1996), Krause et al. (2000).
- • Disturbs sleep, Mann and Roschkle (1996), Bordely et al. (1999).
- • Alters sleep EEG after awake exposure, Huber et al. (2000).
- • Alters human reaction times, Preece et al. (1999), Induced potentials, Eulitz et al. (1998), slow brain potentials, Freude et al. (1998), Response and speed of switching attention (need for car driving) significantly worse, Hladky et al. (1999). Altered reaction times and working memory function (positive), Koivisto et al. (2000), Krause et al. (2000).
- • Brain cortex interaction as shown by significantly altered human EEG by cellphone radiation, during a 15 minute exposure, Lebedeva et al. (2000).
- • Weakens the blood brain barrier ($p < 0.0001$): Persson, B.R.R., Salford, L.G. and Brun, A., 1997.

- • A Fifteen minute exposure, increased auditory brainstem response and hearing deficiency in 2 kHz to 10 kHz range, Kellenyi et al. (1999).
- • While driving, with 50 minutes per month with a cell phone, a highly significant 5.6-fold increase in accident risk, Violanti et al. (1996); a 2-fold increase in fatal accidents with cell phone in car, Violanti et al. (1998); impairs cognitive load and detection thresholds, Lamble et al. (1999). In a large Canadian study Redelmeier and Tibshirani (1997) the risk of collision when using a cellphone was 4 time higher, RR = 4.3, 95%CI 3.0-6.5. Calls close to the time of collision has RR =4.8 for 5 minutes and RR = 5.9, p<0.001, for 15 minutes.
- • Significant changes in local temperature, and in physiologic parameters of the CNS and cardiovascular system, Khdnisskii, Moshkarev and Fomenko (1999).
- • Causes memory loss, concentration difficulties, fatigue, and headache, in a dose response manner, (Mild et al. (1998)). Headache, discomfort, nausea, Hocking (1998).

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Figure 7: Prevalence of symptoms for Norwegian mobile phone users, mainly analogue, with various categories of length of calling time per day, Mild et al. (1998).

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Figure 8: Prevalence of symptoms for Swedish mobile phone users, mainly digital, with various categories of length of calling time per day, Mild et al. (1998).

These are the same symptoms that have frequently been reported as "Microwave Sickness Syndrome" or "Radiofrequency Sickness Syndrome", Baranski and Czerski (1976) and Johnson-Liakouris (1998).

Cardiac Activity:

- • Cardiac pacemaker interference: skipped three beats, Barbaro et al. (1996); showed interference, Hofgartner et al. (1996); significant interference, p<0.05 Chen et al. (1996); extremely highly significant interference, p=0.0003, Naegeli et al. (1996); p<0.0001, Altamura et al. (1997); reversible interference, Schlegal et al. (1998); significantly induced electronic noise, Occhetta et al. (1999); various disturbances observed and warnings recommended, Trigano et al. (1999)
- • Significantly increases blood pressure, Braune et al. (1998).

Hormone Activity:

- • Reduces the pituitary production of Thyrotropin (Thyroid Stimulating Hormone, TSH):

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Figure 9: A significant reduction in Thyrotropin (Thyroid Stimulating Hormone) during cell phone use, de Seze et al. (1998).

- • Reduces melatonin significantly, Burch et al. (1997, 1998). A GSM cellphone reduces melatonin, but not significantly in a very small sample (N=18) of subjects, de Seze et al. (1999).
- • A reported but yet to be published Australian Study, EMRAA News, June 2000, used a Clot Retention Test on blood samples to detect hormonal changes. A group of 30 volunteers used a Nokia 6150 cellphone for 10 minutes on each of two consecutive days. The CRT test showed significant changes in the thyroid, pancreas, ovaries, testes and hormonal balance.

Reproductive Activity:

- • Decreases in sperm counts and smaller tube development in rat testes, Dasdag et al. (1999).
- • Increases embryonic mortality of chickens, Youbicier-Simo, Lebecq and Bastide (1998).

Genotoxic Activity:

- • Breaks DNA strands, Verschaeve et al. (1994), Maes et al. (1997), which is still extremely significant $p < 0.0001$, at 0.0024 W/kg ($1.2 \mu\text{W/cm}^2$), Phillips et al. (1998).
- • Produces an up to three-fold increase in chromosome aberrations in a dose response manner from all cell phones tested, Tice, Hook and McRee, reported in Microwave News, March/April 1999. The findings were the same when the experiment was repeated and Dr Tice is quoted as stating: "There's no way you're going to get positive results twice over four different technologies as a chance result."
- • Doubles c-fos gene activity (a proto oncogene) for analogue phones and increases it by 41 % for digital phones, Goswami et al. (1999), altered c-jun gene, Ivaschuk et al. (1997), Increased hsp70 messenger RNA, Fritz et al. (1997).
- • Increases Tumour Necrosis Factor (TNF), Fesenko et al. (1999).
- • Increases ODC activity, Penafiel et al. (1997).
- • DNA synthesis and cell proliferation increased after 4 days of 20 min for 3 times/day exposure. Calcium ions were significantly altered, French, Donnellan and McKenzie (1997). Decreased cell proliferation, Kwee and Raskmark (1997), Velizarov, Raskmark and Kwee (1999)
- • Doubles the cancer in mice, Repacholi et al. (1997).
- • Increases the mortality of mobile phone users compared with portable phone users, RR = 1.38, 95%CI: 1.07-1.79, $p=0.013$, Rothman et al. (1996).

- • Increases human brain tumor rate by 2.5 times (Hardell et al. (1999)). Associated with an angiosarcoma (case study), Hardell (1999)
- • Hardell et al. (2000), for analogue phones OR = 2.62, 95%CI: 1.02-6.71, with higher tumour rates at points of highest exposure.
- • Significantly increases the incidence of eye cancer (Uveal Melanoma), by between OR = 4.2, 95%CI: 1.2-14.5, and OR = 10.1, 95%CI: 1.1-484.4, Stang et al. (2001).
- • United States, Motorola Study Morgan et al.
(2000)

High Exposure	RR = 1.07 (0.32-2.66) n = 3
Moderate Exposure	RR = 1.18 (0.36-2.92) n = 3
High/Mod vs Low	RR = 1.13 (0.49-2.31) n = 6

This project underestimated cancer rates by using a high cancer reference group.

- • Carlo and Schram (2001) report that in the industry funded WTR (Wireless Technology Research) programme Dr Joseph Roti Roti confirmed the Tice, Hook and McRee research showing that cellphone radiation significantly damaged DNA through observed micronuclei formation.
- • Muscat et al. (2000) report elevated brain cancer in cellphone users in the United States, with cerebral tumors occurring more frequently on the side of the head where the mobile phone had been used, (26 vs 15 cases, p=0.06) and for a rare brain cancer, neuroepitheliomatous, OR = 2.1, 95%CI: 0.9-4.7. Mean use of cell phones was 2.5 years for cases and 2.2 years for controls, showing that a small increase in cellphone use (0.3 years) produces a large increase in brain cancer risk.
- • Cell phone users in Denmark Johansen et al.
(2001)

Duration of digital subscription	<1 yr	1-2yrs	≥3 yrs
Relative to reference group SIR	0.7	0.9	1.2
Relative to <1 yr group RR	1.0	1.29	1.71

Other cancers are set out in "Table 2" below. Over 67 % of phone users had used their phones for 2 years or less. The reference group had a higher than average cancer rate than the age range of cell phone users, underestimating the cancer rates. This is shown by Standard Incidence Ratios (SIR) of some groups being as little as 0.6. For example SIR for users for <1 year is 0.7.

PICTURE MISSING

Table two shows that even with little cellphone use, and even with the use of a high cancer reference group, there are several elevated cancers approaching significance: Testicular cancer SIR = 1.12, 95%CI: 0.97-1.30, Cervical cancer, SIR = 1.34, 95%CI: 0.95-1.85, Female Pharynx cancer, SIR 2.43, 95%CI: 0.65-6.22, Esophagus cancer,

SIR = 1.53, 95%CI: 0.31-4.46 and female breast cancer, SIR = 1.08, 95%CI: 0.91-1.26.

Conclusions:

To date over 50 studies have shown adverse biological or human health effects specifically from cell phone radiation. These research results to date clearly show that cell phones and cell phone radiation are a strong risk factor for all of the adverse health effects identified for EMR because they share the same biological mechanisms. The greatest risk is to cell phone users because of the high exposure to their heads and the great sensitivity of brain tissue and brain processes. DNA damage accelerates cell death in the brain, advancing neurodegenerative diseases and brain cancer. Brain tumour is already an identified risk factor. Cell phones are carried on people's belts and in breast pockets. Hence liver cancer, breast cancer and testicular cancer became probable risk factors.

Altered attention and cognition, as well as the diversion of talking on a phone while driving is a significant risk factor for accidents and fatal accidents.

Some cardiac pacemakers are susceptible to active cell phone signals, recommending keeping cell phones away from hearts and pacemakers.

Because the biological mechanisms are shown and EMR has been observed to significantly increase the following effects, there is extremely strong evidence to conclude that cell phones are a risk factor for breast, liver, testicular and brain cancer. It is also probable that we will observe a very wide range of other effects including cardiac, neurological and reproductive illness and death. Since cell phone radiation cause many cell damages including DNA and chromosome damage, all of these effects will also be caused by cell sites.

Dose-response studies of neurological, cardiac, reproductive and cancer effects in human populations all point to a near zero exposure level of no effect, Cherry (2000). Since cellphone radiation mimics RF/MW radiation effects which mimics ELF biological and health, the adverse effects occur across the spectrum and includes cellphone radiation, with a safe exposure level of zero.

Hence a risk reduction and public health protection based on keeping exposure below a level that doubles the risk, identifies $0.1 \mu\text{W}/\text{cm}^2$ as the maximum acceptable exposure. This should allow a mean life-time exposure to be less than $0.01\mu\text{W}/\text{cm}^2$ which is necessary to reduce the risk of neurological effects. The lower level is necessary because of the exquisite sensitivity of the brain.

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Appendix E: Lloyd Morgan Critique of INTERPHONE Study

Interphone Brain Tumors Studies To Date

An Examination of Poor Study Design
Resulting in an UNDER-ESTIMATION
of the Risk of Brain Tumors

L. Lloyd Morgan

RRT Conference, London, 8 & 9 September 2008

Introduction

As will be seen, the dominant results from all Interphone studies published to date is **use of a cellphone *protects* the user from a brain tumor.**

There are **two possible conclusions** from these results:

- 1) **Cellphone use does protect** the user from brain tumors, or
- 2) **The Interphone Study is fundamentally flawed.**

- All ORs in 10 Interphone brain tumors studies were counted.
- Redundant ORs were removed to obtain a count of statistically independent ORs
- The results show **there is a persistent protective skew, statistically so strong as to report it is **virtually certain this protective effect is not due to chance.****

Methodology

What If There Is No Risk of Brain Tumors?

(Odds Ratios = ORs)

- Expect: Odds Ratios would be randomly distributed
 - # of ORs <1.0 would be ~equal to # of ORs >1.0
 - Think coin tossing
 - OR=1.0 are excluded
 - OR <1.0 implies protection
 - OR >1.0 implies risk
- 13 Interphone brain tumor studies published to date
 - 10 single-country Interphone brain tumor studies analyzed
 - Excluded: 3 multi-country studies overlapping the single-country studies

Calculation Methodology

- Tally the total number of $ORs > 1.0$, $ORs < 1.0$, and $ORs = 1.0$
- Tally the number of statistically independent (non-redundant) ORs
- Calculate the Protection/Risk ratio ($OR < 1.0 / OR > 1.0$)
- Calculate the cumulative binomial p-values
 - Think: probability of tossing a coin 20 times and getting 18 heads
 - Answer: $p = 2.01 \times 10^{-4}$, or 1 time in 4,970 it will be due to chance.

Methodology

Requires Statistical Independence

- Comparison categories
 - Brain Tumors
 - All
 - Acoustic Neuroma
 - Glioma
 - Meningioma
 - Years since first use (Years)
 - Cumulative hours of use (Hours)
 - Cumulative number of calls (Call #)
 - “Regular” cellphone use (“Regular”)
 - Years of ipsilateral cellphone use (Years Ipsi)
 - Years of contralateral cellphone use (Yrs Contra)
 - Minutes of cellphone use per day (Min/Day)
- Category comparisons between studies, not within studies

Results

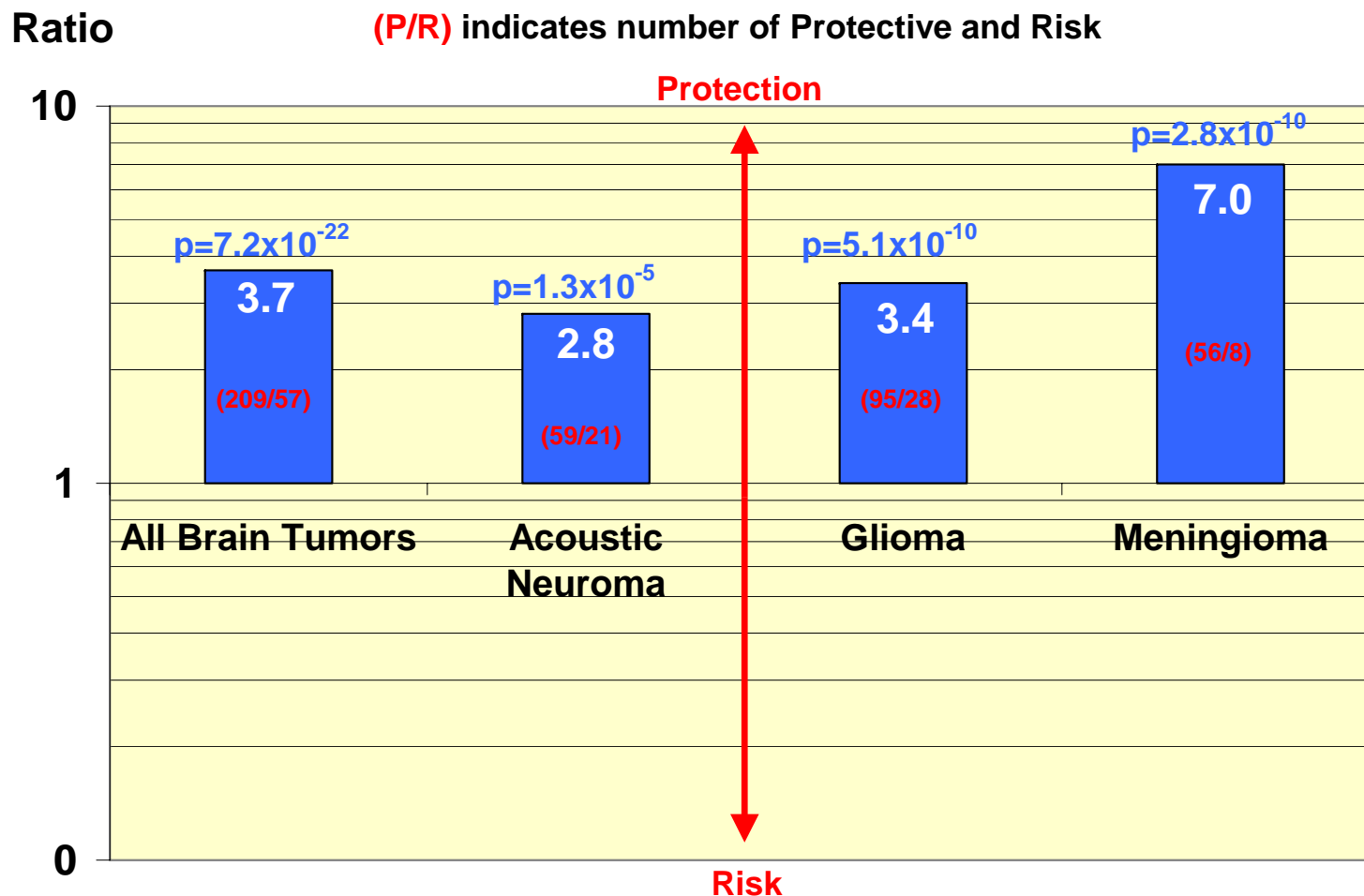
Total ORs and Statistically Independent ORs (OR=1.0 Excluded)

	Total	Independent	% Ind.
Acoustic Neuroma	160	96	60%
Glioma	234	125	53%
Meningioma	124	64	52%
All Brain Tumors	518	285	55%

OR=1.0 are 1.5% of all Odds Ratios

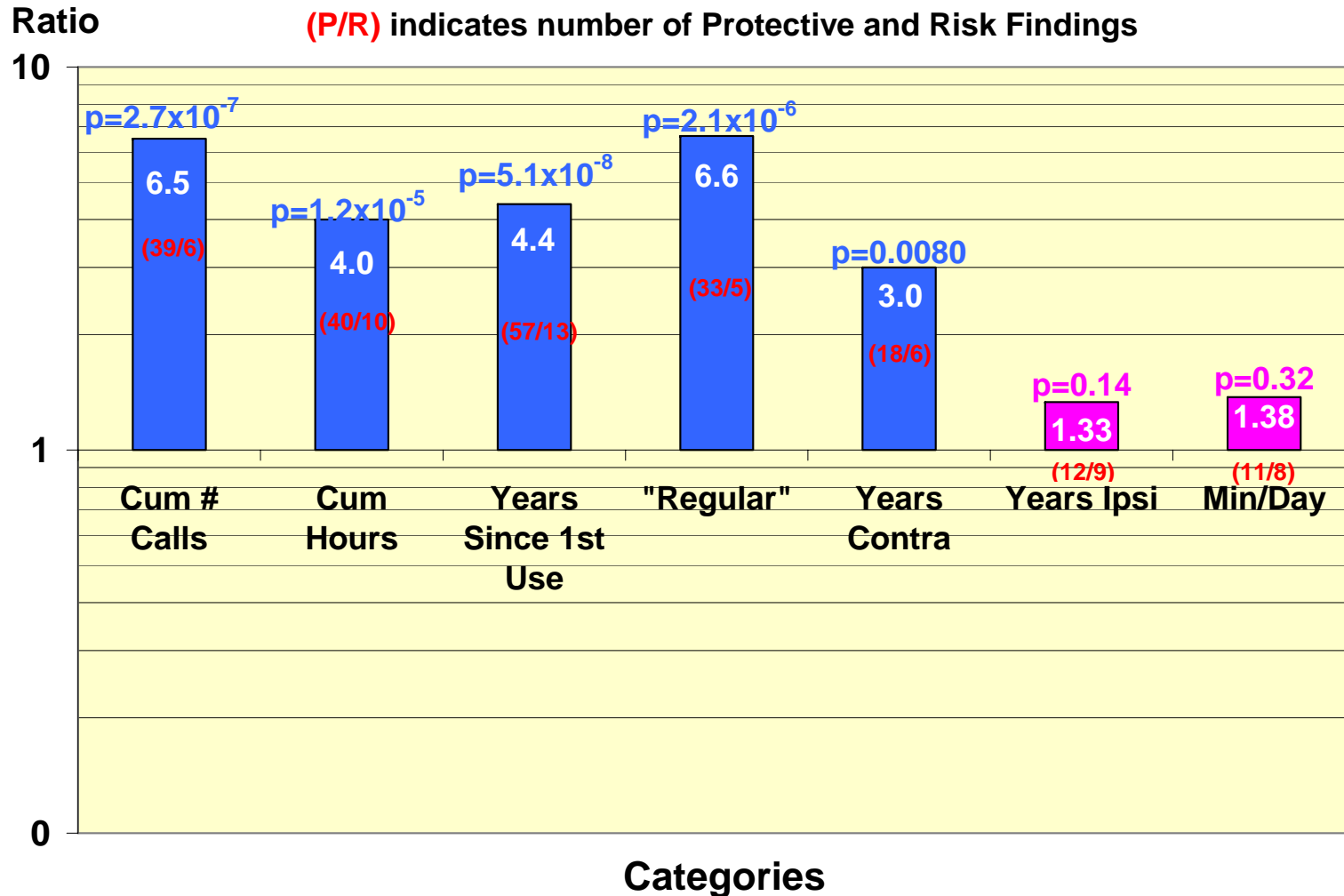
Results

Protection/Risk Ratio by Brain Tumor Type



Results

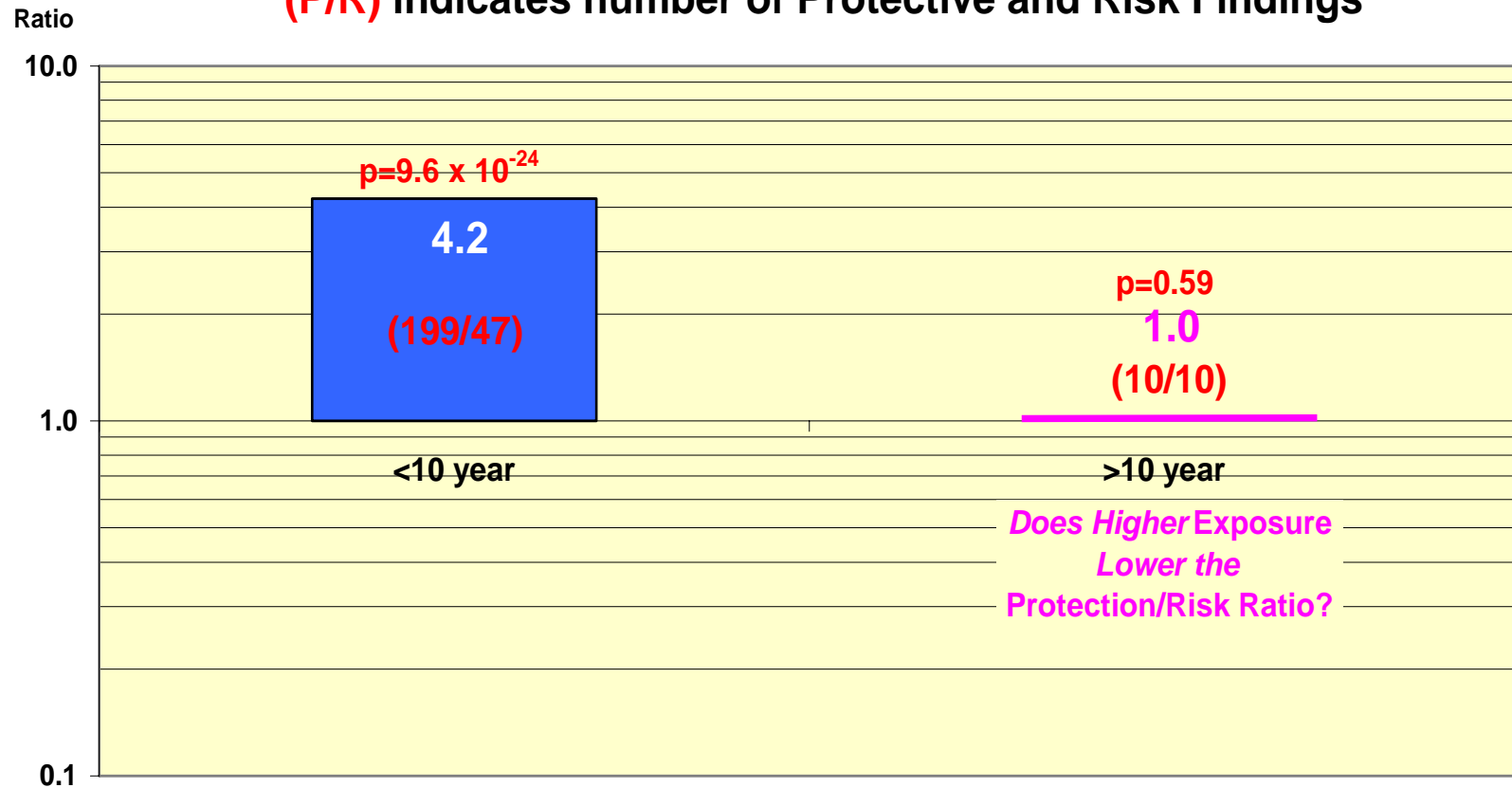
Protection/Risk Ratio by Category



Results

Lower Vs Higher Exposure Time

(P/R) indicates number of Protective and Risk Findings



Interphone Protocol Design Flaws

- **Flaw 1: Selection Bias**
 - Reasonable to assume that controls who use a cellphone are more likely to participate in a “cellphone study” than controls who do not use a cellphone
 - Selection bias increases as the refusal rate increases
 - Weighted average control refusal rate: 41%
 - Is there selection bias? (Löon 2004)
 - » 34% of controls who refused to participate used a cellphone
 - » 59% of participating controls used a cellphone
 - Underestimates risk

Flaw 1: Selection Bias

A Semi-Hypothetical Example

With Selection Bias			
	Exposed	Unexposed	Totals
Cases	60	40	100
Controls	60	40	100
Totals	120	80	200
Odds Ratio	1.00		

Without Selection Bias			
	Exposed	Unexposed	Totals
Cases	60	40	100
Controls	49	51	100
Totals	109	91	200
Odds Ratio	1.54		

Truly Exposed Controls=(60 "exposed" controls) * (59% participants) + (34 non-participating controls) * (40% non-participants)=49

Interphone Protocol Design Flaws

- **Flaw 2: Exposure Misclassification**
 - Tumors outside the radiation plume are treated as “exposed”
 - Overestimates risk of brain tumor
 - **Ipsilateral: exposed Contralateral: unexposed**
 - Percentage of absorbed cellphone radiation by anatomical structure in adults
 - Ipsilateral temporal lobe: 50-60% ~15% of brain’s volume
 - “Ipsilateral” cerebellum: 12-25% ~5% of brain’s volume
 - **62-85% of absorbed radiation is in ~20% of the adult’s brain volume**
 - *Children’s brains will absorb a higher values.*

Flaw 2

A Semi-Hypothetical Example

With Flaw 2 Design Error			
	"Exposed"	Unexposed	Totals
Cases	75	25	100
Controls	60	40	100
Totals	135	65	200
Odds Ratio	2.0		

Without Flaw 2 Design Error			
	Exposed	Unexposed	Totals
Cases	15	85	100
Controls	12	88	100
Totals	27	173	200
Odds Ratio	1.3		

Truly exposed cases=(75 "exposed cases")*(20% truly exposed)=15. Truly exposed controls=(60 "exposed controls")*(20% truly exposed)=12

Interphone Protocol Design Flaws

- **Flaw 3: Short latency times**
 - Known latency times
 - Smoking & lung cancer: ~30 years
 - Asbestos & mesothelioma: 20-40 years
 - Ionizing radiation & brain tumor: 20-40 years
 - Only 6.3% of Interphone cases (16 cases/study) used a cellphone for ≥ 10 years
 - Short latency times underestimates risk
- **Flaw 4: Definition of “regular” user**
 - At least once a week for 6 months or more
 - Exposures one prior to diagnosis are excluded
 - Definition of “regular” user underestimates risk

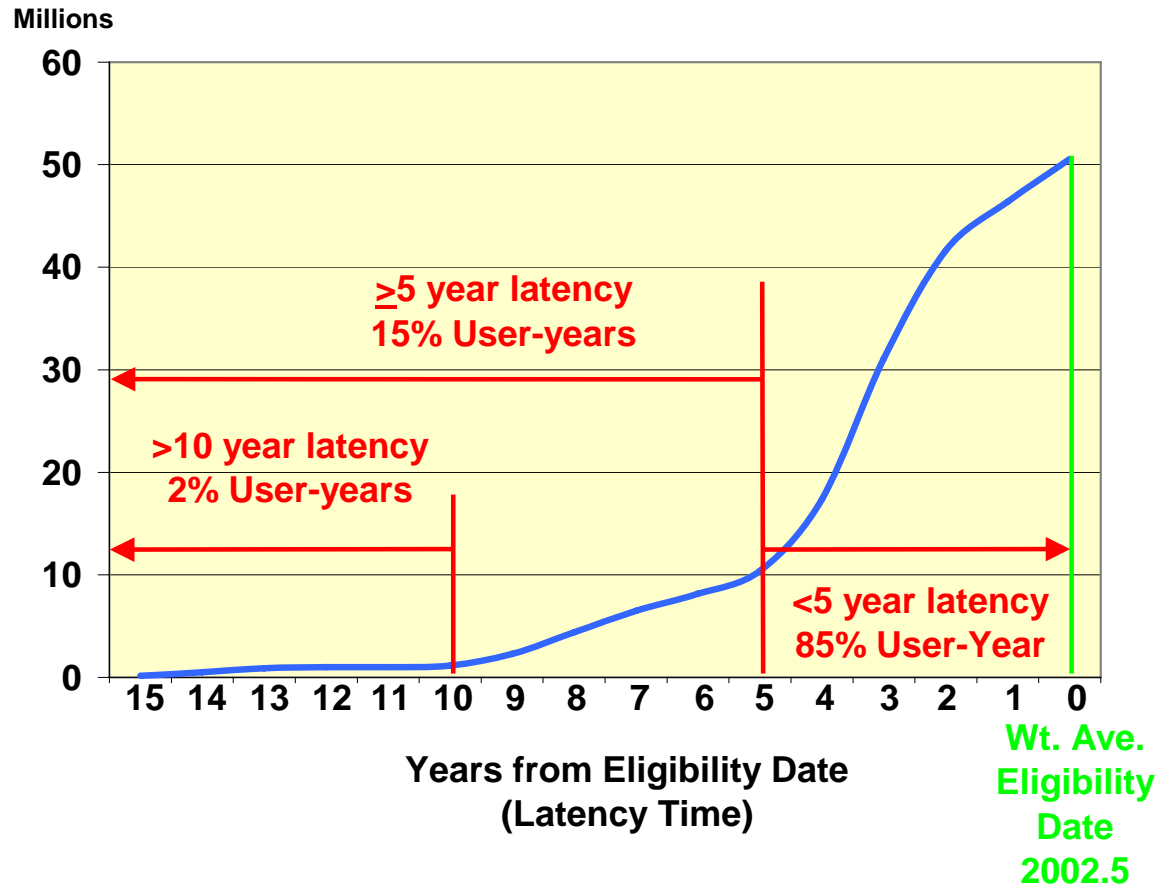
Flaws 3 & 4: Latency Time & “Regular” Use

- UK cellphone subscriber data
 - 85% of “regular” use
 - <5 years
 - 98% of “regular” use
 - <10 years
- Reporting “regular” use
 - Suppresses finding a risk
- Expect 20 to 40 years for brain tumor Dx
 - Years of cellphone use (latency) is too short for Dx

Flaws 3 and 4

Latency Time and the Definition of “Regular Users”

UK Subscribers by Year



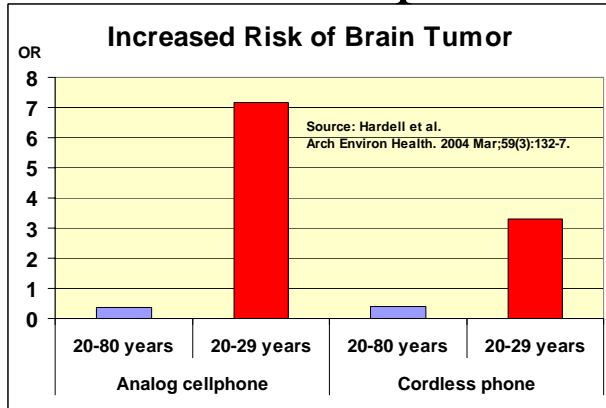
Interphone Protocol Design Flaws

- **Flaw 5:** Young adults and children are excluded
 - Interphone Protocol's age range: 30-59
 - Young adults and children are the highest risk group
 - Underestimates risk

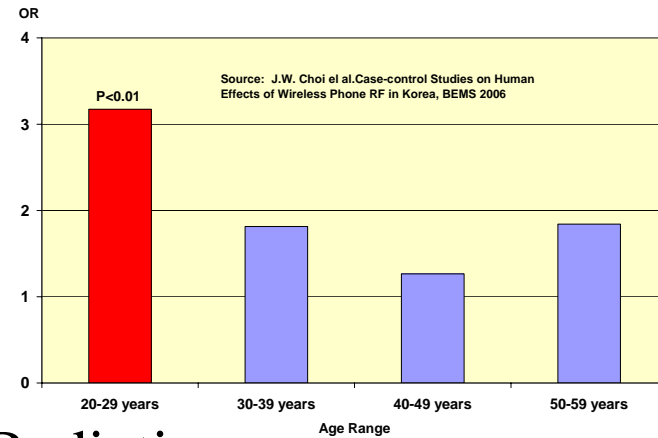
Flaw 5

Young Adults and Children Excluded

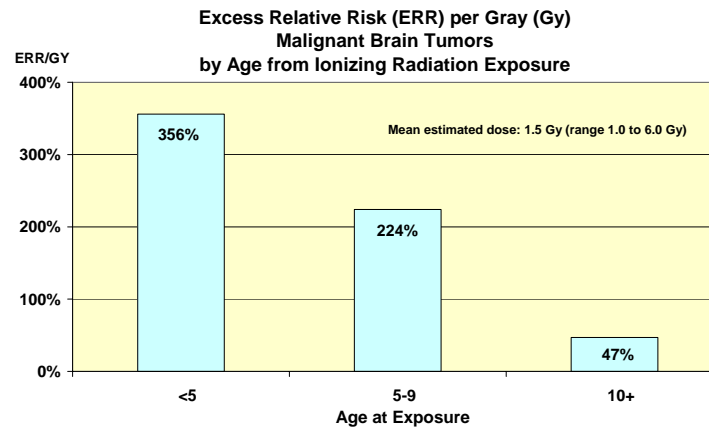
Swedish: Cellphone.



Korean: Cellphone



Israeli: Ionizing Radiation



Source: Sadezki et al., RADIATION RESEARCH 163, 424-432 (2005)

Interphone Protocol Design Flaws

- **Flaw 6:** Cellphones radiating higher power levels are not examined (few exceptions)
 - Analog Vs Digital cellphone use
 - Rural Vs Urban digital cellphone use
 - Without inclusion of cellphones radiating the most power there is an underestimation of risk
 - Requires sufficient number of cases for statistical power
- **Flaw 7:** Cordless phone users are treated as unexposed
 - Underestimation of risk

Flaw 7: Semi-Hypothetical Example

Assumptions:

36% of Swedish cellphone users do not use a cellphone or cordless phone

57% of Swedish do not use a cellphone

There is a 2-fold risk of brain tumors from cellphone use or cordless phone use

Cordless Phone Exposure Treated As Un-Exposed			
	Exposed	Unexposed	Totals
Cases	43	57	100
Controls	27	73	100
Totals	70	130	200
Odds Ratio	2.0		

Cordless Phone Exposure Treated As Exposed			
	Exposed	Unexposed	Totals
Cases	64	36	100
Controls	40	60	100
Totals	104	96	200
Odds Ratio	2.6		

Interphone Protocol Design Flaws

- **Flaw 8:** Exclusion of brain tumor types
 - Includes acoustic neuroma, glioma & meningioma
 - Excludes other brain tumor types
 - Underestimates risk
- **Flaw 9:** Exclusion of brain tumor cases because of death
 - Underestimates risk of the most deadly brain tumors

Interphone Protocol Design Flaws

- **Flaw 10: Recall bias**
 - Light users tend to underestimate use
 - Heavy users tend to overestimate use
 - Result: Underestimation of risk

Flaw Mitigation

- Increase the diagnosis eligibility time
 - Ten Interphone studies: weighted-average 2.6 years
 - Hardell et al. studies: 6 years
- Lower minimum age from 30 years to 10 years
- Do not tell controls what is the purpose of the study
 - Pay cases and controls for participation in study
- Interview proxies in case of death
- Treat unexposed tumors as unexposed
- And, so on, and so on, and so on ...
 - **It could have been done**

Conflicts-of-Interest

- 2008 Global Telecom Industry Revenue: \$3.85 Trillion (£6.8T)
<http://www.plunkettresearch.com/Telecommunications/TelecommunicationsStatistics/tabid/96/Default.aspx>
 - If risk is admitted: major revenue loss
 - Interphone's funding is inadequate to mitigate flaws
 - Substantial funding from cellphone industry
 - €3.2 million (£4M) in Europe, \$1M (£0.6M) in Canada, unknown in Japan, Australia and New Zealand
- Government
 - UK
 - £22.5 billion (~\$40B) selling off the 3G licences
 - Annual income of around £15 billion (~\$27B) in taxation to the UK exchequer
 - Similar industry funding goes to all governments

Conflicts-of-Interest

- Researchers' conflict-of-interest
 - Perhaps unconscious, but they know industry has funded their studies in spite of a “Firewall”
 - Firewall: Industry send funds to 3rd party group
 - 3rd party selects and funds research teams
 - Honest, but “Don't bite the hand that feeds you”
 - **33 *significant protective* results**
 - **Ignored by authors (no commentary in the text)**

Conclusions

- **There is certainty: either cellphone use is protective, or the Study has major flaws**
- The Interphone Protocol *substantially*, underestimates the risk of brain tumors
 - In spite of the protective skew, significant increased risk is found in the Interphone studies
 - When ≥ 10 years **and** ipsilateral use are combined
 - Increased exposure counteracts design flaws' protective skew?
- Without design flaws, risk would increase substantially
- Cellphone industry's conflict-of-interest is obvious
- **Potential public health impact is enormous**
- Studies independent of industry are required

Cellphone Studies

Independent of Industry Funding

- Swedish team led by Dr. Lennart Hardell
 - Findings consistent with what would be expected, if there is a risk of brain tumors from wireless phone use
 - The higher the cumulative hours of use, the higher the risk
 - The higher the radiated power, the higher the risk
 - Analog Vs Digital cellphones
 - Rural Vs Urban users
 - The higher the number of years since first use, the higher the risk
 - The higher the cumulative number of calls, the higher the risk
 - The higher the exposure, the higher the risk
 - Tumor on the same side of the head where the cellphone was used
 - The younger the user, the higher the risk