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Public Comments on Developing an Unified Intercarrier Compensation:========

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I am completely and vehemently opposed to eliminating landlines.
Research on the risks to public health from an over-saturation in the environment of low-level continuous EMF radiation is quite compelling. Cell phones and cell antennas are one source of this danger, and the 'Precautionary Principle' recognized by the European Union and the Bioinitiative Report should be heeded in making any decision regarding the possibility of making the public depend entirely on cell phones. Please do not allow this to happen! We do not want to wait for the corpses to roll in to make a decision that enough research exists regarding spikes in cancer rates in communities located near a high density of cell antennas to warrant maintaining landlines as a permanent alternative to cell phones for the general public... See "Full Signal," a documentary made by Talal Jabari, to hear from scientists internationally on these dangers.

Press Release

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Risks of Brain Tumors Among Cell Phone Users Underestimated in Interphone Study, Says International EMF Collaborative

Data for Acoustic Neuromas and Salivary Gland Tumors, Located Closest to the Ear, Were Not Published—Group Asks for Full Disclosure and Urgent Research on Cell Phone Risks for Children

Berkeley, CA and Sutton Coldfield, England, May 17, 2010. Authors of the report, "Cellphones and Brain Tumors: 15 Reasons for Concern, *Science, Spin and the Truth Behind Interphone*" have released a technical analysis of the long-awaited Interphone Study published today in the *International Journal of Epidemiology*. **Download Report**: *HYPERLINK "http://www.radiationresearch.org" www.radiationresearch.org.*

Despite the Interphone Study Group's long-awaited acknowledgment of increased risk of brain cancer among long-term, heavy users of cell phones, the International EMF Collaborative says the study's design results in serious underestimation of risk of brain cancer.

The 11 key design flaws were fully detailed in the group's landmark report last August (HYPERLINK "http://snurl.com/wdgbd" http://snurl.com/wdgbd). One example was that individuals using cordless phones but not cellphones were considered 'unexposed' for purposes of the Interphone analysis, though exposed to the same radiation as cell phones.

The results published today appear to show that in many cases use of a cellphone *protects* users from brain tumors, but this is a reflection of the design flaws, according to Lloyd Morgan, B.Sc., lead author of *"Cellphones and Brain Tumors: 15 Reasons for Concern"*. Other issues with the Interphone study, he says, include:

Results were only provided for brain cancers (gliomas) and meningiomas, but not tumors within the 20% of the brain's volume irradiated by cell phones.
Risk was not broken down by gender, which may have obfuscated even higher risk of meningiomas in women.
The 5-year old results are woefully inadequate as a gauge of risk today, as adults and children now speak on cell phones many hours a day compared to only 2- 2 ½ hours a month at that time.

Eileen O'Connor, Director of the Radiation Research Trust and member of the International EMF Collaborative, says "Four billion people own mobile phones worldwide, many of those users are children. Responsible governments must advocate for public transparency of risks so that an informed public may have more options to exercise precaution".

VIDEO - INTERPHONE DESIGN FLAWS WITH L. LLOYD MORGAN, B.Sc. – *COMING SOON* - HYPERLINK "http://vimeo.com/8109152"
http://vimeo.com/8109152

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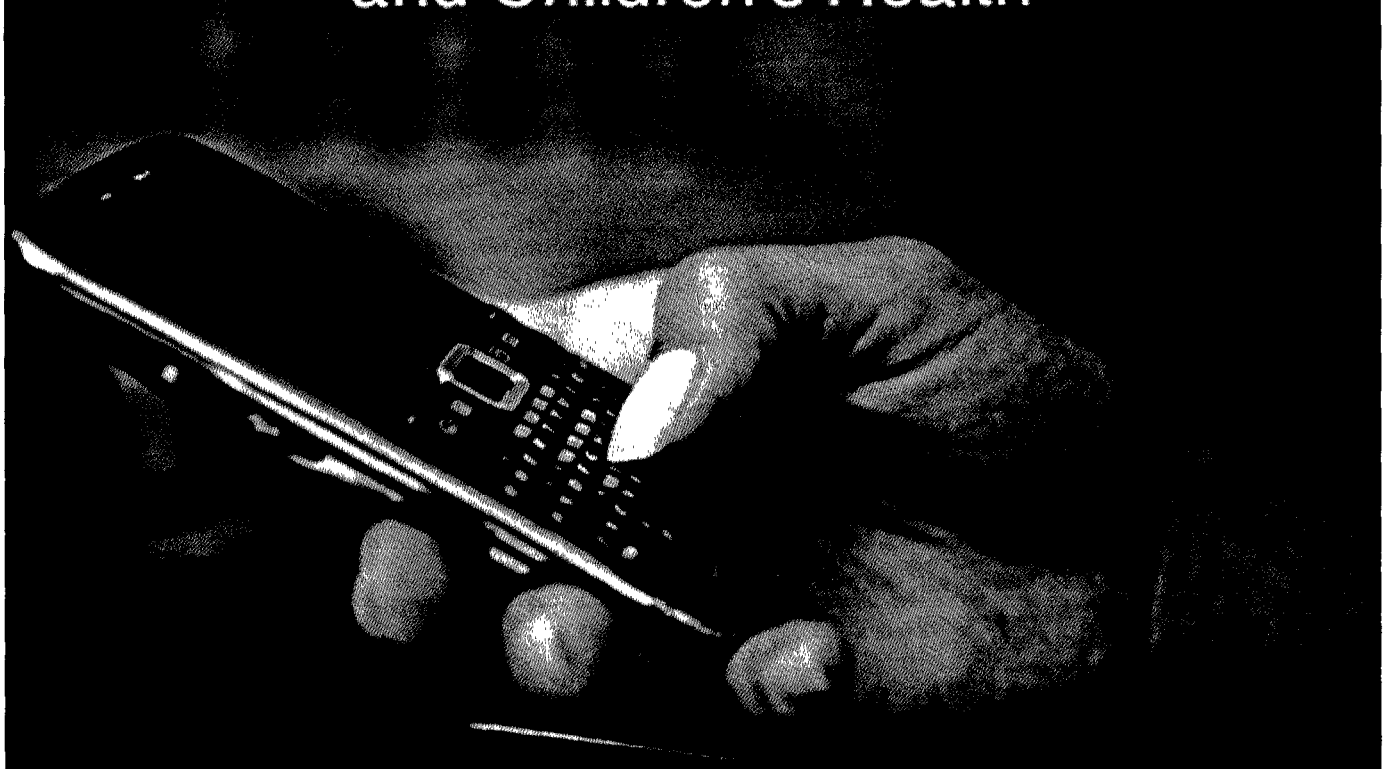
Cell Phone Radiation

Science Review on Cancer Risks and Children's Health



ENVIRONMENTAL WORKING GROUP

ewg.org/cellphone-radiation

Cell Phone Radiation
Science Review on Cancer Risks and Children's Health

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Cell Phone Radiation Science Review
Executive Summary

More than 4 billion people around the world use cell phones (ITU 2009). Because cell phone technology has been around for just two decades, scientists do not yet fully understand long-term health risks from cell phone radiation. But recent research has prompted serious concerns about exposure to wireless emissions.

Prior to 2003, studies of cancer risk and cell phone use produced conflicting results. FDA told consumers that scientists had found no harmful health effects from exposure to cell phone emissions. (FDA 2003).

But FDA's assurances were based on studies of people who had used cell phones for just 3 years, on an average (FDA 2003), not long enough to develop cancer. At that time, studies had not addressed the risks of longer-term exposures.

The research gap is closing. Scientists around the world have recently associated serious health problems with using cell phones for 10 years or longer:

- A joint study by researchers in Denmark, Finland, Norway, Sweden and the United Kingdom found that people who had used cell phones for more than 10 years had a significantly increased risk of developing glioma, a usually malignant brain tumor, on the side of the head they had favored for cell phone conversations (International Agency for Research on Cancer (IARC) 2008; Lahkola 2007).
- French and German scientists reported an increased risk of glioma for long-term cell phone users (Hours 2007; Schuz, Bohler, Berg 2006). Analysis of all published cell phone-brain tumor studies found that people who had used a cell phone for 10 or more years, the overall risk for developing a glioma on the cell phone side of the head increased by 90 percent (Hardell 2009; Kundi 2009).
- Cell phone use for 10 years and longer has been also associated with significantly increased risk of acoustic neuroma, a type of benign brain tumor, on the primary side of cell phone use (IARC 2008; Schoemaker 2005). An extensive review of published studies of acoustic neuroma found that long-term cell phone users had a 60 percent greater risk of being diagnosed with the disease (Hardell 2009; Kundi 2009).
- A study from Israel reported an association between frequent and prolonged mobile phone use and parotid (salivary) gland tumors (Sadetzki 2008). Scientists analyzing data from Sweden and Denmark combined found that people who had used cell phones for at least 10 years ran an increased risk of benign parotid gland tumors (IARC 2008; Lonn 2006).
- Multiple studies reported that the brains of young children absorb more radiation than those of adults (de Salles 2006; Gandhi 1996; Kang 2002; Martinez-Burdalo 2004; Wang 2003; Wiart 2008), potentially rendering them more vulnerable to brain tumors (NRC 2008b). Researchers in Sweden found the highest risk of brain tumors among people who started using cell phones during adolescence (Hardell 2009).

Recent studies link cell phone radiation to:

Brain cancer: Two analyses of 25 original publications identified a 50 to 90 percent increase in risk for two types of brain tumors: glioma and acoustic neuroma (Hardell 2009, Kundi 2009).

Salivary gland tumors: An Israeli study found an increased risk of 50 to 60 percent for salivary gland tumors among people with highest cell phone use (Sadetzki 2008).

Behavioral problems: A study of 13,159 Danish children showed 80 percent elevated risk for emotional and hyperactivity problems among young children who use cell phones and whose mothers also used cell phones during pregnancy (Divan 2008).

Migraines and vertigo: A study of 420,095 Danish adults showed that long-term cell phone users were 10 to 20 percent more likely to be hospitalized for migraines and vertigo than people who took up cell phones more recently. (Schuz 2009).

Scientists have known for decades that high doses of the radiofrequency radiation emitted by cell phones can penetrate the body, heat tissues, trigger behavioral problems and damage sensitive tissues like the eyeball and testicle (Heynick 2003; IEEE 2006).

Yet when cell phones went on the market in the 1980s, federal regulators did not require manufacturers to prove they were safe (GAO 1994).

Recent studies raise particular concerns about the impact of cell phone emissions on children. The National Research Council (NRC) has observed that "with the rapid advances in technologies and communications utilizing [radiation in the range of cell phone frequencies], children are increasingly exposed... at earlier ages (starting at age 6 or before)" (NRC 2008b). The NRC called for "investigation of the potential effects of RF fields in the development of childhood brain tumor" (NRC 2008b).

- Research by France Telecom scientists showed that under standard conditions of use, twice as much cell phone radiation would penetrate a child's thinner, softer skull than an adult's (Wiart 2008). These results confirm earlier findings that children's heads absorb more radiofrequency radiation than adults (Gandhi 1996; Kang 2002; Wang 2003).
- Children will be exposed to cell phone radiation for more years and therefore in greater total amounts than the current generation of adults (NRC 2008b).

Few research studies have focused on the health hazards of children's cell phone use, even though the youth market is growing. But one recent study of 13,159 Danish children showed that young children who use cell phones and whose mothers also used cell phones during pregnancy are 80 percent more likely to suffer emotional and hyperactivity problems (Divan 2008).

In response to the growing debate over the safety of cell phone emissions, government agencies in Germany, Switzerland, Israel, United Kingdom, France, and Finland and the European Parliament have recommended actions to help consumers reduce exposures to cell phone radiation, especially for young children.

In contrast, the two U.S. federal agencies that regulate cell phones, the Food and Drug Administration (FDA) and the Federal Communication Commission (FCC), have all but ignored evidence that long term cell phone use may be risky.

Government actions: radiation standards and public education

Health agencies in six nations — Switzerland, Germany, Israel, France, United Kingdom, and Finland — have recommended reducing children's exposures to cell phone radiation.

In 2008, the European Parliament passed a resolution urging member countries to develop lower radiation emission limits for cell phones. Legislation introduced in the French Senate would ban marketing and sales of phones for children under age 6.

Brussels, Belgium; Salzburg, Austria; and Christchurch, New Zealand have proposed strict local cell phone radiation standards. Toronto has issued guidance to parents on reducing children's cell phone use.

The FCC adopted radiation standards developed by the cell phone industry 17 years ago. These standards, still in use, allow 20 times more radiation to reach the head than the rest of the body. They do not account for risks to children.

While compiling a database of radiation emitted by more than 1,000 cell phones sold in the U.S., the Environmental Working Group has found that emissions can vary by a factor of up to 8 from one phone to another.

The cell phone industry has reported 270 million wireless subscriptions by the end of 2008, equivalent to 87 percent of the U.S. population (CTIA 2009, ITU 2009). This number is only expected to grow. Consumers need — at a minimum — easy access to cell phone radiation information so that they can make informed purchasing decisions and protect themselves and their families from potential health concerns.

Studies: Cell phone radiation may cause tissue damage

Cell phones communicate via electromagnetic waves. During signal transmission, a comparable amount of radiation travels outward, towards the base station, and inward, towards the ear or head of the cell phone user. (IEGMP 2000).

Cell phone waves are in the "radiofrequency" range. They lack the penetrating energy of X-rays and radioactivity. Scientists are still exploring how cell phone radiation may cause the harmful effects that some studies have described.

Scientific research conducted over the past decade has associated cell phone radiation with increased risk of developing brain and salivary gland tumors, neurological symptoms such as migraine and vertigo, and neurodevelopmental effects observed as behavioral problems in young children (BioInitiative 2007; Divan 2008; Kundi 2009; Sadetzki 2008; Schuz 2009).

> Cell phones, radios and TV transmissions emit non-ionizing radiation that has a longer wavelength, lower frequency and lower overall energy per photon than UV light, X-rays and gamma rays (a form of radioactivity), which are known as ionizing radiation because they have enough power to eject an electron from its orbit and leave behind a charged ion that can damage cells and tissues.

The National Research Council has reported that exposure to cell phone radiation may affect the immune, endocrine and nervous systems, fetal development and overall metabolism (NRC 2008b). Children are likely to be more susceptible than adults to effects from cell phone radiation, since the brain of a child is still developing and its nervous tissues absorb a greater portion of incoming radiation compared to that of an adult (Gandhi 1996; Kang 2002; Kheifets 2005; Schuz 2005; Wang 2003; Wiart 2008).

FCC industry radiation standards have little margin of safety

The FCC's cell phone radiation standards closely follow the recommendations of the Institute of Electrical and Electronics Engineers (IEEE) (FCC 1997). These standards allow 20 times more radiation to penetrate the head than the rest of the body and do not account for risks to children.

FCC standards limit the radiation absorbed by a cell phone user's brain and body to a specific absorption rate, or SAR, measured by the amount of the phone's radiation energy (in watts, W) absorbed per kilogram of tissue (W/kg).

Current FCC regulations permit SAR levels of up to 1.6 W/kg for partial body (head) exposure, 0.08 W/kg for whole-body exposure, and 4 W/kg for exposure to the hands, wrists, feet and ankles (FCC 1997, 1999).

The FCC standards are based on animal studies conducted in late 1970s and early 1980s (Osepchuk 2003). FCC, on the recommendation of the IEEE, adopted SAR level of 4 W/kg as the point of departure for determining legal SAR limits for cell phones. In contrast to the FCC decision, an independent analysis by the EPA scientists concluded, on the basis of the same body of data, that biological effects occur at SAR levels of 1 W/kg, 4 times lower than the SAR level chosen by IEEE (U.S. EPA 1984). Exposure to radiofrequency radiation at these SAR levels induces tissue heating that leads to behavioral alterations in mice, rats, and monkeys, that may be a "potentially adverse effect in human beings" (IEEE 2006).

Current FCC standards fail to provide an adequate margin of safety for cell phone radiation exposure and lack a meaningful biological basis.

For example, the FCC standard for the head is just 2.5 times lower than the level that caused behavioral changes in animals. The standard that applies to hands, wrists, feet, and ankles has no safety margin whatsoever.

The FCC adopted IEEE's proposal to allow 20 times more radiation to the head than the average amount allowed for the whole body, even though the brain may well be one of the most sensitive parts of human body with respect to radiofrequency radiation and should have more protection.

To receive the FCC approval for selling a cell phone in the U.S. market, manufacturers typically conduct the phone's SAR tests themselves or contract with the private industry. Private industry organizations (Telecommunication Certification Bodies) are also actively involved in all steps of determining the compliance of cell phones and other wireless devices with the FCC rules (FCC OET 2008f).

SAR testing of cell phones is carried out on a mold in the shape of an adult torso or head which is filled with a viscous fluid mixture selected to simulate the electrical properties of human tissue (GAO 2001). To determine SAR, a cell phone is placed next to the outer surface of the mold and turned on to transmit at the maximum power while a probe is inserted into the viscous inner mixture at various locations, measuring the radiofrequency energy that is being absorbed (GAO 2001).

FCC, the cell phone industry, and the academic community all acknowledge that SAR measurements have significant precision problems (Cardis 2008; FCC OET 2008e; GAO 2001; Wiart 2008). Studies by scientists in academia and the cell phone industry demonstrate that SAR is significantly influenced by the age, shape of the head, and tissue composition (Conil 2008; Wang 2003; Wiart 2008).

The greatest debate is whether the current methods for SAR measurement is adequate for assessing radiation absorption in children's brains (Gandhi 1996; Wang 2003). Recent research on SAR in test models for children's brains and bodies indicates that SAR levels in children would be much higher than in adults (Conil 2008; de Salles 2006; Gandhi 1996; Martinez-Burdalo 2004; Wang 2003; Wiart 2008).

Cell phone standards ignore children

Scientists in a number of countries agree that the head and brain of a child absorb significantly more radiation than those of an adult (de Salles 2006; Gandhi 1996; Kang 2002; Wang 2003; Wiart 2008). Yet U.S. cell phone emission levels and federal standards are based on radiation absorbed by adults and fail to account for children's higher exposures and greater health risks.

In general, as head size decreases, the percentage of energy absorbed by the brain increases,(Martinez-Burdalo 2004). Moreover, children's tissues have higher water and ion content compared to adult tissues (Peyman 2009). Both factors increase radiation absorption, acccording to researchers from the U.S., the Finnish cell phone company Nokia, Institute of Applied Physics in Spain and the U.K. Health Protection Agency (Gandhi 2002; Keshvari 2006; Martinez-Burdalo 2004; Peyman 2009).

All these data, taken together, suggest that when a child uses a cell phone that complies with the FCC standards, he or she could easily absorb an amount of radiation over the maximum allowed radiation limits defined by the federal guidelines. FCC standards give adults only a slim margin of safety over emission levels that harm animals. For children, the margin is much slimmer – if one exists at all.

Consumers have a right to full information on cell phone radiation levels

Cell phone manufacturers opposed SAR disclosure (Lin 2000) until 2000, when the FCC began posting cell phone SAR values on its web site. After the FCC decision, the Cellular Telecommunications Industry Association (CTIA) began requiring manufacturers to disclose cell phone SARs.

According to CTIA guidelines, a mobile phone SAR value must be listed in the user manual or on a separate sheet. The trade association does not require listing the SAR value on the box or the phone itself (Microwave News 2000).

Cell phone radiation levels are rarely available at retail locations. Consequently, consumers cannot easily identify low-radiation phones.

FCC maintains a database of mobile phone SAR values for devices currently on the market, but it is difficult to use. With significant effort, a consumer can navigate the FCC website to find the SAR value for a specific phone.

To search the FCC database, the consumer needs the mobile phone's FCC ID number, located on a sticker underneath the phone's battery. The first three characters of the FCC ID is the Grantee Code; the remaining numbers and letters of the ID are a product code that can be entered into the online FCC ID Search Form (http://www.fcc.gov/oet/ea/fccid), to pull up five to seven data entries. Consumers must scroll manually through each of the data entries to locate the document that lists the SAR value for the specific mobile phone.

In contrast to this cumbersome process, the German Federal Office for Radiation Protection (BfS) maintains a detailed, open directory of information on mobile phones available in the German market (BfS 2008b). Such a publicly available database greatly facilitates consumers' access to SAR data, enables informed purchasing decisions and encourages phone manufacturers to offer lower-SAR phones.

Recommendations

The U.S. government should require phones to be labeled with their radiation emissions at the point of sale, so consumers can make informed decisions about the phones they buy.

The cell phone industry should offer consumers phones that operate with the least possible radiation, and should make each phone's radiation emissions available at the point of sale.

Cell phone users can protect themselves and their families by buying low-radiation phones. Look for currently available low-radiation options in the EWG's cell phone radiation buyer's search tool that lists radiation output of more than 1,000 cell phones.

Cell phone users can also reduce exposures by using their phone in speaker mode or with a headset.

And please help us tell the government to update its cell phone standards.

Section 1: Do cell phones cause cancer or other illnesses?

Research on cancer risk in cell phone users

Researchers and public health experts worldwide actively debate if cell phone radiation can lead to brain cancer (American Cancer Society 2008; FDA 2003; Hardell 2009; IARC 2008, 2009b; Kundi 2009). While earlier, short-term studies did not find an increased risk of brain cancer (Ahlbom 2009; Croft 2008; FDA 2003), long-term data published over the last four years found an increased risk of developing two types of brain tumors on the ipsilateral side (the side of the brain on which the cell phone is primarily held) among people who used a cell phone for longer than 10 years (Hardell, Carlberg 2006b; Hours 2007; Lahkola 2007; Lonn 2005; Schoemaker 2005; Schuz, Bohler, Berg 2006; Takebayashi 2008):

- Glioma – a typically malignant tumor of the brain that arises from glial cells that provide physical support for the central nervous system;
- Acoustic neuroma – a benign tumor of the vestibulocochlear nerve that innervates the ear.

Two recent studies also reported increased risk of salivary gland (parotid gland) tumors among cell phone users (Lonn 2006; Sadetzki 2008).

In the late 1990s, the International Agency for Research on Cancer (IARC) developed a multinational case-control study, INTERPHONE, to address strong public concerns about cell phone safety (Cardis 1999). The goal of the INTERPHONE study was to investigate whether the radiofrequency radiation emitted by cell phones is carcinogenic (IARC 2009b). Thirteen countries participated in the project (Australia, Canada, Denmark, Finland, France, Germany, Israel, Italy, Japan, New Zealand, Norway, Sweden and the UK). The study ran from 2000 to 2006, cost 30 million U.S. dollars (Economist 2008) and involved 14,078 study participants, among them 2,765 glioma, 2,425 meningioma, 1,121 acoustic neurinoma, 109 malignant parotid gland tumour cases and 7,658 controls (Cardis 2007).

The publication of final results and conclusions of the entire INTERPHONE study has been delayed for three years since the conclusion of the study (IARC 2009a; Microwave News 2009). Scientists have questioned whether the study design methods were adequate for detecting increased cancer risk, and whether recall biases might have impacted the quality of the data and resultant conclusions (Cardis 2007; Kundi 2009; Vrijheid, Armstrong 2009; Vrijheid, Cardis 2006; Vrijheid, Deltour 2006; Vrijheid, Richardson 2009). Meanwhile, scientists from different international centers have begun to publish their findings independently (Cardis 2007; Lonn 2005; Schlehofer 2007; Schoemaker 2005; Schuz, Bohler, Schlehofer 2006; Takebayashi 2006).

As described in the article published by the Economist in September 2008:

> *"Delays in releasing the report have been due to "the difficulty of interpreting the findings due to potential biases" and to the "conducting of additional analyses to try and disentangle the potential impacts of selection and recall errors on the risk estimates". The Interphone researchers are split into three camps. One believes any increased incidence of tumours shown in the study is purely the result of the biases. Another thinks it really has found increased risks of certain tumours and wants to call for precautionary measures. A third group is just keeping quiet. One person who knows many of the scientists, but prefers not to be named, describes the relations between members of the three groups as "strained"—harsh language in the world of scientific research."* (Economist 2008)

The latest update of the INTERPHONE study results, published on October 8, 2008 (IARC 2008), included 6 publications that found some increase in the risk of glioma for long-term cell phone users, especially on the ipsilateral side (Christensen 2005; Hours 2007; Lahkola 2007; Lonn 2005; Schuz, Bohler, Berg 2006). This side of the head absorbs 97-99% of the total electromagnetic energy deposited in the brain during calls (Cardis 2008), which supports the link between cell phone use and ipsilateral brain tumor development. Only two of the INTERPHONE studies did not find an increased glioma risk (Hepworth 2006; Takebayashi 2008). Increased risk

of glioma associated with long-term cell phone use has been also reported by the Hardell group in Sweden (Hardell, Carlberg 2006b; Hardell 2009).

INTERPHONE results for acoustic neuroma are more varied. Of the 7 INTERPHONE reports on acoustic neuroma, 5 publications based on less than 10 years exposure did not detect an increased risk (Christensen 2004; Hours 2007; Klaeboe 2007; Schlehofer 2007; Takebayashi 2006). In contrast, two publications that were based on longer than 10-year exposure reported an increased risk of acoustic neuroma (Lonn, Ahlbom 2004; Schoemaker 2005). Similar to glioma, the risk for developing acoustic neuroma appears to be strongest for tumors on the ipsilateral side and long-term exposures (Hardell, Carlberg 2006a; IARC 2008).

A meta-analysis that combined results from all brain tumor studies published to date reported that among people who had used cell phones for more than 10 years, the risk of ipsilateral brain tumor increased by 90% for glioma and 60% for acoustic neuroma (Hardell 2009; Kundi 2009). Some studies have also reported an increased risk of the benign brain tumor meningioma, although the risk appears to be smaller and thus much harder to detect (Hardell 2009; Kundi 2009; Takebayashi 2008). Authors of the study noted that the risk appears to be higher in rural areas where phones typically radiate at higher intensities to allow signals to reach distant transmission towers (Hillert 2006).

While the publication of the final INTERPHONE summary is pending (IARC 2009a), detailed post-study analysis suggested that some of the negative findings may have been related to the study design and methods for determining past personal patterns of cell phone use (Hardell and Hansson Mild 2006; IARC 2008; Vrijheid, Cardis 2006; Vrijheid, Deltour 2006; Vrijheid, Mann 2009; Vrijheid, Richardson 2009). For example, among studies where the observed effects were weak, an increased risk of brain tumor was nevertheless reported for long-term users, users with the largest number of calls, and users with the largest numbers of telephones (Hours 2007; Schoemaker 2009).

Recently, a large-scale, multi-center study in Israel also found an association between salivary (parotid) gland cancer and heavy use of cell phones, especially for rural areas where cell phones typically transmit at higher power (Sadetzki 2008). As reported by the team of Israeli scientists, the anatomic location of the parotid gland just below the ear would makes it vulnerable to cell phone radiation exposure. Parotid tumor occurs at a relatively young age (43-55 years of age), so that many current cell phone users may already be at risk for these tumors (Sadetzki 2008).

Researchers found a 48-58% increased risk of salivary gland tumors among people who make the greatest total number of calls or who log the most time on the phone without a hands-free device compared to others in the study group, on the side of the brain on which the cell phone was held (ipsilateral). No increased risk was seen for tumors on the other side of the head (Sadetzki 2008). The Israeli findings are in close agreement with an earlier study conducted in Sweden and Denmark; this study, based on a cohort about 1/3rd the size of the Israeli cohort, observed a 40% increased risk of ipsilateral benign tumors (Lonn 2006).

The fact that scientists have measured increased tumor risk in so many studies of cell phone users is even more powerful given that people have used cell phones widely for only about a decade, while cancer typically requires 15-20 years to develop. It seems likely that studies conducted in future years may find more consistent and higher cancer risks (Ahlbom 2004; Ahlbom 2009; Krewski 2001; Krewski 2007; Kundi 2009; Kundi 2004).

Strikingly, the field of research on the health effects of cell phone use has exhibited the signature pattern of a so-called "funding effect," a biased outcome due to source of funding, observed in studies funded by tobacco companies or the manufacturers of industrial chemicals such as the endocrine disrupting plasticizer BPA (vom Saal 2005). In 2001, the U.S. Government Accountability Office voiced a strong concern about the reliability of results from industry-funded studies conducted without government oversight (GAO 2001). A recent systematic review of the source of funding and results of studies of health effects of cell phone use indicated that studies funded by the cell phone industry were ten times more likely to report no adverse effects compared to studies funded by public agencies or charities (Huss 2007; Huss 2008). Thus, some of the heterogeneity in the earlier literature could be related to the source of funding, whereby research sponsors could influence the design of the study, the nature of the exposure, and the type of outcome assessed.

Cell phones and health effects other than cancer

New lines of research are examining central nervous system diseases other than brain tumors in relation to cell phone use:

- A recent Danish study noted an increased risk for neurological symptoms such as migraine and vertigo for cell phone users (Schuz 2009);
- Scientists have found an increased risk for Alzheimer disease associated with electromagnetic radiation (Huss 2009);
- A study from the University of California, Los Angeles found a correlation between prenatal exposure to cell phone radiation and behavioral problems in children (Divan 2008).
- Six studies from the U.S., Australia, Japan and Europe reported that exposure to cell phone radiation has an adverse effect on sperm counts, motility and vitality (Agarwal 2009; De Iuliis 2009; Erogul 2006; Fejes 2005; Salama 2009; Yan 2007).

In animal studies, scientists have found that exposure during gestation to radiofrequency radiation like that emitted by cell phones is associated with decreased fetal growth, developmental abnormalities, and death of offspring (BioInitiative 2007; Heynick 2003). In occupational health studies for female physiotherapists, conducted in Sweden, Israel, and Finland, scientists found that workplace exposure to radiofrequency radiation during pregnancy is associated with low birth weight, congenital malformations, fetal death, and spontaneous abortions (Kallen 1982; Lerman 2001; Taskinen 1990).

The key question in the cell phone research field is how radiofrequency radiation like that from cell phones affects biological tissues and cells. Scientists have proposed and explored a number of possible mechanisms:

- A number of studies examined the potential for genotoxicity of elecromagnetic fields (harm to genetic material in body cells that can lead to mutations and cancer) (BioInitiative 2007; Phillips 2009). While the evidence is not yet conclusive, one quarter of studies published on this issue found a genotoxic effect from low-level exposures (Vijayalaxmi 2008).
- Scientists have reported that cell phone radiation affects levels of reactive oxygen species (ROS) inside the cell (Irmak 2002; Zmyslony 2004). In turn, higher ROS levels trigger intracellular signaling cascades that interrupt the smooth functioning of the cell. Changes in the activation status of molecules within these signaling cascades can lead to inflammation, heart disease, cancer and other chronic health conditions (Boutros 2008; Muslin 2008; Skaper 2007).
- Cell phone radiation-induced reactive oxygen species may well be the causative agent that induces DNA damage, which is a precursor to cancer (Phillips 2009) and a potential mechanism of toxicity to sperm cells (De Iuliis 2009).
- Radiofrequency radiation has been associated with a change in the activity of white blood cells (Aly 2008).
- Exposure to cell phone radiation has been associated with cell death and activation of intracellular signaling molecules (Lee 2008). There is a vigorous debate in the literature regarding the types of conditions under which radiofrequency radiation would cause cell death (Guney 2007; Nikolova 2005; Palumbo 2008; Zhao 2007).

As described in a recent expert review, "In a living cell, many important processes occur by electron transfer across membrane structures in a well-organized manner, ions cross selective channels, proteins get activated and deactivated by cascades of precisely regulated enzymes" (Kundi 2009). These electronic processes would likely be affected by the electromagnetic fields, leading to altered cellular function, growth, and differentiation (Karinen 2008; Moisescu 2008; Zareen 2009). While none of these processes individually can be considered equivalent to the development of disease, all of them are associated with chronic adverse health effects and need to be considered in the assessment of radiofrequency radiation impact on biological organisms.

Section 2: Cell Phone Safety Standards

Radiofrequency radiation associated with cell phones

FCC established the first radiation standards for cell phones in 1996, 13 years after cell phones were first marketed in the U.S. The agency adopted limits recommended by industry (IEEE C95.1-1991) that were established to protect against high-dose thermal effects, that allow a 20-fold higher exposure to the head (1.6 W/kg) compared to the rest of the body (0.08 W/kg), and that do not account for a child's higher exposure and greater vulnerability to cell phone radiation.

In the U.S., cell phones operate at electromagnetic wave frequency of either 800-900 megahertz (MHz) or 1800-1900 MHz. This frequency range is called radiofrequency (RF), since radios and TVs operate in the same portion of electromagnetic spectrum. The power density or intensity of transmitted electromagnetic field (EMF) is measured in watts (W) per m2 or, more commonly, milliwatts per cm2 (mW/cm2).

Cell phone radiation is transmitted by the antenna and the circuit elements inside the handset. The antenna and the circuit elements send out the electromagnetic wave (RF radiation) to transmit the signal. The inner antenna is usually a metal helix or a metal rod a few centimeters long that is able to transmit RF radiation of sufficient power so as to deliver the signal from the handset to the base station. The antenna is typically located on the back of a cell phone or a wireless device. The power at which a cell phone must transmit to reach a base terrestrial station is affected by many factors, such as frequency (900 or 1800 MHz), the phone distance from the base station, and physical obstacles between the phone and the base station. To overcome obstacles and interference, a cell phone transmits at greater power. This power is controlled from the base station.

In a rural area with sparse locations of cell phone towers, cell phones need to transmit signal at a greater power (Hillert 2006). A study in Sweden demonstrated that in the rural area, the highest power level was used about 50% of the time, while the lowest power was used only 3% of the time. The corresponding numbers for the city area were approximately 25% and 22% (Lonn, Forssen 2004). In agreement with these data, rural users of cell phones appear to be at a higher tumor risk compared to urban users, likely due to higher power radiation emitted by a phone when located further away from a base station (Hardell 2005; Sadetzki 2008).

EMF radiation emitted by a cell phone antenna is not very directional – similar amounts of radiation are transmitted outward, towards the base station, and inward, towards the ear/head of a cell phone user where they readily penetrate into the body and are absorbed into the inner tissues (Independent Expert Group on Mobile Phones (IEGMP) 2000). Of note, it is possible to design directional antennas so as to decrease radiation exposure to the cell phone user (Wireless Galaxy 2009). Multiple factors influence how much radiation goes into the head, including: the type of digital signal coding in the network, such as GSM (Global System for Mobile Communication), CDMA (Code division multiple access) or UMTS (Universal Mobile Telecommunication System); the antenna design; location of the antenna relative to the head; and the position of the hand or use or an earpiece (Swiss Federal Office of Public Health 2009c).

Of the total radiation emitted towards the head, most (97–99%, depending on frequency and cell phone network) is absorbed in the brain hemisphere on the side where the phone is used (Cardis 2008). The temporal lobe, an area of the brain involved in auditory processing, formation of long-term memory, as well as some aspects of speech and vision, receives the highest radiation exposure (Cardis 2008). Additionally, when a phone is worn near the waist during its use (as may occur when a corded or a cordless headset is used), much of the outgoing radiation is be absorbed by adjacent soft tissues, which may pose health risks (Agarwal 2009; Swiss Federal Office of Public Health 2009c; Whittow 2008).

Absorption of radiofrequency energy involves interaction with polar molecules or ions inside the cells and in extracellular fluids such as cerebrospinal fluid, leading to readily detectable temperature elevation in organs and tissues (ICNIRP 1998; IEEE 2006). The heat generated in tissues absorbing RF energy can cause thermal effects that range from behavioral problems to damage to sensitive tissues like the eyeball or testicle. Researchers have

also suggested non-thermal mechanisms of action for some of the effects seen in studies, including effects on ion channels within a cell, effects on membrane enzymes, creation of membrane pores, and free radical formation; scientists worldwide are actively investigating these possible effects of cell phone radiation (NRC 2008b; Weaver 2006).

Specific absorption rate (SAR) for the cell phone radiation

Biological effects caused by radiofrequency radiation depend on the rate at which the energy is absorbed by a particular mass of tissue, calculated as specific absorption rate, or SAR, and measured in watts per kilogram (W/kg). Since brain structures on the side where a cell phone is used (the ipsilateral side) receive significantly higher dose of radiation, and since radiation is unevenly absorbed into different types of tissues (bone, cartilage, nervous tissue, or distinct anatomical structures within the brain), international experts agree that more precise SAR measurements can be obtained when averaging over a smaller volume of tissue (Cardis 2008).

In general, energy absorption rate increases with greater conductivity of tissue and decreases with greater tissue density. Absorption rate is also directly proportional to the intensity of the electromagnetic field (its power density). To carry out an SAR test, a mold in the shape of human torso or head is filled with a fluid designed to simulate the electrical properties of human tissue. Typically, a head model is filled with a thick, viscous mixture that is meant to simulate the conductivity of head tissues; the mixture includes water, salt, sugar, and a chemical viscosity additive. During testing the phone is placed next to the outer surface of the mold and made to transmit a signal at full power while an inner probe is moved through the fluid mixture, measuring the radiofrequency energy that is being absorbed at various locations (IEC 2005). The certified SAR level of a given phone is supposed to be the highest SAR value measured during those tests.

FCC, the industry, and the academic community all acknowledge that SAR measurements have significant precision problems (Cardis 2008; Conil 2008; FCC OET 2008e; GAO 2001; Wiart 2008). Studies by scientists in academia and the cell phone industry, demonstrated that it is difficult to generalize between the SAR induced in two given heads, for people of different ages or body types (Wiart 2008). Although significant methodological improvements occurred over the last decade, in 2008 FCC reported persisting "issues and concerns in applying these [SAR] procedures correctly" (FCC OET 2008b). Additionally, two modeling studies carried out in Japan demonstrated that the whole body SAR can be substantially higher than the current standard when short subjects are exposed to high-power cell phone radiation (Hirata 2007; Wang 2006).

The current SAR standard may pose especial risk to the health of children (Martinez-Burdalo 2004). Children's tissues have higher numbers of ions compared to adults, resulting in greater conductivity and increased capacity to absorb radiation (Gabriel 2005; Peyman 2009). Children's heads also have smaller thicknesses of the pinna, skin and skull, reducing the distance from the handset to the peripheral brain tissues (Conil 2008; Wiart 2008). These factors result in higher SAR exposure for young children. According to a recent study with SAR testing models designed to correspond to the 5-8 year old child, a child's head would absorb twice the radiation of an adults' (Wiart 2008). Similar results have been reported by the University of Utah researchers in 1996 (Gandhi 1996) and by the researchers from the Nagoya Institute of Technology (Japan) in 2003 (Wang 2003). Due to higher absorption of radiation, when a child uses a high-emitting cell phone, he or she could easily get an exposure over the current FCC limit (Conil 2008).

U.S. SAR standards for cell phones

The FCC limits for cell phone radiation exposure (47CFR 2.1093(d)), based on IEEE recommendations, permit the following SAR levels for whole-body exposure and for partial-body or localized exposure (FCC 1997, 1999):

- Partial-body exposure (head): up to 1.6 W/kg, averaged over 1 g of tissue;
- Whole-body exposure: up to 0.08 W/kg, averaged over 1 g of tissue;
- Hands, wrists, feet, and ankles: up to 4 W/kg, averaged over 10 grams of tissue.

The current SAR standards for radiofrequency radiation were based on animal studies conducted in the late 1970s and early 1980s. These studies demonstrated behavioral alterations, such as disruption of food-motivated

learned behavior, in several animal species, including non-human primates (squirrel monkeys) at an SAR above 4 W/kg (IEEE 2006; Osepchuk 2003). According to the Institute of Electrical and Electronics Engineers (IEEE) International Committee on Electromagnetic Safety, these behavioral changes "may be a potentially adverse effect in human beings" (IEEE 2006).

FCC, on the recommendation of the IEEE, adopted an SAR level of 4 W/kg as the point of departure for determining legal SAR limits for cell phones. In contrast to the FCC position, an independent analysis by the EPA scientists concluded, on the basis of the same body of data, that biological effects occur at SAR levels of 1 W/kg, 4 times lower than the level chosen by IEEE (U.S. EPA 1984). The EPA's Science Advisory Board reviewed the draft EPA report twice prior to publication. The Science Advisory Board concluded that the report "represents an adequate statement of the current scientific literature and can serve as a scientifically defensible basis for the Agency's development of radiation protection guidance for use by Federal agencies to limit exposure of the general public to radiofrequency radiation" (SAB 1984).

Based on the EPA analysis, a point of departure at 1 W/kg SAR may well be a more scientifically defensible hazard level that should be used for determining legally acceptable exposure limits. In fact, the EPA scientist in charge of editing the 1984 report, D.F. Cahill, published a peer-reviewed paper where he indicated that SAR of 0.4 W/kg is likely to be a conservative threshold point (Cahill 1983), 10 times lower than the departure point chosen by IEEE. This conclusion is supported by a growing body of studies from researchers world-wide that observe biological effects of cell phone radiation at SAR values significantly below the limits adopted by FCC (reviewed in (BioInitiative 2007; Independent Expert Group on Mobile Phones (IEGMP) 2000)).

Of note, the IEEE-recommended SAR of 4 W/kg as the point of departure for adverse health effects corresponds to short-term exposure and does not take into account long-term or chronic exposure (RFIAWG 1999). Thus, the existing FCC cell phone standard may well be insufficient for protecting human health from potential effects of life-long use, especially for susceptible populations such as young children.

Slim margin of safety provided by the current FCC standards

The FCC standards, adopted from the 1992 IEEE recommendation, are not based on a comprehensive risk assessment and fail to provide a reasonable margin of safety for exposure to cell phone radiation. Assuming a conservative, and likely overestimated departure point for health effects at an SAR value of 4 W/kg, the exposure standard for the head, at 1.6 W/kg, has only a 2.5-fold margin from the level that produced adverse behavioral effects even though it is possibly the most sensitive part of the human body, while exposure to hands, wrists, feet, and ankles at 4 W/kg, has no safety margin whatsoever. Moreover, as discussed above, children aged 5-8 may receive twice higher SAR compared to adults (Wiart 2008), so that under the current radiation standards a young child can easily receive a level of radiation exposure at which adverse behavioral effects are observed in animals.

The approach that IEEE/FCC took to the development of the cell phone radiation standard stands in stark contrast to the risk management approach practiced by the Environmental Protection Agency (EPA). According to EPA, protective reference values should be derived in a way that accounts for both the uncertainty and the variability in the data available (U.S. EPA 2008). In this framework, variability refers to heterogeneity or diversity in the human population, such as different exposure frequencies and duration and differences in response such as genetic or age-specific difference in vulnerability to a particular physical, chemical, or biological agent. Further, uncertainty is typically due to a paucity of available information, for example, for extrapolation from animal data to humans, extrapolating from short-term to chronic exposure and lack of information on all health endpoints affected by the exposure (NRC 2008a; U.S. EPA 2002). To account for uncertainty and variability, one of several, generally 10-fold, default factors are used in EPA risk assessments for operationally deriving the reference exposure values from experimental data (U.S. EPA 2009).

The goal of applying the uncertainty/variability factors for developing general population exposure standards is to ensure that an adequate margin exists to protect infants, young children, and other vulnerable populations from harmful exposures. The choice of specific uncertainty factors (UF) depends on the quality of the studies available and the extent of the research database. EPA has developed certain general principles that apply to most risk assessments (U.S. EPA 2002):

- Interspecies UF accounts for different sensitivity between humans and laboratory test species; it generally falls between 3 and 10, but factors more than 10 might also be applied;
- Intraspecies UF accounts for variability in response between different people; this factor is generally set at 10 and needs to be higher so as to specifically protect children;
- Subchronic-to-chronic duration UF is typically set at a default value of 10 whenever the results of a short-term exposure study are used to derive a long-term exposure standard;
- Finally, for certain exposures during the vulnerable period of development, such as exposure of young children to pesticides, an additional safety factor of 10 is used (mandated under Food Quality Protection Act of 1996).

Of note, the development of the IEEE standard did not involve risk assessment and uncertainty factor considerations as applied by the EPA. A statement from a recent review on the history of the standard is very telling: "to account for uncertainties in the data and to increase confidence that the limits are below levels at which adverse effects could occur, somewhat arbitrary safety factors (typically 10-50) are applied to the established threshold" (Osepchuk 2003).

As described by the IEEE 2005 "Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields", IEEE applies a safety factor of 10 for whole body exposure and adds an additional factor of 5 so as to "recognize public concerns and take into account uncertainties in laboratory data and in exposure assessment" (IEEE 2006). Why a factor of 5 and not 10, the default factor typically used by EPA in cases of uncertainty (U.S. EPA 2002)? According to IEEE, the International Committee on Electromagnetic Safety determined that "an additional factor of 10 was likely excessive and a factor of 2 not sufficiently differentiating from the upper tier" (IEEE 2006). IEEE has argued that even this 5-fold factor may be excessive and unnecessary and that exposure limits for the general population need to be set at the same higher level as for occupationally exposed people in the workplace (IEEE ICES 2002; Microwave News 2001). IEEE based this recommendation on an untested hypothesis that there would be no difference in sensitivity of different population subgroups to electromagnetic radiation (IEEE ICES 2002).

In its assessment, IEEE has sanctioned a 20-fold higher SAR values for the head (1.6 W/kg) than the whole-body exposure (0.08 W/kg). There are no scientific data to support this decision. As indicated in the authoritative assessment from the Radiofrequency Interagency Work Group (RFIAWG), a task force that included the National Institute for Occupational Safety and Health (NIOSH), EPA, FCC, Occupational Safety and Health Administration (OSHA), and the National Telecommunications and Information Administration, the brain may well be the most sensitive part of the human body with respect to radiofrequency radiation, and would require a more and not less protective standard (FDA 2008a; RFIAWG 1999).

Over the past several years, IEEE has been pressuring FCC to further relax the SAR standard for mobile phones, so that greater energy absorption into the head would be legally permitted (IEEE ICES 2002; Li 2006; Lin 2006; Microwave News 2001; Silva 2002). As promoted by the IEEE, the new upper limit for exposure to the head would be 2 W/kg instead of the FCC limit of 1.6 W/kg (IEEE 2006). The new IEEE standard (2006) also proposed to increase allowed SAR levels for the ear ("pinna") from 1.6 W/kg to 4/0 W/kg, the same as current standards for hands, wrists, feet and ankles (IEEE 2006)

IEEE also proposed to switch to a method of SAR determination that involves averaging absorbed radiation over 10 g of tissue (IEEE 2006), even though it is well known that averaging over a greater volume tends to underestimate the SAR value by a factor of 2-3 (Cardis 2008; Gandhi 2002). Although so far this proposal has not been adopted by the FCC, in the past FCC had a disconcerting track record of accepting IEEE recommendations without peer review by an independent body of scientific experts (GAO 2001; Lin 2006).

U.S. cell phone certification is primarily carried out by private industry organizations

Cell phones certified by FCC for use in the U.S. must be shown to comply with the legal SAR limits. Yet, cell phone manufacturers opposed public SAR disclosure until 2000, when the FCC began posting cell phone SAR values on its web site (Lin 2000). After the FCC decision, the Cellular Telecommunications Industry Association (CTIA) began requiring manufacturers to disclose cell phone SARs.

It takes effort and persistence to locate the radiation emission (SAR) value for a cell phone either on the manufacturer's website or in the FCC database. There is no standard format for SAR disclosure by the manufacturers, so a search can be very time consuming. According to CTIA guidelines, a mobile phone SAR value must be listed in the user manual or on a separate sheet. The trade association does not require listing the SAR value on the box or the phone itself (Microwave News 2000).

The FCC Office of Engineering and Technology (OET) is the main division within the FCC responsible for cell phone certification and oversight of all radiofrequency equipment in general. FCC has several equipment approval programs, all of which involve the use of the private sector to varying degrees, including:

- **Verification** (self-approved by the manufacturer). According to 47CFR 2.902, "Verification is a procedure where the manufacturer makes measurements or takes the necessary steps to insure that the equipment complies with the appropriate technical standards. Submittal of a sample unit or representative data to the Commission demonstrating compliance is not required unless specifically requested by the Commission"

- **Declaration of Conformity** (manufacturer self-approved using an accredited lab). According to 47CFR 2.906, "Declaration of Conformity is a procedure where the responsible party, as defined in Sec. 2.909, makes measurements or takes other necessary steps to ensure that the equipment complies with the appropriate technical standards. Submittal of a sample unit or representative data to the Commission demonstrating compliance is not required unless specifically requested."

- **Certification.** According to 47CFR 2.906, "Certification is an equipment authorization issued by the Commission, based on representations and test data submitted by the applicant".

Certification of a cell phone or any other type of device can be approved by the FCC or a Telecommunication Certification Body (TCB), which is a private industry certification organization. As described in 47CFR 2.960, "The Commission may designate Telecommunication Certification Bodies (TCBs) to approve equipment as required under this part. Certification of equipment by a TCB shall be based on an application with all the information specified in this part. The TCB shall process the application to determine whether the product meets the Commission's requirements and shall issue a written grant of equipment authorization. The grant shall identify the TCB and the source of authority for issuing it."

According to the FCC, "A TCB is a private organization, which is authorized to issue grants, within its scope of designation, for equipment subject to the FCC's certification procedure. Under these rules, a TCB has the authority to review and grant an application for certification to the FCC rules" (FCC OET 2008f). Examples of devices that can receive certification either through the FCC or through a TCB include cell phones; radiofreqency lights; microwave ovens; family radio; telemetry transmitters; walkie talkies (FCC OET 2008c). Of note, the rules for FCC-TCB interaction are not listed in 47CFR. As described by an FCC representative in a conversation with EWG on April 1, 2009, FCC-TCB interaction is a "constantly developing process." Typically, FCC gives new guidelines to TCBs on an ongoing basis, usually in the format of TCB workshops held 2-3 times a year (FCC OET 2005a, b, 2006, 2008a).

Considering the widespread use of cell phones and other wireless communication devices, it is surprising that the vast majority of them do not undergo direct FCC review. FCC has defended the use of the private sector for certification and issuing grants of equipment authorization, stating that in the Agency's opinion, a private certification system allows for rapid adjustment to changing technology with shorter product life cycles; faster product approvals; access to technical expertise and ability to certify equipment; increase in resources performing conformity assessment; efficiencies in designing and approving products in the same geographic location; as well as reduced uncertainty and delay in obtaining certification (FCC OET 2005a). However, multiple issues of oversight, conflict of interest, adequate auditing and public disclosure hamper the transparency of the TCB certifications (GAO 2001).

In the TCB process, the manufacturer, an accredited lab, or a TCB can test the SAR value of a sample phone. A TCB then reviews the mobile phone test data and application for compliance. The application must demonstrate concordance with the FCC limits (47CFR2.1093(d)) for the phone to receive equipment authorization. If the review is favorable, TCB enters the product into the FCC database and FCC issues a so-called "grant of equipment

authorization" within a few days. The TCB uploads supporting information to the FCC site electronically and FCC does not review the materials before the grant of equipment authorization is issued. The manufacturer pays application fees to the TCB fees but not the FCC (FCC OET 2005a, 2008g).

A path for manufacturer application directly to FCC also exists. This path involves FCC fees, FCC examiner review and FCC engineer review. If no problems or questions arise during the FCC review, the agency issues a grant of equipment authorization in about 30-45 days from when the application was received; the process may be delayed depending on potential FCC queries (FCC OET 2005a).

Over 100 FCC-recognized TCBs exist in the U.S. alone, and the number of international FCC-recognized TCBs is much greater (FCC OET 2009). While statistics specific for mobile phones' equipment authorization are not publicly available, in 2005, from over 7000 applications for radiofrequency equipment authorization, fewer than 1000 grants were authorized by the FCC and the rest of the applications were authorized by TCBs (FCC OET 2006). In 2006 and 2007, the number of TCB-authorized applications continued to rise to over 9000 in 2007, while the number of FCC-authorized applications remained around 500 (~ 5% of the total) (FCC OET 2008e). Specific statistics for cell phones are not available. However, statements from TCB suggest that majority of cell phones go through TCB certification, as illustrated by a representative quote from the website of Intertec, an accredited TCB:

"The FCC has designated Telecommunication Certification Bodies (TCB) to certify products for the FCC in a shorter timeframe, allowing manufacturers like you to get to market quicker. Intertek is a TCB and can help you with your FCC testing and certification in less than half the time it takes the FCC.... Partnering with Intertek for both FCC Testing and FCC Certification saves both time and money... We have expert TCB reviewers throughout the United States and Asia, enabling fast, simple, and convenient FCC testing and certification for manufacturers around the globe... Our reviewers have undergone detailed TCB training from the FCC, and they maintain a continuing education program with the FCC to stay abreast of any changes that may occur to any Part of the Rules. Each reviewer has had significant hands-on experience performing FCC tests and preparing their own applications to the FCC. We can issue your certification within days, not months. The FCC currently averages 35 days to issue certification. Since time-to-market is such a critical factor, that's a risk not worth taking. With TCB reviewers around the world and direct links to forms and guides to help you with the process, Intertek is the answer for quick and accurate FCC testing and certification." (Intertec 2009)

While the FCC has authority to audit any grants of equipment authorization and conduct its own verification, this happens very rarely. In 2005, FCC established an Audit and Compliance Branch within the OET Laboratory Division in order to test and evaluate various types of authorized equipment and perform TCB audits (FCC OET 2005b, c, 2008d). Initially, the Audit and Compliance branch was tasked with auditing 20% of TCB Grants; sampling and testing 2% of of the total number of products approved by TCB for a given year (FCC OET 2005b). This degree of oversight was soon found by the Commission to be insufficient and, in October 2008, FCC introduced a new set of rules for internal auditing programs that TCBs need to carry out (FCC OET 2008a). The surveillance sample amount was raised to 5% of authorized equipment, including 1% of grants for wireless devices that are subject to SAR measurements (FCC OET 2008a).

TCBs are also required to conduct post-market surveillance, auditing at least 5% of the total number of products certified by the TCB. For post-market testing, TCBs can obtain samples by requesting a grantee to submit a sample of the product certified or by purchasing a sample of the product from the marketplace. The TCB must file with the FCC an annual summary of all surveillance audits performed, and TCBs are required to notify FCC if a violation is detected (FCC OET 2008h). However, as EWG found out in a conversation with FCC Auditing and Compliance Branch on April 1, 2009, FCC does not store the audit information, and TCBs are not required to submit the actual results of their audits to FCC; in fact, auditing data are considered to be TCB's proprietary information.

Under the 47CFR rules and regulations, FCC can request a TCB to provide reports of surveillance activities carried out by the TCB or to test samples of products certified by the TCB. Occasionally, FCC conducts independent testing, usually in response to a complaint from the field. If a non-compliance or violation instance is detected, such as inappropriate radiofrequency channel use or electromagnetic interference with medical devices (FCC 2009; FCC OET 2008a, h), the FCC Enforcement Bureau (http://www.fcc.gov/eb/) has the authority to issue a wide range of sanctions (FCC OET 2008a). In a conversation with EWG on April 1, 2009, FCC officials indicated

that cell phone radiation emissions are generally not a subject of violations enforcement, since, in the opinion of FCC, these types of issues are resolved during the TCB/FCC certification process.

Section 3: Government Action on Cell Phone Radiation Levels

Worldwide, scientists, public health experts, and many government agencies are making recommendations for children to avoid using cell phones and generally for cell phone users to aim towards lower radiation exposure (Leitgeb 2008; Mead 2008). Recommendations from government agencies of several countries and international organizations are summarized below.

Country	Agency or Organization	Recommendations on restricting children's cell phone use	Headset recommendation	Other recommendations
Switzerland	Federal Office of Public Health (FOPH 2009c)	"Either keep your calls short or send a text message (SMS) instead. This advice applies especially to children and adolescents."	"Use a wireless hands-free system (headphone, headset) with a low power Bluetooth emitter to reduce radiation to the head."	"When buying a mobile phone, make sure it has a low SAR." "Whenever possible, only use your phone when the signal quality is good.""Be wary of radiation shields and other such protective devices that are claimed to limit exposure to radiation. They may reduce the connection quality and therefore force the phone to transmit at a higher output power."
Germany	Federal Office for Radiation Protection (Bundesamt fur Strahlenschutz (BfS) 2008d)	Exposure minimization for children and youngsters.	Best to use a headset instead of talking directly into the cell phone.	Use a landline telephone whenever available. Use cell phones with a low SAR value (<0.6 W/kg). Avoid making calls on a cell phone (or make shorter calls) when phone has a weak signal. Send an SMS instead of calling. (translated from German)
France	Legislation being developed by the French Senat and the Ministry of Health and Sports (Ministère de la Santé et des Sports 2009; Sénat français 2009)	Under the new legislation, "all public communication, whatever the means or support, that aim, directly or indirectly to promote sale, availability or use of cell phones by children younger than 12 years old would be prohibited. Sale or free distribution of products containing radiofrequency devices and aimed specifically for use by children younger than 6 years of age may be forbidden by order of the Health Minister, in order to limit excessive exposure of children." (translated from French)	Under the new legislation, "radiofrequency devices that would be connected to any public cell phone service provider may not be sold without an accessory device that would allow limiting head exposure to radiofrequency waves." (translated from French)	

Israel	Ministry of Health (2008)	Limiting children's use of cell phones	Use wired earpieces	Avoid cellular communication in enclosed places such as elevators and trains. (translated from Hebrew in (Azoulay 2008))
United Kingdom	Department of Health (2005)	"UK Chief Medical Officers strongly advise that where children and young people do use mobile phones, they should be encouraged to: use mobile phones for essential purposes only; keep all calls short - talking for long periods prolongs exposure and should be discouraged."		"Keep your calls short." "Consider relative SAR values when buying a new phone."
Canada	The city of Toronto's Department of Public Health (Toronto Public Health 2008a, 2008b)	"Given that cell phones are in increasingly common use by children and youth ages 10 to 19 years, it is prudent to continue to direct messages to the public so as to avoid unnecessary exposure to RFs [radiofrequencies] among young people." "While cell phones are important for communication and for safety reasons, parents should be aware of what they can do to reduce any risks from their child's use of a cell phone." "Today's children have started to use cell phones at a younger age, therefore their lifetime exposure to cell phone RFs will likely be greater. As a result, the chances that a child could develop harmful health effects from using a cell phone for a long time may be greater."	"Toronto Public Health is recommending that children, especially pre-adolescent children, use landlines whenever possible, keeping the use of cell phones for essential purposes only, limiting the length of cell phone calls and using headsets or hands-free options, whenever possible."	"Parents who buy cell phones for their children should look for ones with the lowest emissions of RF [radiofrequency] waves." "When cell phone reception is low (this happens when the base station antenna is far away) and when a cell phone is being used during high speed travel (i.e. driving in a car) power being emitted from the cell phone must be increased in order to maintain reception. Cell phone use by children should be limited during these times in order to reduce exposure to RFs."
Finland	Finnish Radiation and Nuclear Safety Authority (Säteilyturvakeskus (STUK) 2009)	"It would be good to restrict children's use of mobile phones." "Precaution is recommended for children as all of the effects are not known."	"Parents are recommended to guide their children to use a hands-free that minimises the exposure of head significantly. When using a hands-free it is recommended to keep the mobile phone at least a few centimetres away from the body."	"Parents are recommended to advice their children to use rather SMS messages than mobile phone calls." "Parents may restrict the number of their children's mobile phone calls and their duration." "STUK does not find it justifiable to totally prohibit children's use of mobile phones. Mobile phones also create safety because they make children's communication with parents easier."

Russia	Russian National Committee on Non-Ionizing Radiation Protection (2008)	"Potential risk for the children's health is very high." "The current safety standards for exposure to microwaves from the mobile phones have been developed for the adults and don't consider the characteristic features of the children's organism."		"Ultimate urgency to defend children's health from the influence of the EMF [electromagnetic fields] of the mobile communication systems."
European Parliament		"[The Parliament notes] that the limits on exposure to electromagnetic fields which have been set for the general public are obsolete. They do not take account of developments in information and communication technologies or vulnerable groups, such as pregnant women, newborn babies and children. The plenary therefore calls on the Council... to set stricter exposure limits for all equipment which emits electromagnetic waves in the frequencies between 0.1 MHz and 300 GHz" (European Parliament 2008b).	"Use of hands-free kits"	"A wide-ranging awareness campaign to familiarise young Europeans with good mobile phone techniques, such as the use of hands-free kits, keeping calls short, switching off phones when not in use (such as when in classes) and using phones in areas that have good reception" (European Parliament 2009).
United States	Food and Drug Administration (FDA) Office of Women's Health (FDA 2007)			"Cell phones should expose people to the least RF [radiofrequency radiation] possible." "People who use cell phones need to be told of any bad effects."

Recommendations from governments and international agencies

Switzerland

For personal cell phone use, the Swiss Federal Office of Public Health (FOPH) states: "The effects of radiation from mobile telephony on brain function and the occurrence of brain tumours are currently under investigation. Until such time as reliable research findings are available, it is advisable to minimize exposure of the head to radiation" (Swiss Federal Office of Public Health 2009c). Swiss FOPH advises to:

- Use a wireless hands-free system (headphone, headset) with a low power Bluetooth emitter to reduce radiation to the head.
- When buying a cell phone, make sure it has a low SAR.
- Either keep your calls short or send a text message (SMS) instead. This advice applies especially to children and adolescents.
- Whenever possible, only use your phone when the signal quality is good.
- People with active medical implants should keep their cell phone at least 30 cm away from the implant at all times.

With respect to overall exposure to cell phone radiation in the radiofrequency range in the entire Switzerland, since 1999 public exposures to emissions in 900 MHz range have been restricted to 4 V/m (6 mW/cm2), while exposures in 1800 MHz range have been restricted to 6 V/m (10 mW/cm2).

Germany
For the past several years, the German Federal Office for Radiation Protection (Bundesamt fur Strahlenschutz, BfS) has been advocating a cell phone SAR safety level of 0.6 W/kg (BfS 2008b). As part of this process, a "Blue Angel" eco-seal has been developed for low-emission cell phones (Blaue Engel 2008). In 2008, BfS estimated that approximately 30% of cell phones in the German market have emissions at or below 0.6 W/kg (BfS 2008b).

BfS recommends a precautionary approach to cell phone use for children, such as using a landline; making shorter cell phone calls; avoiding using a cell phone when the connection is weak; and, as much as possible, using a headset and substituting text messaging instead of making a call (BfS 2008d). BfS has also recommended the same precautions for adult cell phone users, additionally including a recommendation for purchasing cell phones with low SAR values (BfS 2007).

France
The French Senat is now considering legislation restricting the use of cell phones for children, including a ban on the advertising of cell phones to children under the age of 14, ban on sales of phones intended for use by children under the age of 6. The new legislation will also require all handsets to be sold with accompanying headsets (Bremner 2009; Le Monde 2009; Ministère de la Santé et des Sports 2009; Sénat français 2009).

Israel
In 2008, Israel's Ministry of Health stated that although it is still not clear whether cell-phone use is connected to an increased risk of developing cancerous growths, current research already supports a policy of "preventive caution" (Israel Ministry of Health 2008). The Ministry published a set of guidelines that called for limiting children's use of cell phones, avoiding cellular communication in enclosed places such as elevators and trains, and using wired, not wireless, earpieces (Azoulay 2008). The Ministry developed these guidelines following a national study that detected an association between cell phone use and the risk for developing tumors of the salivary gland (Sadetzki 2008; Traubmann 2007).

United Kingdom
The UK Department of Health supports "a precautionary approach" to the use of cell phones until more research findings become available. 2000 and 2005 editions of the Department of Health publication "Cell Phones and Health" stated that where children and young people do use cell phones, they should be encouraged to:

- Use cell phones for essential purposes only;
- Keep all calls short - talking for long periods prolongs exposure and should be discouraged.

The UK Chief Medical Officers recommend that if parents want to avoid their children being subject to any possible risk that might be identified in the future, the way to do so is to exercise their choice not to let their children use cell phones (UK Department of Health 2005).

The UK Department of Health further stated in its publication "Government Response to the Report from the Independent Expert Group on Cell phones (Stewart Group)": "Consumer should have access to the SAR values when considering purchasing a cell phone. The Government will expect SAR measurements to be displayed at all points of sale and with each cell phone and on the world wide web. The Government considers that the SAR value should be viewed in context, for example, by comparing the SAR value against the recommended exposure limits" (UK Department of Health 2004).

Finland
In January 2009, the Finnish government stated that children's cell phone use should be restricted, for example, by sending text messages instead of talking, making shorter calls, using a hands-free device, and avoiding the use of cell phones when connection is weak. According to the Finnish report, "although research to date, has not demonstrated health effects from cell phone's radiation, precaution is recommended for children as all of the effects are not known" (STUK (Finnish Radiation and Nuclear Safety Authority) 2009).

Regarding the current studies on cancer risk of cell phone use, Finnish government concluded that while "on the grounds of the studies to date, it is not possible to make such a conclusion that cell phones would cause a health risk... Since it takes years to develop a cancer and cell phones have been in common use only for about ten years, the possibility, that a link between cell phone use and cancer might be found in later population studies, cannot be ruled out" (STUK (Finnish Radiation and Nuclear Safety Authority) 2009).

Italy
In 2001-2003, Italy set an exposure limit of 60 V/m and a quality goal of 6 V/m for broadcast and cell phone transmitters in buildings where people work for more than four hours per day.

The European Parliament
The European Parliament resolution on the mid-term review of the European Environment and Health Action Plan 2004-2010, approved on September 4, 2008 by 522 votes to 16, recommended stricter exposure limits for cell phones and other wireless devices. The Action Plan review included a key section on wireless technology:

"[The Parliament notes] that the limits on exposure to electromagnetic fields which have been set for the general public are obsolete. They do not take account of developments in information and communication technologies or vulnerable groups, such as pregnant women, newborn babies and children. The plenary therefore calls on the Council... to take into account the Member States' best practices and thus to set stricter exposure limits for all equipment which emits electromagnetic waves in the frequencies between 0.1 MHz and 300 GHz" (European Parliament 2008b).

Article 22 of the 2008 Resolution highlights the importance of the precautionary approach supported by the European Environment Agency and promotes adoption of the stricter emission standards such as those developed in Belgium, Italy and Austria (European Parliament 2008a).

The European Parliament resolution on "Health concerns associated with electromagnetic fields" (INI/2008/2211), adopted by 559 votes to 22 on 2 April 2009, called for bringing greater transparency to the radiofrequency radiation exposure and for adoption of precautionary measures. The resolution stated:

- Wireless technology (cell phones, Wi-Fi/WiMAX, Bluetooth, DECT landline telephones) emits EMFs that may have adverse effects on human health. Most European citizens, especially young people aged from 10 to 20, use a cell phone, while there are continuing uncertainties about the possible health risks, particularly to young people whose brains are still developing.
- The scientific basis and adequacy of the EMF limits should be reviewed by the European Commission.
- As well as, or as an alternative to, amending European EMFs limits, the Commission, working in coordination with experts from Member States and the industries concerned, should draw up a guide to available technology options serving to reduce exposure to EMFs.
- EU member states should make available to the public, maps showing exposure to high-voltage power lines, radio frequencies and microwaves, and especially those generated by telecommunications masts, radio repeaters and telephone antennas. That information should be published on the internet.
- A wide-ranging awareness campaign should be initiated to familiarize young Europeans with good cell phone techniques, such as the use of hands-free kits, keeping calls short, switching off phones when not in use (such as when in classes) and using phones in areas that have good reception.

U.S. Food and Drug Administration Office of Women's Health
FDA Office of Women's Health released a publication in 2007 offering several recommendations:

- "More studies on cell phone RF [radiofrequency radiation] are needed."
- "Cell phones should expose people to the least RF possible."
- "People who use cell phones need to be told of any bad effects."

International Commission on Non-Ionizing Radiation Protection (ICNIRP) Statement on EMF Emitting New Technologies (ICNIRP 2008):

"Recent developments in telecommunication and wireless technology have led to increasing numbers of new devices and systems that emit radio frequency (RF) electromagnetic (EM) energy. Implementing these developments has resulted in large numbers of individuals at the workplace or in the general public being exposed to RF-EMFs... There are questions being posed about health effects associated with exposure to these new systems and devices, which have not been tested per se in terms of health risks. They may have signal characteristics that are unique and different from the currently used technologies, and they may also cause the total level of exposure to rise because of the superposition of electromagnetic fields (EMFs) emitted by new and existing sources."

BioInitiative Report
In 2007, the BioInitiative Working Group, an international collaborative group of radiation scientists, cancer researchers and public health policy professionals issued the "BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF [extremely low frequency electromagnetic fields] and RF [radiofrequency radiation])." The report highlighted extensive concerns about the safety of existing electromagnetic field radiation limits for power lines, cell phones, and many other sources of electromagnetic radiation exposure in daily life. The BioInitiative group urged for development of "new public safety limits and limits on further deployment of risky technologies" (BioInitiative 2007).

The Russian National Committee on Non-Ionizing Radiation Protection
According to the 2008 report from the Committee, children younger than 18 years of age may face increased health risks from cell phone radiation, since:

- Absorption of the electromagnetic energy in a child's head is considerably higher than that in the head of an adult because children's brain has higher conductivity, smaller size, thin skull bones, and due to smaller distance from the antenna;
- Child's organism is more sensitive to the EMF compared to adult's;
- Developing brain has higher sensitivity to the accumulation of the adverse effects under chronic exposure to the EMF;
- EMF affects the formation of the process of the higher nervous activity;
- Today's children will spend longer time using cell phones than today's adults.

As a result, in the opinion of the Committee, children are likely to face the following health hazards following long-term exposure: "disruption of memory, decline of attention, diminishing learning and cognitive abilities, increased irritability, sleep problems, increase in sensitivity to the stress, increased epileptic readiness" (Russian National Committee on Non-Ionizing Radiation Protection 2008).

European Environment Agency (EEA)
EEA stated that "precautionary and proportionate actions taken now to avoid plausible and potentially serious threats to health from EMF are likely to be seen as prudent and wise from future perspectives" (EEA 2007).

TCO certification program, Sweden
TCO Development, a standard-setting group owned by the Swedish Confederation of Professional Employees, develops product certifications for various types of office and electronic equipment. TCO certification program recommends a cell phone SAR value below 0.8 W/kg (TCO 2001). http://www.tcodevelopment.com/

Austrian Institute for Applied Telecommunications (Österreichische Institut für angewandte Telekommunikation (ÖIAT))
The Austrian Institute for Applied Telecommunications in co-operation with the Austrian Federal Chancellery, the Federal Ministry for Social Security, Generations and Consumer Protection, and Mobilkom Austria developed an information website, Handywissen.at, with recommendations for cell phone use. While the ÖIAT does not consider that the current state of science indicates health risks from cell phones, their website provides tips for the cell phone users such as:

- If possible, do not make phone calls when the signal quality is poor (as displayed by the number of bars on the phone). If the reception is poor, the cell phone automatically increases radiation strength to transmit the signal.

- Use hands-free equipment (headset). Regardless of whether a wired head set or Bluetooth is used - headsets reduce the radiation exposure to the head from the cell phone.
- Attention: radiation protection products (for example, a cell phone sticker) are mostly counterproductive or have no physical effect.
- Use cell phone models with a low SAR value.
- For shorter information exchange, send SMS.
- Radiation emitted by the cell phone is highest in the first moment of establishing connection. Bring the cell phone to the ear after the person on the other end of the line responds (Austrian Institute for Applied Telecommunications 2008). (translated from German)

Eurobarometer survey
In 2006-2007, the European Commission Directorate General for Health and Consumer Affairs commissioned a survey of public perception of health risks associated with electromagnetic fields. The survey found:

- Two-thirds (65%) of EU citizens are not satisfied with the information that they receive about potential health risks linked to EMF and consider available information "insufficient."
- Across the European Union, the vast majority (80%) of citizens do not feel that they adequately informed on the existing protection framework relating to potential health risks of electromagnetic fields.
- Majority (60%) of the European public does not consider public authorities to be efficient enough in protecting them from potential health risks.

Cities taking action

Toronto, Canada
In 2008, the Toronto's Department of Public Health stated: "Research on the health effects from cell phone RFs on children is very limited since the use of cell phones by young people is a relatively new trend. Scientists are not yet sure what the health effects in children are from using a cell phone. While research continues in this area, some scientists feel that children may be more susceptible to harmful effects of RFs from cell phones for several reasons:

- Pre-teen children have a smaller head and brain size, thinner skull bones, skin and ears.
- Their nerve cells also conduct energy like RFs more readily than an adult's or teenager's nerve cells.
- Children's brains and nerves are also still developing so they are likely to be more sensitive to exposures of RFs.

Today's children have started to use cell phones at a younger age, therefore their lifetime exposure to cell phone RFs will likely be greater. As a result, the chances that a child could develop harmful health effects from using a cell phone for a long time may be greater" (Toronto Public Health 2008b).

"Children, especially pre-adolescent children, use landlines whenever possible, keeping the use of cell phones for essential purposes only, limiting the length of cell phone calls and using headsets or hands-free options, whenever possible (Toronto Public Health 2008a)". "Parents who buy cell phones for their children should look for ones with the lowest emissions of RF waves... When cell phone reception is low (this happens when the base station antenna is far away) and when a cell phone is being used during high speed travel (i.e. driving in a car) power being emitted from the cell phone must be increased in order to maintain reception. Cell phone use by children should be limited during these times in order to reduce exposure to RFs" (Toronto Public Health 2008b).

Brussels, Belgium
In 2007, the Brussels Capital-Region of Belgium adopted a maximum limit for exposure to 900 MHz frequency radiation in all publicly accessible zones at 0.024 W/m2 (corresponds to electric field strength of 3 V/m), significantly lower than the FCC maximum permissible exposure (Centre Démocrate Humaniste (cdH) 2007; Parlement de la Région de Bruxelles-Capitale 2007). While the majority of GSM cell phone towers in Belgium transmit at levels below 3V/m, certain stations transmit at significantly higher levels, up to 25 V/m (Belgian Institute for Postal Services and Telecommunications 2009). Following the regional Brussels decision in 2007, the cell phone operators and the Belgian federal Health Ministry jointly challenged the 3V/m rule in court. In January 2009, the Belgian Constitutional Court ruled that individual regions of Belgium have a right to set more strict

radiation emissions standards to protect the health of their citizens (Ecolo 2009; Huytebroeck 2009a). The 3 V/m measure is set for implementation in the Brussels region from September 2009 (Huytebroeck 2009b).

Salzburg, Austria
In 2000, the city of Salzburg has adopted a "precautionary strategy" by setting the maximum exposure level for GSM (Global System for Mobile communications) cell phone base stations at 0.1 mW/cm2.

Christchurch, New Zealand
Christchurch Council in New Zealand established a public exposure limit for radiofrequency radiation at 2 mW/cm2. The standard was challenged in a lawsuit but was upheld by the judge of the South New Zealand Environment Court.

United States: The National Research Council report and research by the National Toxicology Program

In 2008, the National Research Council of the National Academies issued a report, "Identification of Research Needs Relating to Potential Biological or Adverse Health Effects of Wireless Communication". According to the report, outstanding research needs in the area of cell phone health effects include: 1) characterization of exposure to potentially vulnerable populations such as children, pregnant women and the developing fetus, and people with special sensitivities; 2) prospective epidemiological studies of childhood cancers, including brain cancer, and their potential relationship with cell phone use; 3) human laboratory studies that focus on possible adverse effects on electric potentials (brain waves) and neural networks in various parts of the brain; 4) ongoing research of potential biophysical, biochemical, and molecular mechanism of radiofrequency radiation action on living tissue; 5) dosimetry studies with different cell phones and other types of wireless devices and the SAR that they can deliver to different parts of the body (NRC 2008b). FDA has been an official partner with the National Research Council in identifying outstanding research needs in cell phone exposure and health effects research (FDA 2008b).

The National Toxicology Program, in collaboration with several academic centers across the U.S. and internationally, is now developing a large-scale, long-term series of studies to examine the health effects of cell phone radiation in experimental animals (both mice and rats) (Capstick 2008; McCormick 2008; Melnick & Portier 2005). The study partners include the IIT Research Institute (Chicago) and the Foundation for Research on Information Technologies in Society (IT'IS, Switzerland), with animal exposure system operation independently validated by U.S. National Institute of Standards and Technology (NIST, Boulder, CO).

The NTP studies will re-examine the thermal effects of radiofrequency exposure on animals, analyze the health effects of the perinatal pre-chronic exposure (scheduled for completion in 2009), and identify any chronic toxicity or oncogenicity (scheduled for completion in 2011) (McCormick 2008). The overall objective of these studies is to determine the potential toxic and/or carcinogenic effects of exposure to cellular phone radiofrequency emissions in laboratory animals. This information would then be used to determine the adequacy of current guidelines for protecting against potential adverse effects of chronic exposure (Ball 2008).

Section 4: Radiation - Bluetooth, Wired Headsets & Cordless Phones

There is a great need for publicly available information on radiation emission levels associated with cell phones. This disclosure should be done at the point of sale.

A recent market study indicated that shoppers considered the SAR value of a phone important for their safety and a key element of their purchasing decision (Wiedemann 2008). Yet, as found in a 2006 survey by the German Federal Office for Radiation Protection, only 11% of respondents considered themselves well informed on the subject of cell phone radiation (BfS 2008c).

Using a headset is one of the simple, easy steps that consumers can take to decrease their exposure to cell phone radiation. Yet, which headset to use - wired or wireless? The research below discusses the latest science on the subject.

Bluetooth radiation emissions

According to findings and recommendations by government agencies and researchers in different countries, the use of Bluetooth headsets with cell phones decreases the overall levels of SAR exposure to the head (American Cancer Society 2008; BfS 2005; Martinez-Burdalo 2009; Swiss Federal Office of Public Health 2009a).

Bluetooth wireless technology is found in a diverse range of devices, such as cell phone headsets, car speakerphones and other automotive equipment, GPS, gaming equipment, computer accessories such as printers, keyboards, and mice, PDAs (personal digital assistants), personal media players, and medical, health, and wellness devices (CNET Reviews 2009; ICNIRP 2008; Morrow 2002). Bluetooth wireless technology allows radiofrequency devices to form connections for communicating one-on-one or for creating a personal wireless network within an approximately 30-feet-radius sphere. Bluetooth devices are used in a growing number of commercial and personal applications; the Bluetooth Specialist Interest Group, an industry trade association, lists over 6000 products that utilize Bluetooth technology (Bluetooth Special Interest Group 2009).

Bluetooth transmitters operate at frequency around 2.4 GHz. Bluetooth devices are assigned to one of three power classes: 1, 2 and 3. Class 2 transmitters – most commonly found in mobile devices – have a range of 30 feet (10 meters) and operate at 2.5 mW peak transmission power; class 3 devices are weaker than class 2, operating at peak transmission power of 1 mW in a range of less than 10 meters. Class 1 transmitters are the most powerful, with a range of 300 feet and peak transmission power of 100 mW. Class 1 Bluetooth devices can cause exposure to radiation similar to that emitted by a cell phone if they are operated in the immediate vicinity of the body. Bluetooth devices are designed to limit the radiation power exactly to that actually required. When the receiving device indicates that it is a few meters away, the transmitter immediately modifies its signal strength to suit the exact range, which reduces the total emitted radiation and signal interference (IT'IS 2005).
A study commissioned by the Swiss Federal Office of Public Health (FOPH) measured SAR for several Bluetooth devices, including two different class 3 hands-free cell phone headsets. The headsets tested had SAR values of 0.001 and 0.003 W/kg, which is 34 and 12 times lower than the SAR of the lowest-emission cell phone currently available (Swiss Federal Office of Public Health 2009a).

Of note, while the Bluetooth headset reduces radiation exposure to the head, transmission strength from the phone itself is not decreased. Bluetooth headset users frequently keep their phone in a pocket or clipped to the belt, a position that leads to radiation exposure of internal organs (Whittow 2008). As stated on the FCC website, "if the phone is mounted against the waist or other part of the body during use, then that part of the body will absorb RF energy" (FCC 2008). While the health effects of this exposure have not yet been assessed, the Swiss FOPH recommended that "cell phones should not be carried in a front trouser pocket when making calls" and that it may be safest "to hold the phone away from the body to reduce radiation exposure" (Swiss Federal Office of Public Health 2009a). Furthermore, a study from the Loughborough University (U.K.) reported that realistic everyday metallic objects found near the waistline, including a coin, a ring and a zipper increased the SAR in the body at different frequencies (Whittow 2008).

In the U.S., FCC certification of Bluetooth devices does not require measuring and reporting the SAR values. Bluetooth technology falls under the list of "low-power, non-licensed radiofrequency devices" that are classified in 47CFR Part 15 (FCC 1993, 2002). According to the FCC regulations, these unlicensed devices need to comply with the maxiumum permissible exposure limit. As stated by FCC:

"The FCC typically does not require RF exposure test data to be submitted with a filing to demonstrate compliance. Sometimes, applicants may choose to include such test data to expedite a filing. However, sufficient information should be included to satisfy the requirements of Section 15.247(b)(4), typically specific operating and installation instructions/requirements, warning/caution instructions and/or labels when applicable. If compliance cannot be ensured or determined based on the supporting information, (the operating configurations and exposure conditions of the host and final products that would operate with the Bluetooth transmitter module.) SAR or MPE evaluation may be requested as required by Section 1.1307(d)." (FCC 2007)

Wired (corded) hands-free headsets — radiation emissions

The use of corded earpieces/headsets is listed by the American Cancer Society as one of the easy ways to decrease SAR exposure to the head and brain during a cell phone conversation (American Cancer Society 2008).

With a corded headset, the voice signal is sent electronically to the earpiece directly from the phone in a similar manner as when standard headphones are plugged into a radio or a music player (Network & Academic Computing Services of University of California Irvine 2008). Depending on the position of a wired headset cable along the body, a certain proportion of the phone output radiofrequency radiation can be transmitted along the cable and elicit measurable SAR values in the torso and the head of the user (Kuhn 2008).
In the U.S., wired headsets are not regulated and their SAR values are generally not publicly available (Carnoy 2000). Several studies examined the issue of corded headsets safety, the potential for the headset/headset wire to act as a secondary antenna, and the effects of headset wire on radiation exposure to the torso (Carnoy 2000). One conclusion is clear: radiation exposure to the head is reduced with the use of a cordless headset, according to studies from the School of Electrical & Electronic Engineering at the Queen's University of Belfast (Troulis 2003) and the University of York Department of Electronics reached similar conclusions (Porter 2004) and Motorola (Bit-Babik 2003).

The Motorola study reported that, with a headset, SAR in the head is 8 times lower than when making calls holding the phone to the ear (Bit-Babik 2003). While this is a significant decrease, some degree of radiation exposure to the head occurs nevertheless (Bit-Babik 2003), which stands in contrast to statements from wired headset manufacturers that "SAR readings at the head are virtually zero when a corded mobile headset is used" (Plantronics 2005).

Unlike the earlier publications, a 2008 study carried out in the framework of the German research program on mobile telephones found that under a worst-case scenario for use of a GSM 1800 cell phone there was an increase in the SAR value in the inner ear (Kuhn 2008). It is possible that SAR exposure to the head when using a wired headset may be dependent on the cell phone transmission frequency and the type of transmission system, although researchers concluded that when a headset is used the overall exposure in the region of the head is reduced (Kuhn 2008).

Importantly, using a corded headset does not decrease the radiation output of the cell phone, which becomes absorbed into the torso instead of the head (FCC 2008). The Troulis (2003) study reported that for a waist-mounted cell phone, absorption of radiation by the body reduces the phone's efficiency, thus increasing the required output power level. In this study, the peak 1 g SAR value was 0.450 W/kg for the phone itself, and with the hands-free wire connected, SAR increased to 1.14 W/kg. For a phone worn near the waist, this increased radiation would be absorbed into the body.

Scientific consensus has not yet been reached on whether corded or wireless headsets provide best radiation protection to the head and sensitive internal organs. Headset use has been recommended by government agencies in several countries as a way to reduce radiation exposure to the head (Switzerland, Germany, France, Israel, Austria, and the city of Toronto). According to the Swiss government, "As the brain is a sensitive organ, it is

wise to use a hands-free kit (headset), since this reduces exposure of the head to radiation" (Swiss Federal Office of Public Health 2009a). Yet, which one is best?

Israel's Ministry of Health urges cell phone users to rely on a wired, not wireless headset; the Swiss government recommends a wireless hands-free system (headphone or a headset) with a low power Bluetooth emitter; the Austrian government recommends using either a wired or a wireless headset; the German Federal Office for Radiation Protection and the city of Toronto's department of Public Health simply recommend the use of headsets without stating which one is preferable. The UK Department of Health stated in a 2005 publication that the level of effectiveness of hands-free kits to reduce SAR is still uncertain (UK Department of Health 2005). Recent publication from the Swiss Foundation for Research on Information Technologies in Society (IT'IS) recommended for manufacturers to conduct tests of wired headsets' SAR values to ensure that the phone-to-headset cable does not transmit radiofreqequency radiation towards the head and to the torso (Kuhn 2008).

While research on safer wireless technology is ongoing, one conclusion is clear: whether using either corded or Bluetooth headsets, it is reasonable to choose a phone with the lowest SAR value and to keep the cell phone away from the body during use.

Other common sources of radiofrequency radiation exposure

In addition to exposures from cell phones and Bluetooth devices, people are exposed to EMF radiation from a wide range of wireless devices at home and in the workplace, such as cordless home phones, baby monitors, and Wireless Local Area Networks (WLAN) (Frei 2009; Hillert 2006). Scientists at the Foundation for Research on Information Technologies in Society (IT'IS, Switzerland) reported an SAR value of 0.077 W/kg for baby monitor; 0.055 W/kg for cordless phone, and 0.81 W/kg for WLAN (IT'IS 2005). Additionally, IT'IS found that a class 1 Bluetooth USB plug-in antenna had an SAR of 0.466 W/kg, while a class 2 Bluetooth USB plug-in antenna had an SAR value of 0.0092 W/kg (Swiss Federal Office of Public Health 2009a). While research on this question is only beginning, a recent study from Spain suggested that cell phone exposures constitute the majority of radiofrequency exposure for an individual person, significantly exceeding exposure due to other wireless devices such as Bluetooth or WLAN (Martinez-Burdalo 2009).

Several studies on the association between cell phone use and cancer have raised question about the potential health impact of radiofrequency radiation from cordless home phones which is the same type of radiation as that emitted by cell phones (Hardell, Carlberg 2006b; Hardell 2003; Mild 2007). A recently published study from Switzerland found that people who owned either a cordless phone or a mobile phone received more exposure to radio frequency radiation than those not owning either type of phone (Frei 2009).

While the cordless phone handset emits radiation only during a call (same as a cell phone), radiation emission from the cordless phone base station are continuous even when no calls are made (BfS 2008a). The German Federal Office of Radiation Protection recently issued a new requirement for cordless home phone models whereby base stations must be automatically switched off when not in use or when in standby mode (BfS 2008a). The Swiss government recommended keeping cordless phone base units away from relaxation places or work stations occupied for long periods as well as using a corded phone or a headset instead of a standard cordless phone (Swiss Federal Office of Public Health 2009b).

In the U.S., the types of cordless phones and the radiofrequency range they use have changed over the years. In early 1980s, cordless phones operated with frequency of 27 MHz (Phone Warehouse 2000). In late 1980s, FCC changed the cordless phone frequency band to 47-49 MHz (Code of Federal Regulations Chapter 47, section 15.233), followed by cordless phones that operated in 900 MHz range (cell phone frequency), 2.4 GHz (frequency band also used by Bluetooth and wireless LANs) and 5.8 GHz (Pedro 2006; teqFAQ 2009). The range of a cordless phone increased with each subsequent generation; 900 MHz phones have a range of 200 to 1500 feet, while 2.4 GHz and 5.8 GHz have a range of 300 to 2000 feet (Hanks 2004). New technologies such as DECT (Digital Enhanced Cordless Telecommunications) operate in 1900 MHz (cell phone) range (Rhein Tech 2006).

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) recently recommended that public officials setting standards for EMF radiation exposure need to consider simultaneous exposure to radiation from multiple devices, such as cell phone, cordless home phone, Bluetooth, and WLAN, needs (ICNIRP 2008).

Similarly, the Swiss and German governments have recommended precaution with respect to increasing exposure to radiofrequency devices (BfS 2008a). The Swiss government stated that "caution should be exercised primarily when using devices held close to the body, such as laptops, PDAs and Internet telephones" (Swiss Federal Office of Public Health 2009d). Clearly, this question needs to be resolved with a nation-wide study of the total EMF exposure people face on a daily basis.

Rapid growth in cell phone technology

Cell phone technology is constantly developing. Currently, GSM (Global System for Mobile Communication) is a standard protocol for digital mobile communication used for phone calls and transmission of text messages. Cell phones are also used for sending data or surfing the Internet. GPRS (General Packet Radio System) and Edge (Enhanced Data Rate for Global Evolution) are further developments of GSM that can transfer data at higher rates (sometimes called 2.5 Generation systems). The new (third) generation in mobile telecommunications includes W-CDMA (Code Division Multiple Access) and UMTS (Universal Mobile Telecommunication System), which have higher data transfer rate than GSM and are better suited to data and multimedia services while providing same level of cell phone and text messaging service. It is expected that in the near future, 3G technology will supersede the GSM standard (ICNIRP 2008; Swiss Federal Office of Public Health 2009c).

GSM protocol operates at frequencies of 900 and 1800 MHz; 900 MHz protocol has a peak output power of 2000 mW and maximum output power of 240 mW. 1800 MHz protocol operates with a peak output power of 1000 mW and maximum output power of 120 mW. 3G UMTS protocol operates at transmission frequency 2100 MHz, with both peak and maximum output power in the range of 125-250 mW.

References

60 Minutes (Australia). 2009. Wake Up Call. Available: http://sixtyminutes.ninemsn.com.au/article.aspx?id=797215 [accessed June 3 2009].

Agarwal A, Desai NR, Makker K, Varghese A, Mouradi R, Sabanegh E, et al. 2009. Effects of radiofrequency electromagnetic waves (RF-EMW) from cellular phones on human ejaculated semen: an in vitro pilot study. Fertil Steril: in press.

Ahlbom A, Green A, Kheifets L, Savitz D, Swerdlow A. 2004. Epidemiology of health effects of radiofrequency exposure. Environ Health Perspect 112(17): 1741-54.

Ahlbom A, Feychting M, Green A, Kheifets L, Savitz D, Swerdlow A, et al. 2009. Epidemiologic Evidence on Mobile Phones and Tumor Risk. Epidemiology 20(5): 1-14.

Aly AA, Cheema MI, Tambawala M, Laterza R, Zhou E, Rathnabharathi K, et al. 2008. Effects of 900-MHz Radio Frequencies on the Chemotaxis of Human Neutrophils in Vitro. IEEE Transactions on Biomedical Engineering 55(2): 795-97.

American Cancer Society. 2002. Cellular Phones. Available: http://web.archive.org/web/20021107183749/http://www.cancer.org/docroot/PED/content/PED_1_3X_Cellular_Phones.asp [accessed June 2 2009].

American Cancer Society. 2008. Cellular Phones. Available: http://www.cancer.org/docroot/PED/content/PED_1_3X_Cellular_Phones.asp [accessed June 2 2009].

ANSI. 1982. American National Standard Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300 kHz to 100 GHz, ANSI C95.1-1982, American National Standards Institute, New York, NY.

Austrian Institute for Applied Telecommunications. 2008. Handywissen. Available: http://handywissen.at [accessed August 27 2009].

Azoulay Y, Rinat Z. 2008. Health Ministry calls for parents to limit kids' use of cell phones. Available: http://www.haaretz.com/hasen/spages/1006175.html [accessed March 27 2009].

Ball E. 2008. Environmental Factor: Your Online Source for NIEHS News. January 2008. NTP Board of Scientific Counselors Meets. Available: http://www.niehs.nih.gov/news/newsletter/2008/january/ntpboard.cfm [accessed March 11 2009].

Belgian Institute for Postal Services and Telecommunications. 2009. Belgisch Instituut voor postdiensten en telecommunicatie. GSM measurements: summary. Available: http://www.bipt.be/ShowContent.aspx?levelID=357&objectID=1264 =nl&forLang=en [accessed March 13 2009].

BfS. 2005. German Federal Office for Radiation Protection (Bundesamt fur Strahlenschutz, BfS) Moderne Kommunikationstechnologien - Bluetooth und WLAN Available: http://www.bfs.de/de/bfs/druck/infoblatt/Bluetooth_WLAN.html [accessed June 8 2009].

BfS. 2007. Recommendations of the Federal Office for Radiation Protection for mobile phone use. Available: http://web.archive.org/web/20071108231613/http://www.bfs.de/elektro/papiere/empfehlungen_handy.html [accessed March 29 2009].

BfS. 2008a. German Federal Office for Radiation Protection (Bundesamt fur Strahlenschutz, BfS) Cordless phones with low EMF radiation levels. Available: http://www.bfs.de/en/elektro/Strahlungsarme_Dect_Schnurlostelefone.html [accessed March 29 2009].

BfS. 2008b. German Federal Office for Radiation Protection (Bundesamt fur Strahlenschutz, BfS) Radiation Protection Criteria for Mobile Phone Ecolabel. Available: http://www.bfs.de/en/elektro/oekolabel.html [accessed March 27 2009].

BfS. 2008c. German Federal Office for Radiation Protection (Bundesamt fur Strahlenschutz, BfS). Results of the Representative Survey of the Year 2006 Relating to the Perception of Mobile Telecommunication and Comparative. Results of the Years 2003 to 2006. Available: http://www.bfs.de/en/elektro/papiere/Umfragen_Mobilfunk_2003_bis_2006 [accessed March 27 2009].

BfS. 2008d. German Federal Office for Radiation Protection (Bundesamt fur Strahlenschutz, BfS). Special Mobile Phones for Children are not Appropriate. Available: http://www.bfs.de/en/elektro/papiere/bfs_handy_kind.html [accessed March 27 2009].

BioInitiative. 2007. BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF). Available: http://www.bioinitiative.org/report/index.htm [accessed January 27, 2009].

Bit-Babik G, Chou CK, Faraone A, Gessner A, Kanda M, Balzano Q. 2003. Estimation of the SAR in the Human Head and Body due to Radiofrequency Radiation Exposure from Handheld Mobile Phones with Hands-Free Accessories. Radiat Res 159(4): 550-57.

Blaue Engel. 2008. The Blue Angel (Der Blaue Engel). RAL German Institute for Quality Assurance and Certification. Basic Criteria for Award of the Environmental Label. Mobile Phones RAL-UZ 106. Available: http://www.blauer-engel.de/en/products_brands/vergabegrundlage.php?id=89 [accessed December 8 2008].

Blackman C. 2009. Cell phone radiation: Evidence from ELF and RF studies supporting more inclusive risk identification and assessment. Pathophysiology 16(2-3): 205-16.

Bluetooth Special Interest Group. 2009. Available: http://www.bluetooth.com [accessed March 29 2009].

Bondy ML, Scheurer ME, Malmer B, Barnholtz-Sloan JS, Davis FG, Il'yasova D, et al. 2008. Brain tumor epidemiology: consensus from the Brain Tumor Epidemiology Consortium. Cancer 113(7 Suppl): 1953-68.

Boutros T, Chevet E, Metrakos P. 2008. Mitogen-activated protein (MAP) kinase/MAP kinase phosphatase regulation: roles in cell growth, death, and cancer. Pharmacol Rev 60(3): 261-310.

Bremner C. 2009. Mobile phones to be banned in French primary schools to limit health risks. Available: http://www.timesonline.co.uk/tol/news/world/europe/article6366590.ece [accessed June 8 2009].

Cahill DF. 1983. A suggested limit for population exposure to radiofrequency radiation. Health Phys 45(1): 109-26.

Capstick M, Kuster N, Kühn S, Berdinas-Torres V, Ladbury J, Koepke G, et al. 2008. A Radio Frequency Radiation Reverberation Chamber Exposure System for Rodents. Presentation A07.4. In: URSI General Assembly (Union Radio-Scientifique Internationale) http://wwweceuicedu/2008ursiga/. Chicago [accessed March 11, 2009 at ursi-test.intec.ugent.be/files/URSIGA08/papers/A07p4.pdf].

Cardis E, Deltour I, Mann S, Moissonnier M, Taki M, Varsier N, et al. 2008. Distribution of RF energy emitted by mobile phones in anatomical structures of the brain. Phys Med Biol 53(11): 2771-83.

Cardis E, Kilkenny M. 1999. International Case-Control Study of Adult Brain, Head and Neck Tumours: Results of the Feasibility Study. Radiat Protect Dosim 83: 179-83.

Cardis E, Richardson L, Deltour I, Armstrong B, Feychting M, Johansen C, et al. 2007. The INTERPHONE study: design, epidemiological methods, and description of the study population. Eur J Epidemiol 22(9): 647-64.

Carnoy D. 2000. Are Cell Phone Headsets Safe? CNET wireless (November 15, 2000).

Centre Démocrate Humaniste (cdH). 2007. Une législation environnementale en Région bruxelloise pour les technologies de communication sans fil. Available: http://www.andredubus.be/files/Broch_GSM_BD.pdf [accessed March 13, 2009].

Christensen HC, Schuz J, Kosteljanetz M, Poulsen HS, Boice JD, Jr., McLaughlin JK, et al. 2005. Cellular telephones and risk for brain tumors: a population-based, incident case-control study. Neurology 64(7): 1189-95.

Christensen HC, Schuz J, Kosteljanetz M, Poulsen HS, Thomsen J, Johansen C. 2004. Cellular telephone use and risk of acoustic neuroma. Am J Epidemiol 159(3): 277-83.

CNET Reviews. 2009. Bluetooth headset buying guide. Available: http://reviews.cnet.com/bluetooth-headset-buying-guide/ [accessed May 19 2009].

Conil E, Hadjem A, Lacroux F, Wong MF, Wiart J. 2008. Variability analysis of SAR from 20 MHz to 2.4 GHz for different adult and child models using finite-difference time-domain. Phys Med Biol 53(6): 1511-25.

Croft RJ, McKenzie RJ, Inyang I, Benke GP, Anderson V, Abramson MJ. 2008. Mobile phones and brain tumours: a review of epidemiological research. Australas Phys Eng Sci Med 31(4): 255-67.

CTIA. 2008. CTIA – The Wireless Association® Releases Latest Wireless Industry Survey Results. Press release September 10, 2008. Available: http://www.ctia.org/media/press/body.cfm/prid/1772 [accessed June 3 2009].

CTIA. 2009. CTIA – The Wireless Association® Announces Semi-Annual Wireless Industry Survey Results. Press release April 1, 2009. Available: http://www.ctia.org/media/press/body.cfm/prid/1811 [accessed June 3 2009].

De Iuliis GN, Newey RJ, King BV, Aitken RJ. 2009. Mobile phone radiation induces reactive oxygen species production and DNA damage in human spermatozoa in vitro. PLoS One 4(7): e6446.

de Salles AA, Bulla G, Rodriguez CE. 2006. Electromagnetic absorption in the head of adults and children due to mobile phone operation close to the head. Electromagn Biol Med 25(4): 349-60.

Divan HA, Kheifets L, Obel C, Olsen J. 2008. Prenatal and postnatal exposure to cell phone use and behavioral problems in children. Epidemiology 19(4): 523-9.

Ecolo. 2009. L'ordonnance "antennes GSM" reçoit le feu VERT de la Cour constitutionnelle. Available: http://bruxelles.regionale.ecolo.be/spip.php?article112 [accessed March 13 2009].

Economist. 2008. Mobile madness. Available: http://www.economist.com/science/displaystory.cfm?story_id=12295222 [accessed May 19 2009].

EEA. 2007. European Environment Agency. Radiation risk from everyday devices assessed. Available: http://www.eea.europa.eu/highlights/radiation-risk-from-everyday-devices-assessed [accessed March 29 2009].

Erogul O, Oztas E, Yildirim I, Kir T, Aydur E, Komesli G, et al. 2006. Effects of electromagnetic radiation from a cellular phone on human sperm motility: an in vitro study. Arch Med Res 37(7): 840-3.

European Parliament. 2008a. European Parliament resolution of 4 September 2008 on the mid-term review of the European Environment and Health Action Plan 2004-2010 (2007/2252(INI)). Available: http://www.europarl.europa.eu/sides/getDoc.do?type=TA&language=EN&reference=P6-TA-2008-0410 [accessed March 13 2009].

European Parliament. 2008b. European Parliament. The Legislative Observatory. Mid-term review of the European Environment and Health Action Plan 2004-2010 (2007/2252(INI)). Available: http://www.europarl.europa.eu/oeil/FindByProcnum.do?lang=en&procnum=INI/2007/2252 [accessed March 29 2009].

European Parliament. 2009. Health concerns associated with electromagnetic fields. Non-legislative resolution INI/2008/2211 Available: http://www.europarl.europa.eu/oeil/FindByProcnum.do?lang=en&procnum=INI/2008/2211 [accessed May 22 2009].

FCC. 1993. OET Bulletin 63: Understanding The FCC Part 15 Regulations for Low Power, Non-Licensed Transmitters. Available: http://www.fcc.gov/oet/info/documents/bulletins/ [accessed May 19, 2003].

FCC. 1997. Federal Communications Commission Office of Engineering & Technology. Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields. OET Bulletin 65 Edition 97-01 Available: http://www.fcc.gov/oet/rfsafety/ [accessed December 10 2008].

FCC. 1999. Federal Communications Commission Office of Engineering & Technology. Questions and Answers about Biological Effects and Potential Hazards of Radiofrequency Electromagnetic Fields. OET Bulletin 56 Fourth Edition. August 1999. Available: http://www.fcc.gov/oet/rfsafety/ [accessed December 10 2008].

FCC. 2000. ET Docket 93-62 Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation Available: http://www.fcc.gov/oet/dockets/et93-62/ [accessed June 12 2009].

FCC. 2002. Federal Communications Commission Spectrum Policy Task Force Report of the Unlicensed Devices and Experimental Licenses Working Group. Available: www.fcc.gov/sptf/files/E&UWGFinalReport.pdf [accessed May 19, 2009].

FCC. 2004. Brief for Respondents in the United States Court of Appeals for the District of Columbia Circuit 03–1336. EMR Network, Petitioner, v. Federal Communications Commission and United States of America, Respondents on Petition for Review of an Order of the Federal Communications Commission. Available: www.fcc.gov/ogc/briefs/03-1336_041204.pdf

FCC. 2007. Office of Engineering Technology (OET) Knowledge Database. Publication Number: 767150. RF exposure for Bluetooth Modules, Personal Digital Assistant (PDA) Available: http://fjallfoss.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?id=20467&switch=P [accessed.

FCC. 2008. Radio Frequency Safety. Available: http://www.fcc.gov/oet/rfsafety/rf-faqs.html [accessed January 28 2009].

FCC. 2009. FCC Enforcement Bureau. Available: http://www.fcc.gov/eb/ [accessed March 10 2009].

FCC OET. 2005a. Introduction to FCC Rules and Equipment Authorization Program. October 2005 TCB Workshop (presentation by George Tannahill, Technical Research Branch). Available: http://www.fcc.gov/oet/ea/presentations/presentations_tcb_2005.html#secOct05 [accessed March 10, 2009].

FCC OET. 2005b. TCB Training. TCB Workshop - May 2005 (presentation by Raymond LaForge, Chief, Audits and Compliance Branch). Available: http://www.fcc.gov/oet/ea/presentations/files/may05/TCB_Audits_RL.pdf [accessed March 10, 2009].

FCC OET. 2005c. Technical Problems with TCB Filings. February 2005 TCB workshop (presentation by Rich Fabina, Chief, Equipment Authorization Branch). Available: http://www.fcc.gov/oet/ea/presentations/presentations_tcb_2005.html?feb05#secFeb05 [accessed March 10, 2009].

FCC OET. 2006. Equipment Authorization Issues Roundtable Discussions. February 2006 TCB Workshop (presentation by Rashmi Doshi, Chief, Laboratory Division). . Available: http://www.fcc.gov/oet/ea/presentations/presentations_tcb_2006.html?feb06#secFeb06 [accessed March 10, 2009].

FCC OET. 2008a. Audit and Compliance Issues. October 2008 TCB workshop. Available: http://www.fcc.gov/oet/ea/presentations/presentations_tcb_2008.html?oct08#secOct08 [accessed march 10, 2009].

FCC OET. 2008b. Discussions on SAR Measurement Issues. FCC/OET Laboratory Division October 2008 TCB Workshop. Available: http://www.fcc.gov/oet/ea/presentations/presentations_tcb_2008.html?oct08#secOct08 [accessed 2009 March 10].

FCC OET. 2008c. FCC Office of Engineering and Technology (OET) Equipment Authorization. Authorization procedures. Available: http://www.fcc.gov/oet/ea/procedures.html [accessed March 10 2009].

FCC OET. 2008d. FCC Office of Engineering and Technology (OET) Office Functions. Laboratory Division. Auditing and Compliance Branch. Available: http://www.fcc.gov/oet/function/#sec11 [accessed March 10 2009].

FCC OET. 2008e. FCC Presentations. TCB Workshop - Feb 2008 [accessed March 10, 2009 at http://www.fcc.gov/oet/ea/presentations/presentations_tcb_2008.html?feb08#secFeb08].

FCC OET. 2008f. Federal Communications Commission Office of Engineering and Technology Laboratory Division. Telecommunications Certification Bodies - Roles and Responsibilities. Available: www.fcc.gov/oet/ea/FCC-Overview-TCB-Program.pdf [accessed March 10, 2009].

FCC OET. 2008g. Steps for Submittal of Application for Equipment Authorization FCC Form 731. Available: http://www.fcc.gov/oet/ea/ea_app_info.html [accessed March 11 2009].

FCC OET. 2008h. TCB Post-Market Surveillance. KDB publication 610077 10/31/2008. Available: https://fjallfoss.fcc.gov/oetcf/kdb/forms/FTSSearchResultPage.cfm?id=20540&switch=P [accessed March 10, 2009].

FCC OET. 2009. Telecommunications Certification Bodies (TCB) Search. Available: https://fjallfoss.fcc.gov/oetcf/tcb/reports/TCBSearch.cfm [accessed March 11 2009].

FDA. 2003. Cell Phone Facts. Consumer Information on Wireless Phones. Questions & Answers. Available: http://web.archive.org/web/20031205121949/www.fda.gov/cellphones/qa.html [accessed June 10 2009].

FDA. 2008a. Cell Phones. Available: http://www.fda.gov/cellphones/ [accessed January 28 2009].

FDA. 2008b. Cell Phones Cooperative Research and Development Agreement (CRADA). Available: http://www.fda.gov/cdrh/wireless/research-crada.html [accessed January 28 2009].

FDA. 2009. Cell Phones. Available: http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/HomeBusinessandEntertainment/CellPhones/default.htm [accessed June 2 2009].

Fejes I, Zavaczki Z, Szollosi J, Koloszar S, Daru J, Kovacs L, et al. 2005. Is there a relationship between cell phone use and semen quality? Arch Androl 51(5): 385-93.

Freeman J. 1999. Don't get fooled again. USA Today August 9, 1999.

Frei P, Mohler E, Neubauer G, Theis G, Burgi A, Frohlich J, et al. 2009. Temporal and spatial variability of personal exposure to radio frequency electromagnetic fields. Environ Res 109(6): 779-85.

Gabriel C. 2005. Dielectric properties of biological tissue: variation with age. Bioelectromagnetics Suppl 7: S12-8.

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

Gandhi OP, Lazzi G, Furse CM. 1996. Electromagnetic absorption in the human head and neck for mobile telephones at 835 and 1900 MHz. IEEE Transactions on Microwave Theory and Techniques 44(10): 1884 - 97.

GAO. 1978. Efforts By The Environmental Protection Agency To Protect The Public From Environmental Nonionizing Radiation Exposures CED-78-79 March 29, 1978. Available: http://www.gao.gov/products/CED-78-79 [accessed June 12, 2009].

GAO. 1994. United States General Accounting Office. Status of Research on the Safety of Cellular Telephones. GAO/RCED-95-32. Available: www.gao.gov/archive/1995/rc95032.pdf [accessed June 8, 2009].

GAO. 2001. United States General Accounting Office. Research and Regulatory Efforts on Mobile Phone Health Issues. GAO-01-545. Available: www.gao.gov/new.items/d01545.pdf [accessed December 10 2008].

Guney M, Ozguner F, Oral B, Karahan N, Mungan T. 2007. 900 MHz radiofrequency-induced histopathologic changes and oxidative stress in rat endometrium: protection by vitamins E and C. Toxicol Ind Health 23(7): 411-20.

Hammett WF. 1997. Radio Frequency Radiation: Issues & Standards. New York, NY: McGraw-Hill.

Hanks J. 2004. NEW 5.8 GHz cordless phones: are they better than 2.4 GHz? Available: http://telecom.hellodirect.com/docs/Tutorials/5.8GHzFrequency.1.031903.asp [accessed August 25 2009].

Hardell L, Carlberg M, Hansson Mild K. 2005. Use of cellular telephones and brain tumour risk in urban and rural areas. Occup Environ Med 62(6): 390-4.

Hardell L, Carlberg M, Hansson Mild K. 2006a. Pooled analysis of two case-control studies on the use of cellular and cordless telephones and the risk of benign brain tumours diagnosed during 1997-2003. Int J Oncol 28(2): 509-18.

Hardell L, Carlberg M, Hansson Mild K. 2006b. Pooled analysis of two case-control studies on use of cellular and cordless telephones and the risk for malignant brain tumours diagnosed in 1997-2003. Int Arch Occup Environ Health 79(8): 630-9.

Hardell L, Carlberg M, Hansson Mild K. 2009. Epidemiological evidence for an association between use of wireless phones and tumor diseases. Pathophysiology: in press.

Hardell L, Hansson Mild K. 2006. Mobile phone use and risk of acoustic neuroma: results of the interphone case-control study in five North European countries. Br J Cancer 94(9): 1348-9; author reply 52-3.

Hardell L, Mild KH, Carlberg M. 2003. Further aspects on cellular and cordless telephones and brain tumours. Int J Oncol 22(2): 399-407.

Hepworth SJ, Schoemaker MJ, Muir KR, Swerdlow AJ, van Tongeren MJ, McKinney PA. 2006. Mobile phone use and risk of glioma in adults: case-control study. Bmj 332(7546): 883-7.

Herberman RB. 2008. Statement of Ronald B. Herberman, MD, Director, University of Pittsburgh Cancer Institute and UPMC Cancer Centers to Domestic Policy Subcommittee, Oversight and Government Reform Committee Thursday, September 25, 2008 "Tumors and Cell Phone use: What the Science Says" Available: http://domesticpolicy.oversight.house.gov/story.asp?ID=2199 [accessed June 2, 2009].

Heynick LN, Merritt JH. 2003. Radiofrequency fields and teratogenesis. Bioelectromagnetics Suppl 6: S174-86.

Hillert L, Ahlbom A, Neasham D, Feychting M, Jarup L, Navin R, et al. 2006. Call-related factors influencing output power from mobile phones. J Expo Sci Environ Epidemiol 16(6): 507-14.

Hirata A, Kodera S, Wang J, Fujiwara O. 2007. Dominant factors influencing whole-body average SAR due to far-field exposure in whole-body resonance frequency and GHz regions. Bioelectromagnetics 28(6): 484-7.

Hitchcock T, Patterson RM. 1995. Radio-Frequency and ELF Electromagnetic Energies: A Handbook for Health Professionals. New York, NY: John Wiley.

Hoover RN. 2008. Statement for the Record for the Subcommittee on Domestic Policy Committee on Oversight and Government Reform United States House of Representatives "Tumors and Cell Phone Use: What the Science Says." September 25, 2008. Statement of Robert N. Hoover, M.D., Sc.D., Director, Epidemiology and Biostatistics Program, National Cancer Institute, National Institutes of Health, U.S. Department of Health and Human Services Available: legislative.cancer.gov/files/hearing-2008-9-25.pdf [accessed June 2, 2009].

Hours M, Bernard M, Montestrucq L, Arslan M, Bergeret A, Deltour I, et al. 2007. [Cell Phones and Risk of brain and acoustic nerve tumours: the French INTERPHONE case-control study]. Rev Epidemiol Sante Publique 55(5): 321-32.

Huss A, Egger M, Hug K, Huwiler-Muntener K, Roosli M. 2007. Source of funding and results of studies of health effects of mobile phone use: systematic review of experimental studies. Environ Health Perspect 115(1): 1-4.

Huss A, Egger M, Hug K, Huwiler-Muntener K, Roosli M, Gomes D, et al. 2008. Source of funding and results of studies of health effects of mobile phone use: systematic review of experimental studies. Cien Saude Colet 13(3): 1005-12.

Huss A, Spoerri A, Egger M, Roosli M. 2009. Residence near power lines and mortality from neurodegenerative diseases: longitudinal study of the Swiss population. Am J Epidemiol 169(2): 167-75.

Huytebroeck E. 2009a. Antennes GSM : l'arrêt de la Cour constitutionnelle est un progrès important pour la santé et la qualité de vie des Bruxellois. Available: http://evelyne.huytebroeck.be/spip.php?page=article&id_article=556 [accessed March 13 2009].

Huytebroeck E. 2009b. Les opérateurs de téléphonie mobile et la Région bruxelloise conviennent d'un calendrier de mise en oeuvre des 3v/mètre à Bruxelles. Available: http://evelyne.huytebroeck.be/spip.php?page=article2&id_article=588 [accessed March 13 2009].

IARC. 2008. International Agency for Research on Cancer. INTERPHONE study results latest update - 8 October 2008. Available: http://www.iarc.fr/en/research-groups/RAD/current-topics.php [accessed June 8, 2009].

IARC. 2009a. Status of the INTERPHONE Study 28/05/2009. Joint IARC, CREAL and UICC statement. Available: http://www.iarc.fr/en/media-centre/iarcnews/2009/interphone_status.php [accessed June 8 2009].

IARC. 2009b. The INTERPHONE Study. Available: http://www.iarc.fr/en/research-groups/RAD/RCAd.html [accessed May 20 2009].

ICNIRP. 1998. International Commission on Non-Ionizing Radiation Protection Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz). Health Phys 74(4): 494-522.

ICNIRP. 2008. International Commission on Non-Ionizing Radiation Protection Statement on EMF Emitting New Technologies. Health Phys 94(4): 376-92.

IEC. 2005. Procedure to measure the specific absorption rate (SAR) for hand-held mobile wireless devices in the frequency range of 300 MHz to 3 GHz. International Electrotechnical Commission (IEC), IEC 62209-1 Standard.

IEEE. 2006. IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. New York, NY: IEEE International Committee on Electromagnetic Safety (SCC39).

IEEE ICES. 2002. Approved Minutes 4th SC4 Revision Working Group Meeting. Motorola Research Labs, 8000 W Sunrise Boulevard Ft Lauderdale, FL 33322. January 10-11, 2002 Available: grouper.ieee.org/groups/scc28/sc4/sc-4%204th%20rwg%20minutes-january%202002.pdf [accessed April 20, 2009].

Independent Expert Group on Mobile Phones (IEGMP). 2000. Mobile Phones and Health (The Stewart Report). Available: http://www.iegmp.org.uk/report/index.htm [accessed January 27 2009].

Inskip PD, Tarone RE, Hatch EE, Wilcosky TC, Shapiro WR, Selker RG, et al. 2001. Cellular-telephone use and brain tumors. N Engl J Med 344(2): 79-86.

Intertec. 2009. TCB Testing & Certification. Available: http://www.intertek-etlsemko.com/portal/page/cust_portal/ITK_PGR/SELECT_YOUR_IND_PG/TELECOM_RADIO_EQUIPMENT_PG/TERMINAL_EQUIP_PG/FCC_CERT_PG/TCB_PG [accessed March 11 2009].

Irmak MK, Fadillioglu E, Gulec M, Erdogan H, Yagmurca M, Akyol O. 2002. Effects of electromagnetic radiation from a cellular telephone on the oxidant and antioxidant levels in rabbits. Cell Biochem Funct 20(4): 279-83.

Israel Ministry of Health. 2008. Mobile Phone Public Information. Available: http://www.health.gov.il/pages/default.asp?PageId=4408&catId=838&maincat=46 [accessed March 27 2009].

IT'IS, Kramer A, Kuhn S, Lott U, Kuster N. 2005. Foundation for Research on Information Technologies in Society (IT'IS) report. Development of Procedures for the Assessment of Human Exposure to EMF from Wireless Devices in Home and Office Environments. Available. http://www.bag.admin.ch/themen/strahlung/00053/00673/03571/index.html?lang=en [accessed March 29].

ITU. 2009. International Telecommunications Union. Measuring the Information Society: The ICT Development Index. Available: http://www itu.int/ITU-D/ict/publications/idi/2009/index.html [accessed March 19, 2009].

Kallen B, Malmquist G, Moritz U. 1982. Delivery outcome among physiotherapists in Sweden: is non-ionizing radiation a fetal hazard? Arch Environ Health 37(2): 81-5.

Kang G, Gandhi OP. 2002. SARs for pocket-mounted mobile telephones at 835 and 1900 MHz. Phys Med Biol 47(23): 4301-13.

Karinen A, Heinavaara S, Nylund R, Leszczynski D. 2008. Mobile phone radiation might alter protein expression in human skin. BMC Genomics 9: 77.

Keshvari J, Keshvari R, Lang S. 2006. The effect of increase in dielectric values on specific absorption rate (SAR) in eye and head tissues following 900, 1800 and 2450 MHz radio frequency (RF) exposure. Phys Med Biol 51(6): 1463-77.

Kheifets L, Repacholi M, Saunders R, van Deventer E. 2005. The sensitivity of children to electromagnetic fields. Pediatrics 116(2): e303-13.

Khurana VG, Teo C, Bittar RG. 2009. Health risks of cell phone technology. Surg Neurol: in press.

Klaeboe L, Blaasaas KG, Tynes T. 2007. Use of mobile phones in Norway and risk of intracranial tumours. Eur J Cancer Prev 16(2): 158-64.

Knapp J. 2008. Written Statement of Julius P. Knapp, Chief, Office of Engineering and Technology, Federal Communications Commission Before the Committee on Oversight and Government Reform Subcommittee on Domestic Policy, U.S. House of Representatives "Tumors and Cell Phone Use: What the Science Says." September 25, 2008. Available: http://domesticpolicy.oversight.house.gov/story.asp?ID=2199 [accessed June 2, 2009].

Krewski D, Byus CV, Glickman BW, Lotz WG, Mandeville R, McBride ML, et al. 2001. Recent advances in research on radiofrequency fields and health. J Toxicol Environ Health B Crit Rev 4(1): 145-59.

Krewski D, Glickman BW, Habash RW, Habbick B, Lotz WG, Mandeville R, et al. 2007. Recent advances in research on radiofrequency fields and health: 2001-2003. J Toxicol Environ Health B Crit Rev 10(4): 287-318.

Kuhn S, Cabot E, Christ A, Capstick M, Leubler C, Kuster N, et al. 2008. Regulation of SAR values by the use of headsets for mobile radio telephones [in German] (Bestimmung von SAR-Werten bei der Verwendung von Headsets für Mobilfunktelefone). A project of the Foundation for Research on Information Technologies in Society (IT'IS), Switzerland. Available: http://www.emf-forschungsprogramm.de/akt_emf_forschung.html/dosi_HF_002.html [accessed May 19 2009].