Guidelines for Cell Phone Use

Documents provided by Environmental Health Trust

Ellen Marks
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Mixed Signals---The Good & Bad News

What Industry Wants You to Think and the Truth

Berkeley City Council Workshop Session
8 November 2011

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Cellphone Use Is Causing Cancer

The Good News

Used Differently Cellphones Can Be "Safe Enough"

The Bad News

Cellphone Use Is Causing Cancer

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Topics

• Electromagnetic Fields (EMFs) basics
  – EMF Spectrum
    • Ionizing Radiation (IR) & Non-Ionizing radiation (NIR)
      – “Distance Is Your Friend”

• Human studies
  – Seven cancers
  – Higher risks in children
  – Damaged sperm

• Animal studies (in-vivo)
  – DNA damage
  – Blood-Brain Barrier (BBB) leakage
  – Sperm damage

• Cell studies (in-vitro)
  – Genotoxic effect (damaged DNA)
    • Varies by type of cellphone microwave radiation
Topics

• Breaking News
EMF Spectrum

Courtesy of Dr. Devra Davis
Ionizing Radiation (IR) & Non-Ionizing radiation (NIR)

- IR has sufficient energy to *directly* break chemical bonds (e.g., mutate DNA)
  - IR has been called the *universal carcinogen*
- NIR does not have energy to *directly* break DNA bonds
  - However, it can *indirectly* mutate DNA bonds
    - NIR creates free radicals & increases lifetime
    - Weak hydrogen bonds at certain DNA locations
    - Increased rates of chemical reactions
    - Resonance

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Example of NIR Causing Cancer

Exposure to ultraviolet radiation (UVR) both
UVA and UVB are carcinogenic

UVA is non-ionizing radiation
UVA mutates skin DNA

Because of a quantum mechanical resonance between
broken base-pairs and the frequency of UVA

A "Wiki" source for clinical oncology
http://uwlclinicaloncology2010.wikispaces.com/Melanoma

Because of NIR

• UVA is non-ionizing radiation

Dr. Douglas Brash, Yale Medical School
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Distance Is Your Friend

The Inverse Square Law

– If cell phone is 1/16 inch from your head, then
  • At 1 inch, the absorbed radiation decreases by 256
    – $16^2 = 256$
  • At 4 inches, the absorbed radiation decreases by 4,096
    – $16^2 \times 4^2 = 4,096$
  • At 8 inches, the absorbed radiation decreases by 16,384
    – $16^2 \times 4^2 \times 2^2 = 16,384$
Human Studies
Cancer Risk: What the science says

• Studies have found risk of cancers from long-term cellphone use:
  – Glioma (brain cancer)
    • Cellphones & cordless phone
  – Acoustic neuroma (tumor on acoustic nerve)
    • Cellphones & cordless phones
  – Meningioma (tumor of the meninges)
    • Cellphones & cordless phones
  – Salivary gland cancer (parotid gland in cheek)
  – Eye cancer
  – Testicular cancer
  – Leukemia
Risk of cancer on side where cellphone is used

- **Brain cancer**
  - First use as teenager or younger, 680% risk [1]
  - Children have much higher risk than adults
  - First use between 20 & 49 years, 150% risk [1]

- **Acoustic Neuroma (brain tumor of acoustic nerve)**
  - Use for >10 years, 290% risk [2*]
  - >122 hours per year, 1-5 years prior to diagnosis, 208% risk [3]
  - 70% risk [4]

- **Meningioma (brain tumor of meninges)**
  - 40% risk [4]
  - >1,640 cumulative hours of use, 96% risk [5*]

- **Salivary (parotid) gland**
  - >10 years, 160% risk [6*]
  - >10 years, 89% risk [7*]

- **Testes**
  - 80% risk [8]

* Industry funding

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Salivary Gland Cancers: Since 2002
Tripled in Israel, 20% under age 20

Slide courtesy of Dr. Devra Davis

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Cancer Risk: Cumulative Hours of Use

• Brain cancer
  – >2,000 hours, 5-10 years use, 540% risk [9]
  – >1,640 hours, 82% risk [5*]
  – For every 100 hours of use, risk is increased by 4% [9]

• Acoustic neuroma
  – >1,000 hours, 210% risk [4]
  – For every 100 hours of use, risk in increased by 6% [9]

• Meningioma
  – >1,640 hours, 1-4 years use, 308% risk [5*]

* Industry funding
Cancer Risk: >10 Years of Use

• Brain cancer
  – 218% risk [5*]
    • When compared to 1 to 1.9 years of cellphone use
  – 160% risk [10]
  – High-grade cancer (III-IV), 120% risk [9]

• Acoustic Neuroma
  – 80% risk [9]
  – 210% risk [2*]
  – >15 years, 280% risk [4]

• Meningioma
  – 60% risk [4]
  – 1 to 1,000 cumulative hours, 90% risk [4]

* Industry funding
Other Risks

• Eye cancer (uveal melanoma)
  – “probable/certain exposure to mobile phones”, 320% risk [11]

• Leukemia
  – Exclusive use of GSM cellphone, 200% risk [12]
  – >15 years of use, 108% risk [13]

• Human sperm
  – Decreased sperm count, motility, viability, and normal morphology [14]
  – Decreased motility (how fast they swim) [15]

• Children absorb more cellphone radiation than adults [16*]

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Damaged Human Sperm

• Dose-response
  – Increased hours of cellphone use lowers sperm count [18]
    • Surviving sperm are highly damaged

• Keeping cellphone pants pocket: risk of testicular cancer [8]
  – 80% increase risk, left pocket-left testicle; right pocket-right testicle
Animal Studies
Damaged DNA

• Two hour cellphone exposure [17-20]
  – 38-75% of FCC exposure limit

• Four, 6 & 24 hour exposures [21]
  – 75%-125% of FCC exposure limit
    • 125% is 100% of European exposure limit

• Two hours/day for 120, 150 and 200 days
  – Rearrangements of DNA segments in testes [22]
    • 100% of FCC exposure limit

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Damaged Sperm

- Six hours/day over 18 weeks, abnormal clumping of sperm cells [23]
- “This study suggests …a significant genotoxic effect on epididymal spermatozoa is evident” [24]
- Sperm head abnormalities in mice [25]

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Blood-BRAIN Barrier (BBB) Leakage

• BBB protects mammalian brains from neurotoxins normally in the blood from entering the brain (e.g. albumin)
  – Cellphone radiation found BBB leakage in rats resulting in dead neurons at 0.75% of FCC exposure limit [26]
  – 2 hour exposure created BBB leakage with neuronal damage in rat brains [27]
    • As low as 2.5% of FCC exposure limit
  – Exposed rats had impaired memory, compared to sham exposed controls [28]
    • As low as 0.6% of FCC exposure limit
Cell Studies, Human
Genotoxic Studies

• Human fibroblast cells exposed to G2 cellphone radiation found the detection threshold for genetic damage at 19% of the FCC exposure limit [29]
  – For G2 or 2\textsuperscript{nd} generation GSM cellphones

• Human fibroblast cells exposed to G3 cellphone radiation found the detection threshold for genetic damage at 3% of the FCC exposure limit [30]
  – For G3, or 3\textsuperscript{rd} generation, or “smart phone” UMTS cellphones

• Three days after 1 hour exposure
  – DNA repair was reduced. Size of the effects depended on frequency and whether it was GSM or UMTS radiation [31]
With Human Studies
& Animal Studies
& Human Cell Studies

Beyond A Reasonable Doubt
Cellphones Are Causing Cancer

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Breaking News

• Published Monday, 17 October 2011
  – Exposure Limits: The underestimation of absorbed cell phone radiation, especially in children
    • Cellphones are certified to meet FCC exposure limits
      – Two FCC approved process
        One industry design (exclusively used)
        » Other uses MRI scans of “Virtual Family”
    • As commonly used, all cellphone violate limits
      – Children receive more than double exposure

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FCC Approved Cellphone Certification Process #1

- Industry-design process
  - Exclusive used
    - Pour liquid into mannequin
    - Add liquid
    - Robotic arm inside head measures absorbed radiation
    - Phone is certified to meet exposure limit
  - Smaller heads will absorb more radiation
    - Children absorb double the radiation
FCC Approved Cellphone Certification Process #2

• Used by the FDA
  – FDA has responsibility for cellphone safety, not FCC
• Computer simulation process using MRI scans
  – Uses “Virtual Family” members
    • Children and pregnant women
  – Can be use for vulnerable tissue (eyes, testis)
  – 1,000-fold better resolution
  – Less expensive
References:


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References:


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Thank You
This paper describes how cellphones are certified to meet the Federal Communications Commission’s (FCC) exposure limit for the maximum amount of microwave cellphone radiation that will be absorbed in the head or other parts of the body of a cellphone user. The only trouble is that the *industry-designed* certification process so under-estimates the actual absorption of cellphone radiation that *all* cellphone users who keep their cellphone in their pockets absorb cellphone radiation above the FCC exposure limit. Further, even if not kept in pockets, when held next to the head, 97% of the population will exceed the certified level of absorbed radiation, and even more so for children who will absorb more than two times the certified cellphone radiation.

That’s the bad news. The good news is that this paper describes an alternative FCC approved process already used extensively within the Food and Drug Administration (FDA). The alternative process uses MRI-scans of a set of real human beings to determine the amount of radiation absorbed in every tissue. It is called, the “Virtual Family” and includes a 5-year old girl, a 6-year old boy, an 8-year old girl, an 11-year old girl, a 14-year old boy, a 26-year old female, a 35-year old male, an obese male adult and 3 pregnant women at 3rd, 7th and 9th months of gestation, allowing for appropriate cellphone certifications for the most vulnerable cellphone users.

In contrast, the existing cellphone certification process uses a plastic mannequin head, SAM, of a very large man with a liquid inside the mannequin which assumes all tissues in the head are identical. A robot positions a sensor within the liquid and calculates the maximum Specific Absorption Rate (SAR) with a tolerance of +30%. The FCC exposure limit is SAR=1.6 Watts per kilogram of tissue (1.6 W/kg). Because of the wide tolerance range, SAR values can be as large as 2.08 W/kg, 30% higher than FCC exposure limit.
The paper provides a history of how exposure limits have been developed over several decades and continues with an exposition of chronic cellphone health effects (humans, animals and human cells) reported in science papers. It then describes the two FCC-approved processes for cellphone certification: the existing cellphone process (exclusively used) and the MRI-based computer simulation process (never used for certification). Next it compares the efficacy of the two processes.

The paper explains in detail that the existing exposure limit process is so far from the original intent that we can only wonder what happened! Here are some examples:

- The intent of the ANSI standard was to protect everyone, “from small infant to large adult,” but the FCC exposure limit only protects large adult males.
- There has been no change in the standard since 1991. Sadly, the 1991 standard allowed for a 5-fold higher exposure for workers “as a concomitant of [their] employment,” while pretending to increase the “safety” factor for the general public. However, this change allowed for the general public to be exposed 5-times longer than workers, thus nullifying any difference between workers and the general public.
- The original intent of the exposure limit was to protect those with “greater sensitivity (infants, the aged, the ill, and disabled), [from] greater exposures (24 hr/day vs. 8 hr/day . . . [and] voluntary vs. involuntary exposures.” Today, this is totally ignored. Everyone is exposed involuntarily 24/7, including infants and even fetuses in the womb.
- The current cellphone certification process was designed by industry. A single cellphone is brought to a certification facility with no knowledge how this particular cellphone was chosen (randomly, or selected from many because its radiation levels were lower). Though millions of “certified” cellphones may be sold, no further testing is ever done! Is this enforcement of the regulation, or is it turning a blind eye to enforcement?
- In those countries that use the ICNIRP exposure guidelines, there is no oversight to protect the citizens whatsoever. For example, the UK’s Health Protection Agency makes this very clear when it states, “There is no explicit UK legislation that limits people’s exposure.”
- It is clear that sperm is being damaged by cellphones when men keep cellphones in trouser pockets, but no warnings have been given to the public about this quite common practice.
- The higher risk to children is clear: Children absorb twice that cellphone radiation to the heads, up to triple in the their brain’s hippocampus and hypothalamus, greater absorption in their eyes, and as much as 10-times more in their bone marrow when compared to adults.

The paper concludes:

- Because the SAM-based cellphone certification process substantially underestimates the SAR for 97% of the population, especially for children, the SAM-based certification process should be discontinued forthwith.
- An alternative FDTD computer simulation cellphone certification process is immediately available and provides 3-orders of magnitude higher resolution than the SAM-based system for the head.
- The anatomically based “Virtual Family” includes sensitive groups such as small children, pregnant women and the fetus.
- Advisories found in cellphone manuals violate the FCC compliance guidelines, because they do not take into account customary use of phones in pockets and held directly next to the head.
- The SAM-based cellphone certification process is unable to address exposure to sensitive tissues such as the testes or the eyes, while the FDTD method can address exposures to such sensitive tissues.
● Because billions of young children and adults with heads smaller than SAM are now using cellphones extensively, and because they absorb proportionally greater cellphone radiation, it is essential and urgent that governments around the world revise approaches to setting standards for cellphone radiation, to include sufficient protection of children.

● Cellphones for which SAR values were certified prior to June 2001 were not required to be replicatable between different certification facilities, and therefore a cellphone’s certified SAR level cannot be trusted if certified prior to June 2001.

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1. Johnny says:
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   Ever since, all of us in this world has noted the dangers of cell phone dangers, all of us should stay united with one voice propose to Federal Communications Commission’s further enhance the safety of the peoples and upgrade the whole system.

   Thank you prevention is better that cure.

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NON-THERMAL EFFECTS AND MECHANISMS OF INTERACTION BETWEEN ELECTROMAGNETIC FIELDS AND LIVING MATTER

An ICEMS Monograph

RAMAZZINI INSTITUTE

Edited by
Livio Giuliani and Morando Soffritti

European Journal of Oncology

National Institute for the Study and Control of Cancer and Environmental Diseases “Bernardino Ramazzini”
Bologna, Italy
2010
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Comparative assessment of models of electromagnetic absorption of the head for children and adults indicates the need for policy changes

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Abstract

Globally more than four billion phones are in use, with more than half of all users believed to be children and young adults. Over the past two decades, models of the human head have been devised based on imaging studies and used to estimate the extent and rate of radiation energy absorption to the brain, the Specific Absorption Rate (SAR). IEEE and ICNIRP SAR recommendations rest solely on avoiding thermal effects on the adult male head under conditions of a six minute long call and do not take into account the long-term cell phone use, the length of calls, non-thermal biological effects, the smaller size and greater physiological vulnerability and increased absorption to the heads of children and females. Currently recommended approaches by the IEEE calculate peak spatial average SAR for safety compliance testing of cell phones based on a physical model of an adult male head with an added 10 mm plastic spacer to model the ear (pinna). By incorporating such a spacer, the IEEE model assumes that the RF energy absorption in the ear (or pinna) may be treated like extremities of the body such as the legs and the arms that are not proximate to the brain. The 10 mm spacer artificially results in 2 to 4 times lower exposures to the head. Recent epidemiologic studies of adults from those few nations where cell phone use has been extensive for a decade or longer indicate significantly increased risk of a variety of brain tumors. These findings, together with the limitations of currently used head models and the growing use of phones by the young and females, indicate a clear and compelling need for improved, biologically-based...
models of the head in order to better estimate population-wide exposures of children and women to cell phones and provide the grounds for improved policies to reduce those exposures.

Key Words: health effects, mobile phones, Specific Absorption Rate (SAR), children and adults, radio frequency radiation, brain and cell phone.

Introduction

Cell phone use has grown exponentially throughout the world in less than a decade. More than half of the world’s population uses cell phones today as telephones as well as clocks, radio, video, and tools for exchanging information. Current technology of 2G and 3G phones operates in the microwave range, from 800 to 2450 megahertz (MHz). Standards for these phones rest on guidance developed by two non-governmental engineering-based groups, the Institute of Electrical and Electronics Engineers (IEEE) and International Commission on Non-Ionizing Radiation Protection (ICNIRP)\(^1,2\). For compliance with IEEE and ICNIRP exposure limits, the quantification of exposure to the head, the 1 or 10 gram (g) Specific Absorption Rates (SAR), is based on a physical model of an adult male head with a 10 mm spacer at the ear, or pinna, to estimate radiofrequency (RF) thermal energy absorption that can take place in the course of a call with no accounting for the duration of the call assuming that it will not result in change in temperature of the brain. In the U.S., Canada, and most industrial nations, there is no independent review of these standards, monitoring of the cell phone manufacturers for compliance with these standards, or monitoring of cell phone use in real life.

A growing number of in vitro and in vivo studies have confirmed that both 2G and 3G signals at non-thermal levels are genotoxic\(^3,4\). Potential mechanisms of such impact include changes in free-radical formation, alterations in electron conformation, and inhibition of proteins and other factors involved in DNA repair and synthesis. While molecular mechanisms for possible adverse effects have not been completely elucidated, energy absorption of higher frequency signals emitted by recently developed 3G, or even the new generation 4G cell phones, may result in greater biological effects. Based on these considerations, a growing number of national governmental agencies have issued precautionary advisories, urging that children avoid regular use cell phones next to their heads, restricting the marketing and development of cell phones for children, and recommending general methods for reducing direct exposure to the head of adults\(^5\).

To complement such general precautions, this paper briefly reviews the underlying engineering and biology of RF signals associated with different generations of phones, synthesizes evolving evidence on the health effects of RF, clarifies and considers the strengths and limits of currently used models of the head used for testing phones, and summarizes efforts to promote precaution regarding the use of phones.

The changing nature of RF cell signals

Over the past four decades, cell phone types and uses have radically changed. The first generation, known as 1G, was a bulky cell phone introduced in the 1980s based on analog modulation with output power typically around 2 to 3 Watts (W). Examples of these systems are the Advanced Mobile Phone System (AMPS) in North America, Asia
Pacific, Russia, Africa and Israel in the frequency band between 800 and 900 MHz, and the Nordic Mobile Telephone (NMT) 900 system since 1986 in Scandinavia, Netherlands, Switzerland and Asia. The RF from 1G phone was presumed to produce mainly thermal effects, with any potential risks resulting from heating of the tissues.

The advanced generations of cell phones, namely 2G and 3G, employ higher data rates and a broader range of multimedia services and were launched in 1991 and 2001. Unlike 1G cell phones, the maximum radiated power was now controlled by the base station (cell tower or mast). The base station reduced the power emitted by 2G and 3G cellphones to a level that produces a good signal to noise ratio (SNR). These phones rely on digital modulation with mean (rms) output power typically around 250 or 125 mW (maximum 1-2W). Typical examples of these systems are: the North American Digital Cellular (NADC) system (824-894 MHz) since 1991 in USA; the Personal Communication Services (PCS) system (1850-1990 MHz) since 1996 in USA; the Global System for Mobile Communications (GSM) system (880-960 MHz) since 1991 in Europe and Asia Pacific; and the Digital Cellular System (DCS) 1800 (1710-1880 MHz) employed since 1993 in Europe. The modulation signals used in these digital systems are complex with the lowest rate of 217 Hz (e.g., GSM is encoded at 217 pulses/sec). This lower rate was reported to result in greater interaction with the biological tissues, inducing non-thermal effects and increased risks to living cells, even at low absorbed average powers. Current 3G and 4G phones involve modulation with even lower minimum pulse rates and much higher data rates. As a result, 3G phones can result in greater cumulative average exposures, a result of the higher data rates.

Most contemporary cell phones use monopole or helix type antennas, which produce similar radiation patterns. The radiation pattern determines how the energy is distributed in the space. This can be represented by two planes that are orthogonal to each other, one is the electric field, the other is the magnetic field. When a monopole or helix antenna rests in a vertical direction and is unimpeded by any RF absorbing obstacle like the human head or body, it produces a nearly symmetrical pattern of RF around this antenna. In actual use about one half of the RF energy radiated by a cell phone is absorbed by the human head. The closer the cell phone is to the head the greater is the absorbed energy in the head tissues.

**Biologic effects of non-ionizing radiation**

Ionizing radiation (IR) is well known to have potent biological effects that break chemical bonds creating ions. This breakage of bonds results in diseases ranging from cancer to developmental and reproductive impairment, to death. These biological impacts arises because 15% of the IR directly breaks ionic bonds at the backbone of DNA causing mutations that can lead to cancer; 85% of IR damage is caused by the creation of free radicals in the cell’s cytoplasm near the DNA molecule, also resulting in DNA mutations, or through other mechanisms that are still being elucidated.

Non-ionizing radiation (NIR), found at all frequencies with energy levels too low to break chemical bonds from low-frequency electric power systems to microwave (MW) frequencies used by cell phones also produces biological effects when studied in cell cultures and in experimental animals. At low levels, equivalent to exposure from radiation from mobile phones, RF has been shown to result in damage to biological tissues, including both single and double DNA strand breaks, alterations in the permeability of
the blood-brain barrier (BBB), oxidative stress, and damage to neural cells of the brain\^8,9.

Two mechanisms have been identified thus far to explain the variety of non-ionizing electromagnetic fields (EMFs) interactions with biological systems: thermal effects and non-thermal effects. Thermal effects arise directly from the increased movement of molecules results in tissue heating as a result of the absorption of EMFs in a dissipative medium. Absorption of energy at MW/RF frequencies is largely due to the motion of water dipoles and dissolved ions. At high frequencies (such as for the MW/RF band), tissues with high water content, such as occurs in the brains of young children, show electrical conductivity increasing with frequency. Thus, the net thermal response of the body will vary depending on SAR, ambient temperature, clothing, thermoregulatory system and physiological condition.

Non-thermal effects can result from direct interaction of the MW/RF fields on molecules or tissue components, changing electron conformation, altering stress proteins (previously known as heat shock proteins), immune-system function and having other impacts that remain to be clarified. Non-thermal effects are still not very well understood and their exact consequences on human health are still being investigated. Some reported non-thermal effects on tissue are biochemical and electrophysiological effects and can result in changes in the nervous, immune and cardiovascular systems, as well as in metabolism and hereditary factors\^4,10,11.

In a pioneering research effort that created the widely used Comet Assay, Lai and Singh demonstrated that two hours of microwave radiation, comparable to that emitted by a cell phone, damaged DNA of the rat brain\^12. A European study team of a dozen collaborators under the aegis of REFLEX [Risk Evaluation of Potential Environmental Hazards from Low Energy Electromagnetic Field (EMF) Exposure Using Sensitive in vitro Methods], found evidence that low (non-thermal) energy levels of RF exposure induced double strand breaks in DNA of cells exposed to between 0.3 and 2 W/kg\^13. Although the mechanism(s) underlying such non-thermal effects of NIR remains unclear, it seems quite plausible, as with the cancer-promoting effects of inflammatory lesions, that mutagenic damage to DNA could be induced by generated free radicals. In contrast, many other studies of non-thermal or thermal effects of RF issue have yielded no evidence of DNA damage. But, the great preponderance of these negative studies have not reflected independent research but resulted from studies directly funded by the cell phone industry\^14.

Current SAR calculations rest solely on avoiding thermal impacts. In principle, as the newer generation of digital phones radiate lower mean power in comparison to the analogue phones, the risk associated with the heating of tissues should be correspondingly reduced. However, most mobile communication systems are pulse-like in nature and modulated at low frequencies with high data rates. As a result, these newer systems can induce low-levels of currents in the brain tissues that have been linked with a variety of non- or thermal effects, e.g., BBB alterations, single and double strand DNA breaks, chromosomal aberrations, etc., at RF energy levels substantially below the thermal threshold.

Despite the growing industry-independent evidence that NIR has a range of biological impacts, intense controversy surrounds the interpretation of the limited available public health investigations regarding risk for cancer or other chronic diseases. Human studies on both cancer and non-cancer impacts of NIR are inconsistent for reasons that have been thoroughly discussed by a number of authors\^15.
Epidemiologic studies

The biology and epidemiology of the often lethal cancer of the brain is complex. It is unreasonable to expect to be able to detect an increased risk of brain tumors in less than a decade, because brain tumors are known to have latencies that can be between a decade to four decades long. Recently several authors have produced meta-analyses that show that only when studies have followed people for a decade is there evidence of increased risk (Table 1).

For more than a decade, Hardell and his colleagues conducted a series of studies in Sweden, a country where proportionally more of the population has heavily used cell phones for a longer period of time than in many other industrialized nations. Regarding acoustic neuroma (AN), the Swedish group reported an 2.7 to 5.1 fold increased risk of AN for those regularly using an analog cell phone for five years or more compared to those who never or rarely used a cell phone. Hardell’s team also found long-term analogue cell phone use significantly increased the risks of meningioma and astrocytoma. Recently, Hardell and Carlberg found that persons who had used cell phones for 10 years or more also had the highest risk for astrocytoma. This study also included persons who had begun to use cell phones before age 20. Cases with first mobile phone use younger than 20 years age had five times more brain cancer for 1 or more years of use (OR=5.2, 95% CI=2.2-12). For AN, the highest risk was found for greater than 10 years of ipsilateral mobile phone use (OR=3.0, 95% CI=1.4-6.2).

The International Agency for Research on Cancer (IARC) began an international collaborative case-control study on cell phone use and the incidence of brain tumors in 13 countries in 1997 (the INTERPHONE study). Among six INTERPHONE reports from different countries, which included persons who had used phones episodically for less than a decade, none reported a relationship between cell phone use and AN. They did not report any significant relationship between long term cell phone use and glioma, meningioma or other brain tumors. However, the recently published Interphone study found that the heaviest cell phone users, cumulative call time ≥ 1640 hours have increased risk of glioma (OR=1.40, 95% CI=1.03-1.89) and meningioma (OR=1.15, 95% CI=0.81-1.62). Brain tumor risk was not found to be higher among those who use cell phone less frequently.

The lack of an observed association between published studies of cell phone use and risk for malignant or benign tumors in other published studies could reflect a number of methodological limits of study design. Most of these negative studies involved relatively short time periods of cell phone use, infrequent use of cell phones, or a small number of cases. In an effort to refine evaluation of the issue, studies have been carried out that separate out extent and type of cell phone use, including side of the head on which phones are typically used. The Hardell group found a consistent pattern of an association between ipsilateral AN and cell phone use providing that there was a 10-year latency period or longer (OR=2.4, 95% CI = 1.1-5.3). Two additional studies from other investigators in the Nordic region produced similar results. A study used interphone protocol that pooled data from 5 North European countries similarly found an increased glioma risk after a decade of use for ipsilateral cell phone exposure (OR=1.4, 95% CI=1.0-1.9). A significant excess risk for reported ipsilateral phone use to the tumor was also found for glioma regardless of the duration of cell phone use.

A recent meta-analysis of studies produced by a team from California and Korea has corroborated this analysis, noting that the Hardell’s work consistently reflects high
Table 1 - Summary of published articles on brain tumors and long term (≥ 10 years) cell phone use

<table>
<thead>
<tr>
<th>Study Population</th>
<th>Period</th>
<th>Study type</th>
<th>No. cases</th>
<th>No. controls</th>
<th>OR (95% CI)</th>
<th>Cell phone exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Acoustic Neuroma</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardell et al., 2002&lt;sup&gt;17&lt;/sup&gt;</td>
<td>Sweden 2000-2002</td>
<td>Case-control</td>
<td>46</td>
<td>26</td>
<td>1.8 (1.1-2.9)</td>
<td>regular analogue phone use</td>
</tr>
<tr>
<td>Christensen et al., 2004&lt;sup&gt;18&lt;/sup&gt;</td>
<td>Denmark 2000-2002</td>
<td>Case-control</td>
<td>2</td>
<td>15</td>
<td>0.2 (0.04-1.1)</td>
<td>regular use</td>
</tr>
<tr>
<td>Lönn et al., 2004&lt;sup&gt;19&lt;/sup&gt;</td>
<td>Sweden 1999-2002</td>
<td>Case-control</td>
<td>14</td>
<td>29</td>
<td>1.8 (0.8-4.3)</td>
<td>regular use</td>
</tr>
<tr>
<td>Schoemaker et al., 2005&lt;sup&gt;20&lt;/sup&gt;</td>
<td>4 Nordic countries and UK 1999-2004</td>
<td>Case-control</td>
<td>47</td>
<td>212</td>
<td>1.1 (0.7-1.5)</td>
<td>regular use</td>
</tr>
<tr>
<td>Schüz et al., 2006&lt;sup&gt;21&lt;/sup&gt;</td>
<td>Denmark 1982-2002</td>
<td>Cohort</td>
<td>28</td>
<td>42.5</td>
<td>0.7 (0.4-1.0)*</td>
<td>regular use</td>
</tr>
<tr>
<td>Hardell et al., 2006&lt;sup&gt;22&lt;/sup&gt;</td>
<td>Sweden 1997-2003</td>
<td>Pooled case-control</td>
<td>19</td>
<td>84</td>
<td>2.2 (1.4-3.8)</td>
<td>regular analogue phone use</td>
</tr>
<tr>
<td>Hardell et al., 2008&lt;sup&gt;23&lt;/sup&gt;</td>
<td>Sweden</td>
<td>Meta-analysis</td>
<td>83</td>
<td>355</td>
<td>1.3 (0.6-2.8)**</td>
<td>regular use</td>
</tr>
<tr>
<td><strong>Glioma</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Christensen et al., 2005&lt;sup&gt;24&lt;/sup&gt;</td>
<td>Denmark 2000-2002</td>
<td>Case-control</td>
<td>6****</td>
<td>9</td>
<td>1.6 (1.4-6.1)</td>
<td>regular use</td>
</tr>
<tr>
<td>Lönn et al., 2005&lt;sup&gt;25&lt;/sup&gt;</td>
<td>Sweden 2000-2002</td>
<td>Case-control</td>
<td>22</td>
<td>33</td>
<td>0.9 (0.5-1.6)</td>
<td>regular use</td>
</tr>
<tr>
<td>Hepworth et al., 2006&lt;sup&gt;26&lt;/sup&gt;</td>
<td>UK 2000-2003</td>
<td>Case-control</td>
<td>48</td>
<td>67</td>
<td>1.1 (0.7-1.7)</td>
<td>regular use</td>
</tr>
<tr>
<td>Schüz et al., 2006&lt;sup&gt;27&lt;/sup&gt;</td>
<td>Germany 2000-2003</td>
<td>Case-control</td>
<td>12</td>
<td>11</td>
<td>2.2 (0.9-5.1)</td>
<td>regular use</td>
</tr>
<tr>
<td>Lahkola et al., 2008&lt;sup&gt;28&lt;/sup&gt;</td>
<td>5 European countries</td>
<td>Case-control</td>
<td>143</td>
<td>220</td>
<td>0.9 (0.7-1.3)</td>
<td>regular use</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Study Population</th>
<th>Period</th>
<th>Study type</th>
<th>No. cases</th>
<th>No. controls</th>
<th>OR (95% CI)</th>
<th>Cell phone exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meningioma</strong></td>
<td></td>
<td></td>
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<tr>
<td>Lönn et al., 2005&lt;sup&gt;25&lt;/sup&gt;</td>
<td>Sweden</td>
<td>2000-2002</td>
<td>8</td>
<td>32</td>
<td>0.7 (0.3-1.6)</td>
<td>regular use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td>15</td>
<td>1.4 (0.4-4.4)</td>
<td>ipsilateral exposure</td>
</tr>
<tr>
<td>Christensen et al., 2005&lt;sup&gt;24&lt;/sup&gt;</td>
<td>Denmark</td>
<td>2000-2002</td>
<td>6</td>
<td>8</td>
<td>1.0 (0.3-3.2)</td>
<td>regular use</td>
</tr>
<tr>
<td>Hardell et al., 2006&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Sweden</td>
<td>1997-2003</td>
<td>34</td>
<td>84</td>
<td>1.6 (1.0-2.5)</td>
<td>regular analogue phone use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>18</td>
<td>1.3 (0.5-3.2)</td>
<td>regular digital phone use</td>
</tr>
<tr>
<td>Schüz et al., 2006&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Germany</td>
<td>2000-2003</td>
<td>5</td>
<td>9</td>
<td>1.1 (0.4-3.4)</td>
<td>regular use</td>
</tr>
<tr>
<td>Lahkola et al., 2008&lt;sup&gt;28&lt;/sup&gt;</td>
<td>5 European countries</td>
<td>Case-control</td>
<td>42</td>
<td>130</td>
<td>0.9 (0.6-1.3)</td>
<td>regular use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td>73</td>
<td>1.0 (0.6-1.7)</td>
<td>ipsilateral exposure</td>
</tr>
<tr>
<td><strong>Astrocytoma</strong></td>
<td></td>
<td></td>
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<tr>
<td>Hardell et al., 2006&lt;sup&gt;b&lt;/sup&gt;</td>
<td>Sweden</td>
<td>2000-2003</td>
<td>40</td>
<td>40</td>
<td>3.7 (2.0-7.0)</td>
<td>regular analogue phone use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td>18</td>
<td>2.2 (0.8-6.5)</td>
<td>regular digital phone use</td>
</tr>
<tr>
<td><strong>All Malignant Brain Tumor</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardell et al., 2006&lt;sup&gt;29&lt;/sup&gt;</td>
<td>Sweden</td>
<td>2000-2003</td>
<td>48</td>
<td>40</td>
<td>3.5 (2.0-6.4)</td>
<td>regular analogue phone use</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>19</td>
<td>18</td>
<td>3.6 (1.7-7.5)</td>
<td>regular digital phone use</td>
</tr>
</tbody>
</table>

* Standardized incidence ratio was calculated based on observed and expected numbers
** Based on 4 case-control study (Lönn et al 2004, Christensen et al. 2004, Schoemaker et al. 2004, and Hardell et al., 2006)
*** Results from a Meta-analysis, based on three case-control studies (Lönn et al., 2004, Schoemaker et al., 2005 and Hardell et al., 2006)
**** low-grade glioma
quality methods and design. The researchers examined 465 articles published in major journals and focused on 23 studies involving 37,916 participants. In eight of the studies – those that were conducted with the most scientific rigor – cell phone users were shown to have a 10% to 30% increased risk of all types of tumors studied compared with people who rarely or never used cell phones (OR=1.2, 95% CI=1.0-1.3). The risk was highest among those who had used cell phones for 10 years or more.

The results of the entire literature on epidemiology and cell phone use remain controversial, because most studies suffer from a number of methodological shortcomings including: insufficient statistical power to detect an excess risk of brain tumors; reliance on small populations; short-term exposure periods; problems in recollection of past practices and difficulty in characterizing changing exposures throughout a lifetime in large populations. As a number of researchers have suggested, retrieving billing records from cell phone network providers to obtain cumulative duration and frequency of cell phone use and corroborating personal interview would provide the capability to validate self-reported cell phone exposure in future studies. Assuring independent funding for future research will also be critical, given the widely reported biases associated with the design and interpretation of industry-funded studies to date.

Regarding short-term health impacts from RF exposure such as insomnia, impairment of short-term memory, headache, alteration of EEG and other behavioral problems, evidence has been fairly consistent that such effects are worsened in longer term cell phone users. Whether these relatively benign perturbations signal the likelihood that more serious health impacts will occur after longer-term RF exposure is a matter of critical importance for future studies.

Models of the head used to evaluate compliance with safety standards

Given the concerns that have been raised from the biological and epidemiological studies, it is important to establish standards for RF exposures from cell phones that incorporate the best scientific information regarding differences in the heads of people of various sizes, genders and ages. Children’s skulls are thinner and their brains are less dense and more fluid, making them more vulnerable than adults to RF signals. Size alone affects absorption. In addition, other physiological properties such as permittivity, electrical conductivity and density also affect transmission and absorption of RF signals, as does myelination of the nerves of the brain, which is not complete until the early to mid-twenties.

The relative permittivity of a material under given conditions is measuring the extent to which it concentrates lines of flux. The relative permittivity of any material is expressed as the ratio of the amount of stored electrical energy when a potential is applied, relative to the permittivity of the vacuum. The relative permittivity or dielectric constant of the air is 1, while that of an adult brain is around 40 and that of a young child’s brain is higher closer to 60 to 80. This means that peak SAR in a child’s head may be 50% to 100% higher than that for an adult.

Conductivity and absorption of RF signals are a function of the dimensions and dielectric properties of the tissues that are directly exposed, as well as their neural density, with nerve cells being much more active than bone, hair, or skin. Conductivity is a parameter relating the electric field to the current density. For the same intensity of electric field, the increase in the conductivity will increase the current density and the
SAR. The absorption of RF energy will then increase, resulting in greater electromagnetic dissipation. Based on the measurements described by Peyman et al., the permittivity and the conductivity in the children’s head tissues are estimated to be around 20% greater than in adults\cite{41,43,44}.

The combination of both effects, the increase in the concentration of the electric field due to the increase in the electrical permittivity together with the increase of dissipation of RF/MW energy due to the increase in the conductivity, can result in a substantial SAR increase in the children’s head in comparison to the adults\cite{42,43}.

The weight and size of the tissue being used for estimating the SAR will also affect assessments, with exposures averaged over 1 gram of the head being more stringent than those averaged over 10 grams of the whole body, as the latter involves bone and tissue of more varying electrical conductivities and mass densities than the former. The process of myelination of the brain protects nerves from damage by surrounding them with myelin sheaths, with myelination incomplete until the MID-205 could be yet another factor of concern for children and young adults using cellphones.

Recently, the use of cell phones by young and children has been modeled through a variety of simulations; some based on magnetic resonance imaging (MRI) others based on computerized tomography (CT) scans. Some studies have produced SAR simulations for the heads of adults\cite{45,46}, while others took children into consideration\cite{42,44}. A range of results was obtained (Table 2). In the Utah Model\cite{47}, the children’s head was based on a scaled adult model and a SAR increase (compared with adult) of up to 153% was obtained.

In Schonborn’s study, the head model was based on MRI using similar electromagnetic parameters as those for adults, and no significant differences between adult and children SAR results were observed\cite{54}. In another study, the head model was approximated by spheres considering some variation of the electromagnetic parameters, and an increase of around 20% in the calculated SAR was shown\cite{55}.

Using a scaled model for the children’s head with adult electromagnetic parameters, no significant variation for the average SAR in the whole head was observed, and when considering the brain, an increase of around 35% in the SAR was calculated\cite{51}. In De Salles’s study, a 10 year old child head was developed based on CTI from a healthy boy\cite{43}. The physical and the electromagnetic parameters, such as the permittivity, the equivalent conductivity and the density were fitted to this age. SAR results around 60% higher than those simulated for the adults were observed for the children with fitted parameters.

Wiart and his colleagues developed child head models based on MRI. The combined results of these studies indicate that the maximum SAR in 1 g of peripheral brain tissues of the child models aged between 5 and 8 years is about two times higher than in adult models\cite{52}. More recently in an internal IT’IS Foundation Report, Kuster et al.\cite{53} report that spatial peak SAR of the CNS tissues of children is “significantly larger (~2x) because the RF source is closer and skin and bone layers are thinner”.

In all models used, it is readily apparent that smaller heads will absorb proportionally more RF than larger heads, but size is not the only property of interest in estimating differential SAR absorption of younger and older brains. Neuro-development of the brain is an exquisitely complex process that occurs at a more rapid pace in young children than in adults. As a result, even if exposures were equal in persons of all ages, the brains of children are more vulnerable than those of adults. In 1996, Gandhi published a report modeling the greater absorption of RF into the brain of a child compared to that of an adult\cite{47}. Subsequent work refined this analysis, taking into account a range of
### Table 2 - Some tissue-classified models of the head and the whole body for estimating radiofrequency absorption of humans

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Model</th>
<th>Height, Weight, Sex</th>
<th>Derived From</th>
<th>Voxel Size</th>
<th># of Tissues, Organs</th>
<th>Percentage SAR Underestimation</th>
<th>Cumulative Percentage SAR Underestimation for Child</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gandhi et al., Utah 1996</td>
<td>Model</td>
<td>1.75 m ht, 71 kg wt; also scaled models of 5- and 10-year old children</td>
<td>MRI scans</td>
<td>1.974x1.974x2.9 mm for the model of the adult; smaller cell sizes for models of children</td>
<td>32</td>
<td>&lt;153%</td>
<td>&lt;383%</td>
<td>Child's heads scaled from model of the adult and scaled models of 5 and 10-year old children</td>
</tr>
<tr>
<td>Dimbylow, NORMAN* 1998</td>
<td>Model</td>
<td>1.7 m ht, 70 kg wt to correspond to “reference man” ICRP23*</td>
<td>MRI scan single subject</td>
<td>2x2x2 mm, 2.04x2.04x1.95 mm</td>
<td>37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peyman et al., 2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Gandhi and Kang, 2002</td>
<td>Utah Model</td>
<td>MRI-derived model of the adult and scaled models* of 5- and 10-year old children</td>
<td>MRI scans</td>
<td>Different scaling factors for the head and the rest of the body</td>
<td>50% + &gt;100% from 10 mm spacer + 80% for electrical parameters</td>
<td>-200% @ 1900 MHz; 144% @ 835 MHz</td>
<td>10% smaller head results in 50% underestimation of SAR</td>
<td></td>
</tr>
<tr>
<td>Kang and Gandhi, 2002</td>
<td>Model</td>
<td>model of the adult</td>
<td>MRI scans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wang and Fujiwara, 2003</td>
<td>Model</td>
<td>Scaled Models of 7- and 3-year old children adult</td>
<td>MRI scans of the</td>
<td></td>
<td></td>
<td></td>
<td>Multiple studies find children absorb more radiation than adults. See also references 42, 47, 50-52, and 54.</td>
<td></td>
</tr>
</tbody>
</table>

(continued)
Table 2 - Some tissue-classified models of the head and the whole body for estimating radiofrequency absorption of humans

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Model</th>
<th>Height, Weight, Sex</th>
<th>Derived From</th>
<th>Voxel Size</th>
<th># of Tissues, Organs</th>
<th>Percentage SAR Underestimation</th>
<th>Cumulative SAR Underestimation for Child</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gandhi and Kang, 2004</td>
<td>Specific-anthropomorphic phantom (SAM)</td>
<td>Plastic head-shaped phantom with a plastic spacer to represent the pinna</td>
<td>90th percentile head size of military personnel</td>
<td>Filled with homogenous fluid</td>
<td>Underestimates SAR by a factor larger than 2</td>
<td>Not tested for the size of a child’s head</td>
<td>Use of a 6-10mm thick plastic spacer makes it impossible to measure the highest SAR for the pinna</td>
<td></td>
</tr>
<tr>
<td>Martinez-Burdalo et al., 2004</td>
<td>Child</td>
<td>Scaled model from adult electrical parameters</td>
<td>35%</td>
<td>As head size decreases, the percentage of energy absorbed in the brain increases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fernandez et al., 2005</td>
<td>10 years old Brazilian Model</td>
<td>10 year old child (1.2 m height, 35 kg, male)</td>
<td>102 CT scans</td>
<td>0.946 mm x 2.044 mm x 1.892 mm (3.10 mm³)</td>
<td>10</td>
<td>Permittivity &amp; conductivity of 10 year old</td>
<td></td>
<td></td>
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<tr>
<td>De Salles et al., 2006</td>
<td>10 years old Brazilian Model</td>
<td>10 year old child (1.2 m height, 35 kg, male)</td>
<td>102 CT scans</td>
<td>0.946 mm x 2.269 mm x 1.601 mm (3.43 mm³)</td>
<td>10</td>
<td>60%</td>
<td>Permittivity &amp; conductivity of 10 year old</td>
<td></td>
</tr>
<tr>
<td>Wiart et al., 2008</td>
<td>Child’s Head, 5 to 8 years old</td>
<td>MRI scans</td>
<td>100% (2x)</td>
<td>Antenna closer to skin and bone layers are thinner; penetration of radiation is twice as deep in child</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kuster et al., 2009</td>
<td>Child</td>
<td>&gt;100%</td>
<td>CNS tissues</td>
<td>SAR of CNS of children ~twice that for adults</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* NORMAN=NORmalized Man
anatomic differences between adults and children, including conductivity, density and dielectric constants. Gandhi and Kang reported that models with a head that was only about 10% smaller in size could have more than 50% greater SAR with two different antenna lengths, with proportionally deeper penetration of SAR\(^2\). This work also showed that incorporating a plastic ear model or pinna with a 10 mm spacer gave artificially lowered SAR-values, which are up to two or more times smaller than for realistic anatomic models, as a result of the larger distance to the absorptive tissues. The higher dielectric constant and conductivities likely for younger subjects will result in still higher SAR (up to 80% more) for children.

The peak 1-g body tissue SAR for the smaller head sizes calculated using the widely accepted Finite-Difference Time-Domain (FDTD) computational EMFs method can be up to 56% higher at 1900 MHz and up to 20% higher at 835 MHz compared to the larger models. For brain tissue, the proportionality was even higher where the peak 1-g SAR for the smaller model was up to 220% higher at 1900 MHz and up to 144% higher at 835 MHz of the SARs of the larger models. Similar to the results reported in the earlier 1996 paper for head models of adult and children, these latter results confirmed that there is a deeper penetration of absorbed energy for the smaller head models e.g. the children compared to that for the larger head models representative of adults.

In 2004, a IEEE Standards Coordinating Committee introduced a standard anthropomorphic mannequin (SAM) Model, with a 6-10 mm thick plastic spacer instead of “pinna” for determination of SAR of mobile phones for compliance testing against IEEE and ICNIRP Safety Guidelines (IEEE, 2003). That same year, Gandhi and Kang demonstrated that the “SAM model” with plastic spacer used for compliance testing (preferred by industry) gives SARs that grossly underestimate exposures\(^6\). In two different published studies, the use of plastic spacers results in an underestimation of the SAR by up to 15% for every additional millimeter of thickness of such spacers\(^48,50\). Thus, the SAR obtained for SAM is up to two or more times smaller than for the anatomic models of the adult head. When other developmental variables are taken into account, this underestimation is even higher for exposure to the smaller heads of the children.

A modified SAM model with a lossy pinna similar to living tissue for which 1- and 10-g SARs are relatively close to those for anatomic models, could remedy this systematic underestimation of exposure of the children by using a fluid of higher conductivity than that currently used for compliance testing\(^4\). Without this correction, current IEEE limits\(^6\) effectively allow RF that may be 8-16 times higher\(^6\) than those permitted by previous IEEE guidelines\(^56,57\). This is also due to increasing the SAR limit in the pinna from 1.6 W/kg for any 1-g of tissue to 4.0 W/kg for a larger 10-g of tissue that was originally suggested to apply only to the extremity tissues for the arms and the legs\(^57,58\).

In fact, multiple studies have reported that the brains of young children absorb more radiation compared to those of adults\(^43,47-49,51-53\). As the brains of children lack neural integration and are not fully myelinated until the twenties, the impact of such greater absorption may be considerable. In addition, this differential absorption of the brain may well render children more vulnerable to the development of both benign and malignant brain tumors, a point indicated in the review of this subject by the National Research Council\(^59\). Studies by Wiart for French Telecom published last year\(^52\) and other work by Kuster\(^60\) confirmed that a given signal is absorbed about twice as deeply into the bone marrow of the head and cortex of a child in contrast with that of an adult, even though systemic absorption may not differ substantially. A series of papers by De Salles also offers important modeling information regarding the increased vulnerability of a child’s
Y-Y Han et al.: Comparative assessment of models of electromagnetic absorption

Table 3 - Summary of the results confirming that children absorb more radiated electromagnetic energy of the cell phones resulting in higher specific absorption rate (SAR) as compared to adults

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Highlights of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gandhi et al., 1996</td>
<td>Deeper penetration of absorbed energy for models of 10- and 5-year old children; peak 1-g SAR for children up to 53% higher than adults.</td>
</tr>
<tr>
<td>Gandhi and Kang, 2002</td>
<td>Deeper penetration of absorbed energy for smaller heads typical of women and children; peak 1-g SAR for smaller heads up to 56% higher than for larger heads.</td>
</tr>
<tr>
<td>Wang and Fujiwara, 2003</td>
<td>Compared to peak local SAR in the adult head, we found “a considerable increase in the children’s heads” when we fixed the output power of radiation.</td>
</tr>
<tr>
<td>Martinez-Burdalo et al., 2004</td>
<td>As head size decreases, the percentage of energy absorbed in the brain increases; so higher SAR in children’s brains can be expected.</td>
</tr>
<tr>
<td>DeSalles et al., 2006</td>
<td>The 1-g SAR for children is about 60% higher than for the adults.</td>
</tr>
<tr>
<td>Wiart et al., 2008</td>
<td>1-g SAR of brain tissues of children is about two times higher than adults.</td>
</tr>
<tr>
<td>Kuster et al., 2009</td>
<td>Spatial peak SAR of the CNS of children is “significantly larger (~2x) because the RF source is closer and skin and bone layers are thinner”; “bone marrow exposure strongly varies with age and is significantly larger for children (~10x)”</td>
</tr>
</tbody>
</table>

Based on CT images of a 10 year old boy, these models confirm the greater absorption of the child and add further support regarding the need to eliminate the plastic spacer at the ear or pinna in estimating exposures to children. A summary of the results confirming that children (and smaller heads typical of women) absorb more radiated energy of cell phones resulting in higher SAR is given in Table 3.

Implications of modeling limitations for current standards

Both the IEEE and ICNIRP guidelines are based only on short-term EMFs exposure and long-term EMFs exposures are not considered. Please refer to page 496:

“Induction of cancer from long-term EMFs exposure was not considered to be established, and so these guidelines are based on short-term, immediate health effects such as stimulation of peripheral nerves and muscles, shocks and burns caused by touching conducting objects, and elevated tissue temperatures resulting from absorption of energy during exposure to EMFs. In the case of potential long-term effects of exposure, such as an increased risk of cancer, ICNIRP concluded that available data are insufficient to provide a basis for setting exposure restrictions, although epidemiological research has provided suggestive, but unconvincing, evidence of an association between possible carcinogenic effects and exposure at levels of 50/60 Hz magnetic flux densities substantially lower than those recommended in these guidelines.”
The increase in the SAR in the whole head, between the adult and the child, is expected due to the reduced dimensions in the child head, as well as the higher values of the permittivity and of the electrical conductivity of the child brain tissues. Also, children’s skulls are thinner than those of adults, and therefore less resistant to radiation.

Another concern is that only thermal effects of RF are considered when estimating the SAR. However, since most mobile communication systems now are pulse-like in nature, modulated at low frequencies, such as in 2G and 3G (e.g., the GSM, UMTS, CDMA, TDMA systems), they are able to induce pulses of currents in the brain tissues and this can result in some low level non-thermal effects, e.g., BBB alterations, single and double strand DNA breaks, chromosomal aberrations, etc., at RF energy levels substantially below the thermal threshold. Several papers and reports have already shown adverse health effects at exposure levels well below the thermal limits\cite{4, 6, 12, 13, 61}. Further epidemiological studies have shown a many-fold increase in risk for malignant brain tumors, with a larger than 10 years latency period for long-term mobile phone and cordless phone users\cite{23}. As a substantial percentage of the population now uses mobile phones for a long time during each day and for several years, operating the antenna very close to their head, then this exposure can not be classified as short term and effectively may represent a serious risk for their health.

**Future research needs**

There is a need for exposure assessment of juveniles, children, pregnant women and fetuses from personal wireless devices (the wireless devices considered here are the cell phones, wireless PCs and text messaging devices), waist and pocket-mounted devices since mostly adult male models have been considered to date. These studies will focus on development and exposure quantification of anatomic models of several heights and weights of men, women and children of various ages as well as pregnant women and fetuses.

There is an urgent need for characterization of microwave radiated fields from the currently used multi-frequency, multi-element base station antennas; identification of exposed individuals and their locations e.g. school children, building maintenance personnel, etc. There is a paucity of data in regard to radiated electromagnetic fields and the daily variation in time for the newer 4-6 element or more collocated base station antennas and the exposures these antennas entail for the school children and the civilian population living close to such antennas.

An updated survey is needed of the civilian exposure to microwave electromagnetic fields strengths in the U.S. due to the rapidly expanding wireless infrastructure in the last 10-15 years. The last survey involving selected 15 metropolitan areas and mostly focused on VHF and UHF TV stations was reported back in 1980.\cite{62} This data is totally out of date at the present time.

An expert (non-industry dominated) evaluation of the current IEEE and ICNIRP RF/microwave safety standards in the light of more recent biological experiments is also critical. All of the current safety standards are based on extrapolation from acute short-term exposures and do not account for the modulated signals used in cell phones and other personal wireless devices.
Discussion

The summary of modeling research presented here indicates three major shortcomings of the current IEEE and ICNIRP approaches: 1) the assumption that only thermal effects can occur is not valid. There is growing evidence from in vitro and in vivo studies indicating that RF exposures at levels not known to induce thermal effects commonly encountered today have a range of biological effects, affecting production of free radicals, permeability of the BBB, expression of heat shock proteins, and direct damage to DNA, as indicated by the comet assay and a variety of in vitro measures of genotoxicity; 2) properties of the head models currently used fail to take into account differences in dielectric constant and conductivity and improper modeling of the pediatric brain, as well as developmental differences such as myelination between the young and older brains; 3) the assumptions as to typical use patterns used in setting these standards, with a six minute average call time, do not reflect current patterns, according to reports from the cell phone industry, where monthly use can easily top 2000 minutes with many calls well in excess of 6 minutes.

Excepting the occasional advertisement, there is no publicly accessible, independently confirmable, information on the details of rapidly expanding markets and uses of cell phones, which makes the development of standards especially challenging. Cell phones are used by many people for much of their waking hours, having replaced traditional phones, alarm clocks, newspapers, radios, global positioning devices, video-cameras and televisions.

Regarding young children, we do not know the typical practice of the young at this point, because those behaviors are changing rapidly. However, we do know school districts are being urged to adopt cell phones for all middle school students as learning tools. This may well be an excellent idea for the purposes of learning, providing that phones are not used and held directly to the developing brain. Whether the use of cell phones as phones proves a potential hazard to the long-term health of the pediatric brain is an issue that merits serious attention. Radiation compliance standards for operation of cell phones are based exclusively on adult male models of the head. Emerging research indicates that long-term heavy users of cell phones face a doubled risk of several forms of brain tumors and risks may well be greater for those who begin regularly using phones before age 20. In light of these facts, the European Environment Agency and several other national advisory groups have adopted a precautionary approach to keep cell phone exposure to a minimum through use of ear-pieces and speaker phones, wired headsets, and to urge that children generally not use cell phones.

To enhance the ability to protect public health and foster better design of this widely used technology, we advise a three-pronged approach: major studies should be undertaken to construct and validate gender and age-appropriate head models further. More research is needed to identify and evaluate the mechanisms through which non-thermal effects of RF arise and to determine more definitively the extent of health risks from long term use of cell phones, particularly by children. While that work is proceeding, precautionary policies should be advanced to limit potential harm to the developing brain. This should include consideration of directional antennas designed to send signals away from the head since the tissues absorb almost all of the energy radiated in the direction of the head anyway. Responsible public health authorities around the world should disseminate warnings for cell phone users such as those advocated recently in France, Finland and Israel. This involves advising children and their parents...
along with the young to make only short and essential calls, to use text messaging when possible, to use always hands free kits and wired headsets, and maintain the antenna far away from their body during the calls. Given the prevalence of this revolutionary technology, some evidence of its chronic toxicity, and the lack of solid information regarding its potential hazards to humans, it is important that major independent, multi-disciplinary research programs be carried out to study and monitor the long-term impact of RF exposures.

Acknowledgement

Support for this work was provided in part by grants from the National Institute of Environmental Health Science, the Heinz Endowments, the Jennie Zoline Foundation, the Environmental Health Trust, and center grants from the National Cancer Institute to the University of Pittsburgh Cancer Institute. The authors declare that they have no competing interests. Constructive comments have been provided by Lloyd Morgan and Allan Frey.

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IARC CLASSIFIES RADIOFREQUENCY ELECTROMAGNETIC FIELDS AS POSSIBLY CARCINOGENIC TO HUMANS

Lyon, France, May 31, 2011 - The World Health Organization/International Agency for Research on Cancer (IARC) has classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B), based on an increased risk for glioma, a malignant type of brain cancer, associated with wireless phone use.

Over the last few years, there has been mounting concern about the possibility of adverse health effects resulting from exposure to radiofrequency electromagnetic fields, such as those emitted by wireless communication devices. The number of mobile phone subscriptions is estimated at 5 billion globally.

The IARC Monograph Working Group, consisting of 31 scientists from 14 countries, was convened to assess the potential carcinogenic hazards from exposure to radiofrequency electromagnetic fields. They discussed the possibility that these exposures might induce long-term health effects, in particular an increased risk for cancer. This has relevance for public health, particularly for users of mobile phones, as the number of users is large and growing, particularly among young adults and children. International experts shared the complex task of tackling the exposure data, the studies of cancer in humans, the studies of cancer in experimental animals, and the mechanistic and other relevant data.

“Given the potential consequences for public health, it is important that additional research be conducted into the long-term, heavy use of mobile phones...” Dr. Christopher Wild, director of the WHO’s International Agency for Research on Cancer.
UNITED STATES PRESIDENT'S CANCER PANEL EXPRESSES CONCERN

The 2010 U.S. President’s Cancer Panel has reported “the true burden of environmentally induced cancers has been grossly underestimated.” The panel pointed to cell phones and other wireless technologies as potential causes of cancer. In its recommendations, the panel stated:

“Methods for long-term monitoring and quantification of electromagnetic energy exposures related to cell phones and wireless technologies are urgently needed given the escalating use of these devices by larger and younger segments of the population and the higher radiofrequencies newer devices produce.”

"The increasing number of known or suspected environmental carcinogens compels us to action, even though we may currently lack irrefutable proof of harm," Lefall, who is chair of the panel, said in a statement.

Another sensitive issue raised in the report was the risk of brain cancer from cell phones. Scientists are divided on whether there is a link. **Until more research is conducted, the panel recommended that people reduce their usage by making fewer and shorter calls, using hands-free devices so that the phone is not against the head and refraining from keeping a phone on a belt or in a pocket.**

“Even if cell phones raise the risk of cancer slightly, so many people are exposed that it could be a large public health burden.” Dr. Ted Schettler, Director of the Science and Environmental Health Network

“CHILDREN, whose brains are more vulnerable than those of adults, may well be at higher risk than adults from lifelong use. Exposure models used to set standards today rest on the head of a tall, heavy man and do not take into account the greater vulnerability of a man’s sperm, or the smaller and more vulnerable skulls, skin, bone marrow, and brains of children and the fetus.” Devra Davis, PhD  Founder, Environmental Health Trust
BACKGROUND: A Brief History of Federal Oversight of Cell Phone Radiation

Cell phones, microwave radiation-emitting devices used by 303 million Americans, were never required to undergo pre-market safety testing. When first introduced to the U.S. market place in 1983, cell phones were intended for short use by professional adults. According to a 2011 Pew Research report, millions of children and young people have become regular users of cell phones, with 66% of all children acquiring a cell phone before the age of 7. The same report shows the alarming statistic that more than 84% of U.S. teens sleep with their phones “on”, next to their heads so they can be certain to stay connected with their friends, as well as using their phones for a wake-up alarm. Most users do not know that while a cell phone is connected to a network, and even when not on a call its radio transmitter is constantly receiving and sending bursts of radio frequency radiation to the nearest tower. Children and young people are carrying their phones around on their bodies all day, and then exposing their developing brains to radio frequency radiation throughout the night.

Scientific studies over the past 2 decades have consistently shown potential major health risks, including cancer as well as new studies showing damage to men’s reproductive systems from carrying cell phones in their pants pocket and damage to newborns when mothers keep them in their pockets near the fetus.

Industry-funded studies attempt to discredit legitimate, published research showing health effects. City and state legislators in Maine, California, Oregon, New Mexico and Pennsylvania, who have attempted to enact laws to issue consumer precautionary warnings are being threatened (by executives from the CTIA - wireless association of cell phone manufacturers) with massive legal challenges; this is presently the case in the city of San Francisco which has been fighting to uphold its “Right to Know” law against the legal challenges by the industry for two years.

Our government has refused to take any action mainly due to top scientists within the National Cancer Institute (NCI) and the FDA insisting that, before even publicly commenting that there are potential health risks of cell phones they must first see undeniable proof of harm. As with many cancers, we may not have that undeniable proof for decades or a century, if ever. We still do not have undeniable truth that cigarettes cause lung cancer. However, we do have enough scientific evidence NOW about the risks of cell phone radiation to take action as other nations are doing.

While we wait, 303 million U.S. citizens are engaged as unknowing participants in the world’s largest epidemiological study on the topic of non-ionizing radiation and biological effects. Due to lack of adequate federal oversight and refusal of the cell phone industry to admit the truth about the potential health risks of their products, families all over the U.S. are abandoning their landlines with over 25% of all US households now wireless only. The majority of 20-29 year olds do not have landlines and there is a rise in malignant brain tumors (glioma) seen in this age group. Formerly, gliomas were specific to those over 60.

It has been reported to the FCC for many years that there are serious flaws in the testing procedure they use for manufacturer compliance with the radiation exposure standard. Many in the medical profession are alarmed that the FCC testing standards adopted more than a decade ago are based upon the radiation absorption rates for a simulated body the size of an enormous man with a head larger than
95% of the population. Additionally concerning is that current standards only take into account damage from thermal heating from the microwave radiation of cell phone emissions, ignoring the documented biological effects from non-thermal microwaves from a cell phone.

The image below demonstrates the increased absorption of cell phone radiation within the brains of children who are using their cell phones at early ages; studies have shown that people who begin using their cell phones as children develop brain tumors at a faster rate than those who don’t have direct exposure until their adults years.

With Permission, Prof. Om P. Gandhi

Cell phone radiation affects children's brains more than adults' brains

In spite of the underlying major design flaws in the current cell phone emission testing standards, and with knowledge of alternative, more effective testing methods, the FCC and FDA have failed to monitor and update the exposure compliance testing procedures since 2001.

The FCC and FDA are mandated to regulate cell phone radiation exposure to protect U.S. citizens (National Environmental Policy Act of 1969). The FCC eventually established radio frequency exposure limits and testing guidelines as a result of a multi-year proceeding and as required by the Telecommunications Act of 1996. Yet, these regulatory agencies have done little in the past ten years in response to legitimate concerns about the inadequate safety standard and the ineffective and obsolete compliance testing procedures. Instead of informing consumers of the facts and possible health risks of cell phone use, their current websites, including the FCC Kid’s Zone, say there are no known adverse health effects from cell phones or there is no scientific evidence to date that proves that wireless phone usage can lead to cancer. That is a manipulation of the truth and harmful dissemination of information to consumers.

Congress must act NOW to demand that the FCC and FDA conduct a major review and revision of the existing, outdated FCC safety standards and cell phone radiation-emission compliance testing procedures.

In 1993, Congressman Markey requested a report from the GAO in response to raised citizen awareness and concerns about cell phone radiation. In 2001, there was an in depth GAO report issued, “Telecommunications: Research and Regulatory Efforts on Mobile Phone Health Issues,” which called for more research and determined that “standardized testing procedures are lacking.” The regulatory agencies have done very little since that time on this issue.

In 2008, a Congressional House hearing was held on the topic of cell phone safety; the consensus was to call for warning labels and a revision of the exposure standards. As a result of that hearing, legislation
was introduced that called for a revision of the decades old safety standards, a warning label on phones, and more research. Upon the change in Congress in 2010 the legislation has disappeared. A Senate hearing was held on the same topic in 2009. In spite of all the testimony documenting EXISTING science showing definite health risks from cell phone radiation exposure, and attempts by some Congressional representatives to enact legislation, the end result has been no action other than to simply call for more research.

Our federal representatives have been expressing concern about this issue for 18 years, with little resulting action. The time for the federal government to protect U.S. citizens from the potential health hazards of cell phone radiation is long overdue. It is time for Congress to stop calling for more hearings, which, like the top scientists at the National Cancer Institute, will most likely again simply result in a call for more research in an attempt to PROVE beyond a shadow of a doubt that cell phone radiation is harmful. As with cigarettes and asbestos, this could take decades longer as certain cancers can take 20 - 30 years to show up as statistically significant on epidemiological studies and national cancer registries. If we don’t take action NOW to inform citizens about the known facts of possible health risks and about ways citizens can safely use their cell phones, we could be facing a public health epidemic that is unimaginable in terms of future economic and societal costs.

The World Health Organization has classified cell phone radiation a possible human carcinogen, placing it in the same category as DDT, hexachlorobenzene (fungicide), lead and certain toxic dry cleaning fluids.

In 2010, the US President’s Cancer Panel also declared cell phone radiation a potential cause of cancer.

Health Canada, in October, 2011, issued a precautionary warning to its citizens to:

- Limit the length of cell phone calls
- Replace cell phone calls with text messages or use "hands-free" devices
- Encourage children under the age of 18 to limit their cell phone usage

Many other countries around the globe have taken precautionary measures to warn their citizens of the possible health risks of cell phone use. Several have banned the marketing and sale of cell phones to children and advised parents to allow children to use cell phones only in the event of an emergency. See Environmental Health Trust website for a report on the releases of precautionary warnings of other countries:


Our children and grandchildren in the United States deserve the same concern.
**DOCUMENTED RISKS***

For children, those who began using mobile phones as teenagers have four to five times greater risk of developing malignant brain tumors compared to those who did not use phones at these ages.

For men who wish to become fathers, those who use their cell phones 4 hours per day have been found to have half the sperm count of non-users.

For the developing fetus, prolonged cell phone use or placing the cell phone in “standby” mode near the fetus significantly increases the risk of learning problems in children and may present other dangers to child development.

Those who regularly use cell phones with higher radiated power, such as people living in rural areas or using phones in moving cars, face significantly greater risks of brain tumors and other chronic health problems.

Other serious health problems significantly associated with regular cell phone usage include: breast, salivary gland, rectal, testicular cancers; short-term memory loss, sleep and attention disturbances, headache, hearing loss, cognitive impairments, dementia and possibly Alzheimer’s Disease. Concerns also include salivary gland tumors, breast tumors (when kept in bra), damage to reproductive organs and to fetuses.

Experimental studies find that cell phone radiation damages DNA, increases abnormal proteins, alters memory, behavior and brain chemistry, and increases the uptake of pollutants up into the brain.

* Scientific studies corroborating these and other serious health risks can be found at [www.environmentalhealthtrust.org](http://www.environmentalhealthtrust.org) and [www.bioinitiative.org](http://www.bioinitiative.org)
CELL PHONE MANUFACTURERS ARE HIDING “SAFE DISTANCE” WARNINGS IN USER MANUALS

Current research is finding that cancer is developing not only in the brain but also in areas of the body where the cell phone is kept in “on” mode. The FCC’s compliance documents state that carrying or using a cell phone directly against the torso can result in radiation exposure that exceeds the federal safety limits. However, since they are not properly warned against doing so, most consumers carry and use their cell phones in their pockets or tucked into waistbands and even against the breasts inside women’s bras. Studies are showing male reproductive damage for men who carry their phones in their pants pockets and breast cancer surgeons are reporting unusual breast tumors in young women who carry their phones in their bras.

For some unknown reason, the FCC does not require manufacturers to test for radiation absorption into the body (SAR) when a cell phone is positioned directly against the body, the manner in which many people use their phones, e.g.; radiating in a shirt or pants pocket during a call while connected to an earpiece. Instead, the obsolete and seriously flawed cell phone radiation testing standards set by the FCC over 10 years ago allow manufacturers to position each cell phone held up to 1” away from the testing body (aka “phantom”) in a holster. This is in spite of few U.S. citizens using a holster to carry their phone when on their body.

As stated on page 41 of the FCC document Evaluating Compliance with FCC Guidelines for Human Exposure to RF Electromagnetic Fields, .....“a separation distance of 1.5 cm between the back of the device and a flat phantom is recommended for testing body-worn SAR compliance under such circumstances. Other separation distances may be used, but they should not exceed 2.5 cm”. (Note: 2.5 cm = 1”).

Because cell phones are not tested directly against the body in the manner in which they are typically used, but are allowed to be tested held up to 1” away in a holster to determine the highest radiation emission level, the FCC requires that consumers be warned to never use or wear their phone closer than this “separation distance” provided by a holster or they will be exposed to radiation that may exceed the federal limit.

This federal consumer radiation disclosure requirement is stated on page 41 of the FCC testing compliance document mentioned above, “In order for users to be aware of the body-worn operating requirements for meeting RF exposure compliance, operating instructions and caution statements should be included in the manual.”

Also, every cell phone’s approval for federal regulatory compliance contains the same directive from the FCC: “End users must be informed of the body-worn operating requirements for satisfying RF exposure compliance.” (FCC/OET TCB Form 731 Grant of Equipment Authorization under “Grant Comments”).

In spite of being aware that the FCC requires consumers to be warned to never wear or use a cell phone directly against the body, all U.S. cell phone manufacturers engage in the industry-wide practice of deceptively hiding these consumer safety disclosures in technical language, printed in fine print and located in sections of the user guide where a consumer will rarely see them. See iPhone example below
which appears in the user manual in print barely legible to the naked eye, much smaller than #8 font shown:

"iPhone's SAR measurement may exceed the FCC exposure guidelines for body-worn operation if positioned less than 15 mm (5/8th inch) from the body (e.g.: when carrying iPhone in your pocket)....... When using iPhone near your body for voice calls or for wireless data transmission over a cellular network, keep iPhone at least 15 mm (5/8th inch) away from the body, and only use carrying cases, belt clips or holsters that do not have metal parts and that maintain at least 15 mm (5/8th inch) separation between iPhone and the body."

Below is a sample of a “fine print warning” found in the BlackBerry Tour user manual, buried in the back of the pamphlet under compliance information:

"Use hands-free operation if it is available and keep the BlackBerry device at least 0.98 in. (25 mm) from your body (including the abdomen of pregnant women and the lower abdomen of teenagers) when the BlackBerry device is turned on and connected to the wireless network. For more information about carrying your BlackBerry device, see the holster information in the "Additional safety guidelines" section of this document."

Another misleading statement on the FCC consumer website is the Office of Engineering and Technology’s (OET) claim that cell phones are tested held directly against the body. In spite of numerous consumer advocacy complaints and Data Quality Act challenges to seek correction of this, and other dishonest statements on FCC websites, the top staff at the OET has refused to issue corrections.

Regarding FCC compliance testing guidelines for radiation absorption into the brain, cell phones are also tested with a separation distance at the head to simulate the skin and cartilage of the ear. This fact is not disclosed on the FCC consumer website which claims that cell phones are tested directly against the head. The public is not aware of this separation distance during testing, and many people shove their phones into their ears in an attempt to hear better in noisy surroundings, with the antenna closer to their brains and receiving radiation greater than the exposure limits allow. There is no warning in the user manual to warn consumers of this potentially dangerous use position.

Carrying and using a cell phone in one’s pocket is a typical way these products are used and yet most cell phones will exceed the federal safety emission limit of 1.6 W/kg SAR (Specific Absorption Rate) when carried directly against the body. It is a known scientific fact using the Inverse Square Law of Physics, that a cell phone held directly against the body on a call exposes the user to as much as 16 times the radiation as when held 1" away from the body in a holster. (1/4 inch vs. 1 inch)

“Based on my extensive experience as a leader in basic research and director of a comprehensive cancer center for the National Cancer Institute, I believe that we have ample evidence for questioning the long-term impacts of cell phones on health and solid grounds for concerns about the long-term implications of their use.” Ron Herberman, former Director Emeritus of the University of Pittsburgh Cancer Institute.
THE FCC TELLS CONSUMERS THERE ARE NO KNOWN ADVERSE HEALTH EFFECTS FROM CELL PHONES

Current FCC website:

“Recently, some health and safety interest groups have interpreted certain reports to suggest that wireless device use may be linked to cancer and other illnesses, posing potentially greater risks for children than adults. While these assertions have gained increased public attention, **currently no scientific evidence establishes a causal link between wireless device use and cancer or other illnesses.** Those evaluating the potential risks of using wireless devices agree that more and longer-term studies should explore whether there is a better basis for RF safety standards than is currently used. The FCC closely monitors all of these study results. However, at this time, there is no basis on which to establish a different safety threshold than our current requirements.”


THE FCC KID’S ZONE WEBSITE:

“Do cell phones cause brain cancer?
There is no scientific evidence to date that proves that wireless phone usage can lead to cancer or a variety of other health effects, including headaches, dizziness or memory loss.”

http://transition.fcc.gov/cgb/kidszone/faqs_cellphones.html

“If someone begins using a cell phone prior to age 20, there is a 5-fold increased risk of brain cancer later in life.” Lennart Hardell, MD, PhD
The FCC’s role is to provide consumers with usable information; not to sanctify children’s use of cell phones directly against their heads. We may never have definitive proof; but, we DO have enough scientific research NOW to justify advising parents about children’s safe cell phone use.

FDA CLAIMS NO LINK WITH ANY HEALTH PROBLEMS

From FDA website: “Do cell phones pose a health hazard?”

“Many people are concerned that cell phone radiation will cause cancer or other serious health hazards. The weight of scientific evidence has not linked cell phones with any health problems.”


The FCC and FDA are disseminating misleading information to the public and omitting key facts about research and the World Health Organization’s warning that cell phones may possibly cause cancer - facts that would inform consumers so they could make better choices about how to safety use cell phones to reduce any potential health risks or overexposure to radio frequency emissions, especially with respect to children. The CTIA, the powerful association of cell phone manufacturers, has said publicly that they do not claim cell phones are safe- they simply point to the FCC and FDA websites and relay the information from our government’s “industry-friendly” messaging to the public.
Cell Phones: Major Reasons for Concern

1: Industry’s own research shows that long-term use of cell phones significantly increases brain tumor risk.

2: Independent research also shows there is risk of brain tumors from cell phone use.

3: The danger of brain tumors from cell phone use is highest in those who begin using cell phones regularly before age 20.

4: In 1996, FCC mandated exposure limits for cell phones 13 years after phones were introduced using standards developed by an industry group, the IEEE.

5: Cell phone radiation damages DNA, which can lead to cancer and other diseases.

6: Cell phone radiation has been shown to cause the blood-brain barrier to leak, potentially increasing absorption of toxic materials from the blood into the brain.

7: Male fertility is impaired by cell phone radiation.

8: The European Parliament voted for major cell phone policy changes in 2008 based on strong evidence of the health effects of electromagnetic radiation.

9: Cell phone user manuals hide safety disclosures in fine print warning customers to keep the cell phone away from the body even when not in use.


The precautionary principle states that if an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus that the action or policy is harmful, the burden of proof that it is not harmful falls on those taking the action.
CALL TO ACTION

We call upon our federal legislators to:

1. Inform the public of the recent World Health Organization, International Agency for Research on Cancer classification of cell phone radiation as a possible human carcinogen based on an increased risk of glioma, a malignant brain cancer, associated with wireless phone use.

2. Issue precautionary warning information to the public about safe cell phone use:
   - cell phones should not be held directly to the head or body when “on”
   - use devices that place distance between the phone and bodies; do NOT carry or use cell phones in pockets or waistbands
   - children with their thinner skulls and developing brains and bodies may be particularly vulnerable to the suspected health impacts of electromagnetic radiation from cell phones

3. Issue amendment to existing compliance standard that FCC-required consumer safe distance warnings (currently being hidden by cell phone manufacturers in the fine print of all their cell phone user manuals) MUST be displayed prominently so that typical consumers will see them and be adequately informed about safe ways to use their cell phones.

4. Conduct a major review and revision of the existing, outdated FCC safety standards and cell phone radiation-emission compliance testing procedures; consider the most effective testing protocol incorporating state of the art, independent science using appropriate head and body models for persons of different ages and genders to ensure the protection of American consumers, especially children.

5. Require that, until new cell phone radiation testing guidelines are implemented, all new cell phone devices seeking compliance with current FCC regulations MUST be tested directly at the head and body (with no separation distance allowed for the “on the body” test positions. Cell phones must be tested for exposure compliance in the positions that simulate the typical ways consumers use them (i.e.; directly against the body as when used in a shirt or pants pocket, or when tucked into a waistband or woman’s bra while connected to an ear piece.)

"Given the potential consequences for public health, it is important that additional research be conducted into the long-term, heavy use of mobile phones"... Dr. Christopher Wild, director of W.H.O.‘s International Agency for Research on Cancer.
RECENT SCIENTIFIC PUBLICATIONS

1. Hardell, Khurana, et al September 2009: Literature review indicates that using a cell phone for greater than 10 years approximately doubles the risk of being diagnosed with a brain tumor on the same side of the head as that preferred for cell phone use. The data achieve statistical significations for glioma and acoustic neuroma. There is adequate epidemiologic evidence to suggest a link between prolonged cell phone usage and the development of an ipsilateral brain tumor. Dr. Khurana says that because of their much broader use today cell phone use “has far broader public health ramifications than asbestos and smoking, and directly concerns all of us, particularly the younger generation, including very young children.” Khurana V., Teo C., Kundi M., Hardell L., Carlberg M.. Cell phones and Brain tumors: A review including the long-term epidemiologic data. Surgical Neurology 72 (3) 205-214.

2. “Exposure Limits: The Underestimation of Absorbed Cell Phone Radiation, Especially in Children” - Om P. Gandhi, L. Lloyd Morgan, Alvaro Augusto Almeida de Salles, Yueh-Ying Han, Ronald B. Herberman, Devra Lee Davis. In press, to be released October 17, 2011 in Electromagnetic Biology and Medicine. Conclusion: Cell phones used in shirt or pants pocket exceed FCC exposure guidelines and children absorb 2 times as much microwave radiation from cell phones as adults.

3. INTERPHONE STUDY: The 13 country, telecom-industry funded Interphone Study was undertaken for 10 years at the cost of at least $30 million. The results were to be published when the study was completed in 2005 but they were repeatedly delayed because of internal conflict and changes in leadership. While they could not agree on how to report the findings that long term use of cell phones correlated with a rise in malignant brain cancer, researchers from several participating nations including Sweden, France, Denmark, and Israel published their own results and warned their citizens of health risks. Finally in May, 2011 the results were published. Unfortunately the important data showing a 118% increased risk of malignant brain tumor (glioma) from “long term” use (which they consider 10 years at 30 minutes per day) was hidden from the public.

   Expert rebuttal to Interphone Study: Industry, and their paid researchers, also widely publicized to the media that the study had flaws based on recollection bias. They claimed the participants could not accurately say how long they had used a cell phone. This is just another example of the industry, and the science they can “buy” with their billions of dollars in profit, manipulating the message and distorting facts in order to confuse the public.


4. Myung et al 2009: Mobile Phone Use and Risk of Tumors: A Meta-Analysis, investigated the
qualities of individual studies. When combined results were analyzed there was overwhelming evidence of link between cell phone use and glioma when the industry funded studies were removed. J Clin Oncol. 2009 Nov 20;27(33):5565-72.

5. Dr. Siegal Sadetzki 2007, Chaim Sheba Medical Center, Tel Hashomer, Israel - **Conclusion:** Found link between brain tumors and cell phones. They also reported heavy cell phone users were more likely to have tumors of the salivary gland compared to those that did not use cell phones. [http://aje.oxfordjournals.org/cgi/reprint/167/4/457](http://aje.oxfordjournals.org/cgi/reprint/167/4/457)


7. **Over 100 International studies showing health risks of cell phones:**
   Public\Documents\150StudiesShowingHealthRisksofCellPhones.xls

8. **RF Effects on Nonpregnant & Pregnant Animals, Newborns & Infants** - N.Seyhan, G.Güler, A.Tomruk*, E.Ozgur - Gazi University Faculty of Medicine Biophysics Department, Ankara, Turkey, 2011. **Study to be published late October, 2011.** **Conclusion:** Exposure to 1800 MHz GSM modulated RFR significantly increases apoptotic changes in the brain and eye tissues of nonpregnant & pregnant rabbits and their offspring.

9. **Effects of the Exposure to Mobile Phones on Male Reproduction** - La Vignera S, Condorelli RA, Vicari E, D’Agata R, Calogero AE. A Review of the Literature. Journal of Andrology. 2011 Jul 28. **Conclusion:** In aggregate, the literature suggests that mobile phone alters sperm parameters both in the experimental animal and in humans. Sperm motility and morphology seem the two parameters more frequently affected. There are evidence that mobile phone radiation results in an increased oxidative stress with consequent sperm membrane lipid and DNA damage. These abnormalities seem to be directly related with the length of mobile phone used. Nevertheless, more studies are necessary to provide stronger evidences that cellular phone use disturb sperm and testicular function since the existing literature has several limitation. These include dishomogeneity in terms of RF wavelength used, depth of penetration, and length of radiation exposure. *(Note: Numerous typos can be found in the pre-publication version of this English-language paper as the authors were Italian.)*
CURRENT MEDIA REPORTS

GQ Magazine: "Warning: Your Cell Phone May Be Hazardous To Your Health, February, 2010

Australian Sixty Minutes report stating that there should be genuine concern that cell phones are causing brain tumors.

Good Morning America: http://www.youtube.com/watch?v=lKXzHW9qMKE
On Good Morning America with Diane Sawyer, Dr. Mehmet Oz reports that radiofrequency rays from cell phones cause damage to brain cells.

http://online.wsj.com/article/SB100014240527023036576357571174992448.html

Dr. Oz: http://www.youtube.com/watch?v=4Uc8O2-KV5w
http://www.youtube.com/watch?v=Cczwz1SE64c http://www.youtube.com/watch?v=BL1q1cEH-cg
Alan Marks and his family on the Dr. Oz show with Dr. Joel Moskowitz and Dr. Devra Davis.

New York Times: “Experts Revive Debate Over Cellphones and Cancer” -
http://www.nytimes.com/2008/06/03/health/03well.html

CNN with Dr. Sanjay Gupta and Alan Marks: http://thechart.blogs.cnn.com/tag/alan-marks-human-factor/

CNN with Dr. Gupta and Dr. Keith Black, chief of Neurosurgery Cedar Sinai Medical Center speaks out on cell phones and brain cancer. He feels his friend and patient, Johnnie Cochran's glioma was more likely than not attributable to his cell phone use. http://thechart.blogs.cnn.com/2011/05/20/gupta-cell-phones-brain-tumors-and-a-wired-earpiece/

http://www.youtube.com/watch?v=MEEnepGB3GCk Dr. Santosh Kesari, Neuro-Oncologist and Director of Moore Cancer Center at UCSD speaks

Time Magazine, Oct. 26, 2010: “Cell Phone Safety- What the FCC Didn’t Test”
http://www.time.com/time/magazine/article/0,9171,2029493,00.html


CNN: Anderson Cooper interviews Dr. Sanjay Gupta on cell phones and cancer May, 2011

CNN Reports Experts’ Rebuttal to Interphone Study : CNN Health: Critic details flaws of cell phone safety study

When will OUR government take action to warn its citizens?
Case Study of a Long-term Cell Phone User

Alan Marks was a healthy intelligent man. He used a cell phone for over 20 years with 10,000 lifetime hours of use for business. At age 56 he suffered a grand mal seizure and was diagnosed with a cancerous brain tumor (glioma) in his right frontal lobe, the same side to which he always held his cell phone against his ear. His diagnosis came days before Senator Kennedy’s, for whom his son had worked. Upon hearing that the Kennedy family suspected cell phone use led to the Senator’s brain tumor, Alan’s wife, Ellen, researched this issue extensively.

After sending his medical and cell phone use records to neurological experts and electromagnetic scientists around the world their suspicions were confirmed that Alan’s brain tumor was “more likely than not the result of his ipsilateral cell phone use”. Had there been a warning and required pre-market safety testing done on cell phones before they were allowed to be held directly against the brains and bodies of unsuspecting consumers, this horror might have been avoided for Alan and the others who have died or are dying from exposure to long term use of their cell phones. Not only has Alan’s life been destroyed, but dealing with the cognitive, behavioral and financial ramifications of Alan’s illness has destroyed the lives of his family members, as well.

Expert Opinion on this case:

“It is more probable than not that Alan Marks’s glioma was caused by his long-term mobile phone use according to current literature. The risk for glioma for ipsilateral (same side of the head) use of mobile phone use during 10 years or more is significantly increased, odds ratio (OR) -1.9, 95% confidence interval (CI)=1.4-2.4 (Hardell et al 2009, Khurana et al 2009). Since Marks used a mobile phone at least 20 years and 10,000 hours his probability would even be higher than the 95%.”

Signed: Lennart Hardell, MD, PhD, Professor and Director of Oncology, Orebro, Sweden

“Had I known that holding the phone to my ear could cause cancer, I never would have played Russian Roulette with it. This will kill me and I do not understand how this industry and our government can knowingly rob a man of his life and not warn him. And they are doing this to so many innocent people, including children. I pray that our government takes action now so that others do not have to suffer as my family has”. Alan Marks, May, 2009
CAMPAIGN FOR SAFER CELL PHONES COMMITTEE: (*lead authors)

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Om P. Gandhi, Professor & Chair, Department of Electrical Engineering, University of Utah
Beth Greer, Founder, Super Natural Mom
Elizabeth Kelley, Founder, Electromagnetic Safety
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Cell phone use and acoustic neuroma: the need for standardized questionnaires and access to industry data.

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Center for Environmental Oncology-University of Pittsburgh Cancer Institute (UPCI), Pittsburgh, PA 15213, USA.

Abstract

BACKGROUND: The capacity of radiofrequency from cell phones to be absorbed into the brain has prompted concerns that regular cell phone use may increase the risk of acoustic neuroma (AN) and other brain tumors. This article critically evaluates current literature on cell phone use and AN risks and proposes additional studies to clarify any possible linkage.

METHODS: Through a PubMed search, we identified and reviewed 10 case-control studies and 1 cohort study of AN risks associated with cell phone use and a meta-analysis of long-term mobile phone use and its association with AN and other brain tumors.

RESULTS: Most studies did not find association between the development of AN and cell phone use, but some studies that followed cases for 10 years or more did show an association. Among 10 case-control studies, odds ratios for AN associated with regular cell phone use ranged from 0.5 (95% confidence interval [CI], 0.2-1.0) to 4.2 (95% CI, 1.8-10). Cell phone use was not associated with increased risk for AN in the Danish cohort study, which excluded business users from their study. The meta-analysis, which included 3 case-control studies, found that subjects who used cell phones for at least 10 years had a 2.4-fold greater risk of developing ipsilateral AN. In general, retrospective studies are limited in the ability to assess cell phone exposure because of recall bias and misclassification.

CONCLUSIONS: The evaluation of AN risk factors is challenging due to its long latency. Some studies of longer term cell phone use have found an increased risk of ipsilateral AN. Adopting a prospective approach to acquire data on cell phone use, obtaining retrospective billing records that provide independent evaluations of exposures, and incorporating information on other key potential risk factors from questionnaires could markedly advance the capacity of studies to evaluate the impact of cell phones on AN.

PMID: 19328527 [PubMed - indexed for MEDLINE]
Congressional Testimony

Thank you Congressman Kucinich for holding this hearing and inviting me to testify. My name is Ellen Marks and I live in Lafayette, California. I am here today because my husband and friend of more than four decades cannot be.

My husband has a malignant brain tumor and sadly we suspect it is related to his long term cell phone exposure. As difficult as this is for my family, I am compelled to share our very personal story and impress upon you to legislate critical changes concerning cell phone health risks.

My husband and I met when we were 15. He is a self made man. he sold flowers in front of a cemetery at age 13 and then paid his own way through college and medical school. We are the proud parents of three adult children, ages 27, 25, and 23. He attended medical school and then became involved in the real estate industry thirty years ago. We moved from our native Chicago to California in 1984. I wish I could say we lived happily ever after but that is not the case.

The night of May 5, 2008, we excitedly packed to leave the next day for our daughter’s college graduation. At 2 a.m. I awoke to my husband’s bizarre noises and thrashing. I could not wake him and the nightmare has yet to end. The worst of his seizure lasted 25 minutes. When his eyes opened he could not speak or understand anything asked of him by the paramedics. Witnessing a grand mal seizure is something you can never erase from your memory. Arms flail, saliva drools, eyes roll back in the head and the face contorts.

At 4 am, in a cold stark emergency room, I was told my lifelong love has a mass in his right frontal lobe; the part of the brain that allows us to differentiate between good and bad, right and wrong, control our impulses, and relate to those we love. Imagine the pain of having to tell our sons, who had raced to the hospital in the middle of the night, that their dad’s increasingly unexplainable behavior was not a personality problem, but a lethal brain tumor. In the morning I had no choice but to call our daughter to tell her not to pick us up at the Denver airport. Imagine her despair as she stood alone learning her daddy could soon die. It is heartbreaking to think he may not have the chance to walk his princess down the aisle or meet his grandchildren.

Six excruciatingly long weeks later Dr. Berger at UCSF performed a six hour craniotomy and resection of the oligodenroglioma leaving my husband able to walk and talk BUT the personality changes remains. Titanium now holds his skull in place and the tumor will grow back. It was a slow growing tumor and caused unexplainable emotional chaos in our family for years. When you love someone and he becomes another person, to act strangely acting out against those they hold dear, you try with all your heart to find ways to help. Her daddy also tried with all his heart to continue to be a loving father and husband as he willingly sought professional help and took antidepressants and bipolar medications for years, to no avail. He too knew something was wrong, but not how terribly wrong.

Now, as a family, we are learning to understand that the now explainable personality changes are actually an involuntary consequence of his tumor and surgery. Alan has always been a brilliant man with an incredible sense of humor and sense of responsibility to his family.
clings to that sense of responsibility now and is deeply depressed by his limitations. To me, he is still the most handsome man in the world, but the twinkle in his eye is gone. His cell phone and the resulting tumor have robbed us of the pursuit of happiness. Alan, a husband, a father and a son has been handed a death sentence at the age of 56.

My husband had his seizure and diagnosis 10 days before Senator Kennedy. Ironically, our son Zack, who is here with me today, worked for Senator Kennedy a few years ago. When we heard a report stating the Senator’s tumor could be linked to cell phone use my research began. Alan’s cell phone was a vital part of his work, always on, always ringing, always right next to his head.

I often threatened to toss it in the garbage - how I wish I had! He had a cell phone for over 20 years and averaged 30 hours monthly. The tumor is on the side of his head to which he held the phone. He has not been exposed to any other form of radiation.

I learned that there are significant flaws in many cell phone risk studies. I learned that researchers in Scandinavia, where cell phones have been used longer than here, proved there is a 240% increased risk of glioma in people who use their cell phone more than 22 hours a month for greater than 10 years. That is less than one hour daily. I learned that cell phone use is exceptionally dangerous for children. I learned that there is a good chance of an epidemic of these gliomas in 20-30 year olds as they use only cell phones. If this happens we will lose more young people to this than any war in Iraq or Afghanistan.

I am grateful that a distinguished cancer scientist such as Dr. Herberman has made such a courageous decision. How can we wait if waiting means sick or dead people when we have strong evidence, or any evidence, that there is a risk?

What has happened to my husband could happen to you, or worse, to your children or grandchildren. I am sick and tired of hearing that there is not enough conclusive evidence. My family and others are conclusive evidence. I am angry as this horror could have been avoided with a simple warning. Only you the great leaders of our nation can take action to correct this. Governments in many other countries have taken steps to protect their citizens from this travesty. I trust you will not fail us.

I beg of you not to let technological advances invented to enrich our lives rob us of our lives instead. Please demand independent research instead of self-serving studies funded by the cell phone industry. Please demand more rigorous safety standards. Please demand that warnings about cell phone usage and the radiation they emit be stated on every cell phone. By doing so you will protect our most valued resource of all – human life. I love my husband with all my heart and I hate what has happened to him as a result of this cancer.

I pray that his legacy can be that we helped save others from facing the deadly diagnosis and lifestyle our family must endure. If not now, when?

Please refer to our website www.CABTA.org

Thank you.
Exposure Limits: The underestimation of absorbed cell phone radiation, especially in children

Om P. Gandhi1, L. Lloyd Morgan2, Alvaro Augusto de Salles3, Yueh-Ying Han4, Ronald B. Herberman2,5 & Devra Lee Davis2

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The existing cell phone certification process uses a plastic model of the head called the Specific Anthropomorphic Mannequin (SAM), representing the top 10% of U.S. military recruits in 1989 and greatly underestimating the Specific Absorption Rate (SAR) for typical mobile phone users, especially children. A superior computer simulation certification process has been approved by the Federal Communications Commission (FCC) but is not employed to certify cell phones. In the United States, the FCC determines maximum allowed exposures. Many countries, especially European Union members, use the “guidelines” of International Commission on Non-Ionizing Radiation Protection (ICNIRP), a non governmental agency. Radiofrequency (RF) exposure to a head smaller than SAM will absorb a relatively higher SAR. Also, SAM uses a fluid having the average electrical properties of the head that cannot indicate differential absorption of specific brain tissue, nor absorption in children or smaller adults. The SAR for a 10-year old is up to 153% higher than the SAR for the SAM model. When electrical properties are considered, a child’s head’s absorption can be over two times greater, and absorption of the skull’s bone marrow can be ten times greater than adults. Therefore, a new certification process is needed that incorporates different modes of use, head sizes, and tissue properties. Anatomically based models should be employed in revising safety standards for these ubiquitous modern devices and standards should be set by accountable, independent groups.

INTRODUCTION

History of Exposure Testing, Guidelines, and Standard-Setting

August 1974

In 1974, a study determined that at certain frequency ranges resonance increased the absorbed radiation by up to nine times higher than that previously assumed for humans (Gandhi, 1974).
In 1975, behavioral studies were performed on food-deprived rats that had learned to bar press for food rewards in order to determine what exposure levels to non-ionizing radiation (NIR) might impair their ability to work for food reward and therefore be deemed as hazardous. The exposure metric used was the specific absorption rate (SAR), the amount of power absorbed per unit mass of tissue (Watt per kilogram). It was determined that trained rats stopped working for food at a whole body average SAR exposure of 4 W/kg (D’Andrea et al., 1975). This level of exposure increased core body temperatures measured with rectal thermometers. It was deduced that the absorbed electromagnetic power was the reason that food-deprived rodents stopped working for food.

September 1982
The American National Standards Institute (ANSI) published the first exposure NIR exposure standard, which incorporated a 10-fold safety factor for humans exposed to electromagnetic fields between 300 kHz and 100 GHz. No reason per se was given for the size of the safety factor other than there was a consensus (ANSI, 1982, p. 14).

In the ANSI standard concerns were expressed that the standard might not be sufficiently protective. “It was recognized that the specific absorption rate (SAR), which provides the basis for limiting power densities, does not contain all of the factors that could be of importance in establishing safe limits of exposure. First, other characteristics of an incident field such as modulation frequency and peak intensity may pose a risk to health.” [emphasis added] Further, the ANSI standard noted that the database they used did not “provide evidence to recommend special provision for modulated fields” (ANSI, 1982, p. 14; see “In-Vivo and In-Vitro Studies” section below).

ANSI adopted a standard for whole body exposure of 0.4 W/kg averaged over 6 min, and a 20-fold greater spatial peak SAR exposure over any 1 gram of tissue of 8 W/kg averaged over 6 min. Effectively, this allowed much higher exposures within the small area of the brain than are permitted over the body. No reason was given for allowing this. The ANSI standard noted the resonant frequency (70 MHz) “results in an approximate sevenfold increase of absorption relative to that in a 2450 MHz field” (ANSI, 1982, p. 12). The intent of this standard was to protect “exposed human beings from harm by any mechanism, including those arising from excessive elevation of temperature.” (ANSI, 1982, p. 12, italics in the original)

The ANSI standard called for a review of the standard every 5 years (ANSI, 1982, p. 11).

1987–1988
ANSI, not having medical expertise, handed over the setting of exposure limits to the Institute of Electrical and Electronic Engineers (IEEE), a professional society of electrical and electronics engineers from the electronics industry as well as academia. IEEE is not chiefly a medical, biological, or public health organization.

September 1991
In 1991, IEEE first revised the ANSI standard (IEEE, 1991), which has not changed substantially since then, although minor revisions were provided by Standard C95.1 in 2005–2006, and these changes were not adopted by the FCC. It established a two-tier system: one for the general population within an “uncontrolled environment,” and one for workers in a “controlled environment,” the latter defined as “locations where there is exposure that may be incurred by persons who are aware of potential for exposure as a concomitant of employment … where … exposure levels may be
[up to a whole body SAR of 0.4W/kg for any 1 gram of tissue averaged over 6 minutes and a peak spatial SAR of 8 W/kg for any 1 gram of tissue averaged over 6 minutes]."

For the general population, the IEEE revision of the ANSI standard reduced the average whole-body and spatial peak SAR by a factor of 5. This reduction was recommended because of concerns that the general population includes a wide range of ages, vulnerabilities and health status, and in some circumstances, the potential of 24/7 exposures. In explanation of this reduction of general population exposure guidelines, the IEEE standard noted, “To some, it would appear attractive and logical to apply a larger ... safety factor ... for the general public. Supportive arguments claim subgroups of greater sensitivity (infants, the aged, the ill, and disabled), potentially greater exposures (24 hr/day vs. 8 hr/day) ... [and] voluntary vs. involuntary exposures. Non-thermal effects, such as efflux of calcium ions from brain tissues, are also mentioned as potential health hazards.” (IEEE, 1991, p. 23) For the general population the standard revised the whole body average SAR exposure to 0.08 W/kg averaged over 30 min and the spatial peak SAR for any 1 gram of tissue to 1.6 W/kg averaged over 30 min (IEEE, 1991, p. 17).

Because the resultant Specific Absorption (SA) is identical for the general population in an uncontrolled environment, as it is for workers in a controlled environment (0.08 W/kg*30 min = 0.4 W/kg*6 min), the “larger safety factor” for the general population is non-existent.

The IEEE language concerning the 20-fold larger spatial peak SAR when compared to the whole body SAR went further than the ANSI standard it replaced. The IEEE standard stated, “... spatial peak SARs may exceed the whole-body averaged values by a factor of more than 20 times.” (IEEE, 1991, p. 25)

Twenty years later this standard remains unchanged, despite minor alterations in 2005–2006.

1992

October 1997
In 1996, the FCC published the first U.S. regulations on maximum allowable cell phone radiation adopting the ANSI/IEEE C95.1-1992 standard, which became effective on October 15, 1997. FCC’s Bulletin 65 described how to evaluate compliance to the FCC regulations for human exposure to electromagnetic fields (Cleveland et al., 1997). The FCC exposure limits were, and remain, identical to the 1991 IEEE standard. The FCC SAR adopted values were:

(1) For occupational exposures, “0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet, and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) [averaged over 6 minutes].”

(2) For the general population exposures, “0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) [averaged over 30 minutes].”

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Once again, the “larger safety factor” for the general population compared to
workers was non-existent. It should be noted that these exceptions did not include
the ear (also referred to as the pinna). As we shall see in “The SAM Cell phone
Certification Process,” section below, this exclusion of the ear is important.

December 1997

Four months later, the FCC published Supplement C, which provided among other
details, additional information for “portable devices” (AKA cell phones)
certification. The introduction states, “Currently, industry groups and other
organizations are working to develop standardized product test procedures to
evaluate RF exposure compliance with ... SAR limits” (Chan et al., 1997, p. 1). [See
June 2001 below.] As this was prior to the adoption of the SAM cell phone
certification process, Supplement C notes several concerns about the existing cell
phone certification process:

(1) “The lack of standardized test positions for evaluating handsets can result in
difficulties in determining RF compliance with SAR limits;” (Chan et al., 1997,
p. 1–2).

(2) The liquid used to simulate the average electrical properties of an adult head
had not been standardized at this time, “The permittivity and conductivity of
simulated liquid tissues prepared for SAR evaluation must be measured to
ensure that they are appropriate ...These parameters are usually measured
periodically or before each SAR evaluation to determine if it is necessary to add
appropriate amounts of water ...” (Chan et al., 1997, p.12).

(3) “Most test facilities use separate head models for testing handsets on the left
and right side of the head. While some models included ears and others do not,
a few have also used a spacer to represent the ear” (Chan et al., 1997, p. 12).

While there was a standardized method to certify the specific SAR for each cell
phone, it was not repeatable from one certification facility to the next.

An alternate certification process within Supplement C was computer simulation.
“Currently the finite-difference time-domain (FDTD) algorithm is the most widely
accepted computation method for SAR modeling. This method adapts very well to
the tissue models which are usually derived from MRI or CT scans, such as those
available from the visible man projects [see “Virtual Family” discussion below].
FDTD offers great flexibility in modeling the inhomogeneous structures of
anatomical tissues and organs. The FDTD method has been used in many far-field
electromagnetic applications during the last three decades. With recent advances in
computing technology, it has become possible to apply this method to near-field
applications for evaluating handsets” (Chan et al., 1997, p. 16).

April 1998

In 1998, a non governmental organization, the International Commission on
Non-Ionizing Radiation Protection (ICNIRP, 1998), provided “guidelines.” ICNIRP
followed IEEE’s lead by adopting the same two-tier system except that both
the general public and occupational exposures were averaged over 6 min. ICNIRP
far-field guideline was, “A whole-body average SAR of 0.4 W/kg⁻¹ has therefore been
chosen as the restriction that provides adequate protection for occupational
exposure. An additional safety factor of 5 is introduced for exposure of the public,
giving an average whole-body SAR limit of 0.08 W/kg⁻¹.” For general public
exposures, the maximum spatial peak SAR = 2.0 W/kg averaged over 10 g, with
Many governments set or recommend exposure limits based on ICNIRP’s “guidelines”. For example, the United Kingdom’s Health Protection Agency (HPA) states on their web page, “There is no explicit UK legislation that limits people’s exposure to electromagnetic fields, including the radio waves used in mobile telephony,” then goes on to state, “The Recommendation incorporates the restrictions on exposure of the general public advised by ICNIRP in its 1998 guidelines” (HPA, 2010).

The ICNIRP guidelines made no recommendation about how to certify a cell phone. It noted, “These guidelines do not directly address product performance standards, which are intended to limit EMF emissions under specified test conditions, nor does the document deal with the techniques used to measure any of the physical quantities that characterize electric, magnetic, and electromagnetic fields. Comprehensive descriptions of instrumentation and measurement techniques for accurately determining such physical quantities may be found elsewhere (NCRP, 1981, 1993; IEEE, 1992; DIN VDE, 1995)” (ICNIRP, 1998, p. 2).

June 2001

In 2001, the FCC’s Supplement C was revised (Means and Chan, 2001). For the first time, a standardized and repeatable, although not necessarily accurate, industry-designed (see December 1997 above) cell phone SAR certification process was available (the SAM cell phone certification process). Yet, the FCC continued to offer the alternative computer simulation certification process, repeating the language from the December 1997 edition (with minute language changes), and then added, “The FDTD method offers great flexibility in modeling the inhomogeneous structures of anatomical tissues and organs” (Means and Chan, 2001, p. 13).

CHRONIC EXPOSURE EFFECTS

All exposure limit standards and/or guidelines rested on avoiding acute heating effects originally observed in food-deprived rats (Chou et al., 2006). Chronic effects from levels of NIR that did not induce a measurable change in temperature were not taken into account. However, the intent of the ANSI standard was to protect the “exposed human being from harm by any mechanism,” not just heating. The IEEE standard increased safety margin was to protect “subgroups of greater sensitivity” from “24 h/day involuntary exposures,” and from “non-thermal effects, such as efflux of calcium ions from brain tissues.” Then and now, there were many studies showing important effects from chronic non-thermal NIR exposure (See September 1991 above; and BioInitiative Working Group, 2007).

The following studies reported findings of harmful effects, but this is not a comprehensive list. There are studies, often industry funded (Huss et al., 2007), that reported no significant effects. The purpose of this section is to describe the multitude of studies that suggest there is a problem.

In-Vivo and In-Vitro Studies

An extensive number of experimental studies below the exposure limits indicate that pulsed digital radiation from cell phones induces an array of biological impacts ranging from blood-brain barrier leakage to brain, liver, and eye damage in prenatally exposed offspring of rabbits and rats, to genotoxic effects on human cells (e.g., Nittby et al., 2009; Salford et al., 2003; Adlkofe, 2004; Schwarz et al., 2008; Guler et al., 2011; Mulak et al., 2011; Tomruk et al., 2010; Odaci et al., 2008).
When human fibroblast cells were exposed to GSM modulated cell phone radiation, the REFLEX project found that genotoxic effects began at \( \text{SAR} = 0.3 \text{ W/kg} \) (Adlkofer, 2004, Fig. 94, p. 135). Another REFLEX study exposed human fibroblast cells to UMTS modulated cell phone radiation found effects beginning at \( \text{SAR} = 0.05 \text{ W/kg} \) (Schwarz et al., 2008). In these studies, a UMTS modulated signal has a 6-fold lower genotoxic threshold than a GSM modulated signal. But, other studies were not consistent with this finding. This suggests that the concerns of the 1982 ANSI that “other characteristics of an incident field such as modulation frequency and peak intensity may pose a risk to health” were prescient, as the pulsed nature of signals may be more important than their power.

**Brain Cancer Studies**

While some studies of brain cancer from chronic cell phone use find no increase in risk, these studies generally have followed people who have used cell phones for a relatively short time. Where long-term, heavy use of cell phones has taken place for over a decade, several epidemiologic case-control studies have found significantly increased risks of brain cancer. The largest brain cancer case-control study was the 13-country, government and industry-funded Interphone study with 2,708 cases and 2,972 controls for glioma, the most serious among many brain cancer types, restricted to ages 30–59 years. (The Interphone Group, 2010). It examined the risk from cell phones, but not the risk from cordless phones. The second largest brain cancer case-control study was done in Sweden without industry funding by Dr. Lennart Hardell’s team. This study had 1,251 brain cancer cases and 2,438 controls (Hardell et al., 2011) and examined the risk for all malignant brain tumors, not just glioma, from both cell phones and cordless phones, ages 20–80 years.

In May 2010 the Interphone study published its first pooled results from all 13 countries. It reported no overall increased risk of brain cancer (glioma only) among short-term cell phone users, but found a more than doubled risk of brain cancer when cell phones were used for 10 or more years compared to short-term users (1–1.9 years), OR = 2.18, 95% CI = 1.43–3.31 (The Interphone Group, 2010).

In contrast, the Hardell et al. 2011 study found risk of malignant brain tumor from use of cell and cordless phones (wireless phones) for >5–10 years, with >195 cumulative hours, OR = 1.4, 95% CI = 1.1–1.8, and for ≥10 years of use, OR = 2.4, 95% CI = 1.7–3.2. Also, it found a strong dose-response risk for all brain cancer types. For every year since first use of a wireless phone, the risk increased by 5.4%, OR = 1.054, 95% CI = 1.036–1.073. Perhaps, most alarming was the risk found by age at first use. When use began as a teenager or younger the risk of astrocytoma from cell phone with >195 cumulative hours and ≥10 years or use, which was more than 3-fold (OR = 3.1, 95% CI = 2.1–4.4, \( p = 2.5 \times 10^{-8} \)).

One meta-study found a doubled risk of brain cancer when cell phones are used ipsilaterally (cell phone use on same side as tumor location) for 10 or more years, OR = 2.0, 95% CI = 1.2–3.4 (Hardell et al., 2008). Another meta-study found for >10 years of ipsilateral use nearly doubled for risk of brain cancer, OR = 1.9, 95% CI = 1.4–2.4 (Khurana et al., 2009).

The overall Principal Investigator (PI) of the Interphone Study, Dr. Elizabeth Cardis, along with the Israeli Interphone PI, Dr. Siegal Sadetzki, published a commentary, *Indications of possible risk in mobile phone studies: should we be concerned?* Based on the evidence of increased brain tumor and acoustic neuroma risk, they concluded, “Simple and low-cost measures, such as the use of text messages, hands-free kits and/or the loud-speaker mode of the phone could substantially reduce exposure to the brain from mobile phones. Therefore, until
definitive scientific answers are available, the adoption of such precautions, particularly among young people, is advisable” (Cardis and Sadetzki 2011).

These findings and more resulted in the International Agency for Research on Cancer (IARC) finding that RF radiation (30 kHz – 300 GHz) is a Class 2B carcinogen (“a possible human carcinogen”) (Baan et al., 2011). RF sources include: cell phones, cordless phones, Bluetooth, amateur radio, cell phone base stations, wireless routers, Wi-Fi, Wi-Max, baby monitors, and Smart Meters.

**Salivary Gland Tumors**

An Israeli Interphone study found a significant risk for parotid gland tumors (a salivary gland in the cheek, below the ear) from > 266.3 cumulative hours of ipsilateral cell phone use, OR = 1.49, 95% CI = 1.05–2.13, with the heaviest users (> 4,479 cumulative hours) having more than a two-fold increased risk of non-malignant parotid gland tumors, OR = 2.42, 95% CI = 1.14–5.11 of this tumor (Sadetzki et al., 2008).

A Swedish Interphone study of parotid gland tumors found a borderline significant risk for ≥ 10 years of ipsilateral use, OR = 2.6, 95% CI = 0.9 – 7.9, p = 0.078 (Lönn et al., 2006).

Scientists working with the Israeli Dental Association in 2009 reported “a sharp rise in the incidence of salivary gland cancer in Israel that researchers believe may be linked to the use of mobile phones…Among salivary gland cancer cases, researchers found a worrying rise in the number of cases of malignant growth in parotid glands.” “Most oral cancer patients were over 70, with only 2.7 percent under the age of 20.” (Even, 2009).

From 1970–2001, parotid gland tumors in Israel had averaged 37 cases per year. From 2002–2006, the cases increased by 65% to an average 61 cases per year (Czerninski et al., 2011). Fig. 1 from this study shows the number of cases per year for the 3 types of salivary gland tumors (parotid, submandibular, and sublingual glands) with smoothed trend lines. Only the parotid gland trend line grew over time. However, the figure suggests a break-point analysis would be even more informative as the data suggest a flat trend from 1970 to the early 1990s, and then a sharp upward linear trend afterwards.

**Male Fertility**

There is a robust and growing literature in both animals and humans that chronic exposures to cell phone radiation, far below existing standards significantly impairs sperm morphology, motility, viability, and count. Often, the mobile phone is placed in the trouser pocket which may lead to significant exposure of the scrotum in men.

One human study found a significant 59% decline in sperm count in men who used cell phones for four or more hours per day as compared with those who did not use cell phones at all (Agarwal et al., 2008). Included in their study were deleterious effects on sperm viability, motility, and morphology (Agarwal et al., 2008).

A study from Hungary found deterioration of human sperm motility associated with self-reported cell phone radiation exposure (Fejes et al., 2005). An Australian study found genotoxic effects on mice sperm (Aitken et al., 2005), while other studies from this group have reported similar effects on human sperm.

A recent study of mice exposed for 6 months to cell phone base station radiation reported, “The exposure of male mice to radiofrequency radiations from mobile phone (GSM) base stations at a workplace complex and residential quarters caused 39.78 and 46.03%, respectively, in sperm head abnormalities compared to 2.13% in control group. Statistical analysis of sperm head abnormality score showed that there was a significant (p < 0.05) difference in occurrence of sperm head abnormalities in test animals. The major abnormalities observed were knobbled hook, pin-head and...
banana shaped sperm head. The occurrence of the sperm head abnormalities was also found to be dose dependent” (Otitoloju et al., 2010). The researchers reported sperm abnormalities at 489 mV/m (workplace), and 646 mV/m (residential) compared to exposure limits of 41,000 mV/m and 58,000 mV/m, respectively (ICNIRP, 1998).

Lastly, a study of human sperm warns, “RF-EMR in both the power density and frequency range of mobile phones enhances mitochondrial reactive oxygen species generation by human spermatozoa, decreasing the motility and vitality of these cells while stimulating DNA base adduct formation and, ultimately DNA fragmentation. These findings have clear implications for the safety of extensive mobile phone use by males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring” (De Iuliis et al., 2009).

**Leukemia**

Two studies have found that chronic cell phone use increased the risk for leukemia. Adjusting for leukemia risk factors, including benzene, solvents, pesticide exposures at work or home, and working or living near power lines, a study in Thailand, found a 3-fold risk of leukemia from GSM cell phone use (OR = 3.0, 95% CI: 1.4 – 6.8) and more than a 4-fold risk for any lymphoid leukemia (OR = 4.5, 95% CI: 1.3 – 15) (Kaufman et al., 2009).

A British study found borderline significant risks of leukemia from >15 years of cell phone use for acute myeloid leukemia (AML), OR = 2.08, 95% CI = 0.98 – 4.39, p = 0.051, and for all leukemia, OR = 1.87, 95% CI: 0.96 – 3.62, p = 0.060 (Cooke et al., 2010).
TWO CELL PHONE SAR CERTIFICATION PROCESSES

The SAM Cell Phone Certification Process

Specific Anthropomorphic Mannequin (SAM) is a plastic head mannequin (Beard and Kainz, 2004), based on the 90th percentile of 1989 United States military recruits (Gordon et al., 1989). While the exposure limit standard considered body sizes “from small infant to large adult,” (ANSI, 1982, p. 14) only a large adult male that weighed about 220 lb (100 kg) and was 6 foot 2 in (188 cm) in height was used for cell phone compliance testing.

The SAM cell phone certification process uses:

1. a plastic head mannequin with an opening at the top of the head (Fig. 1);
2. a liquid whose electrical permittivity and conductivity parameters are equivalent to the average electrical parameters of the 40 tissue types in a head;
3. a robotic arm (Fig. 2) with a small electric field probe attached (the effective 3-dimensional resolution is limited by the dimensions of the probe).

For cell phone certification a liquid is poured into the head with the average permittivity and conductivity of the head tissues. A cell phone is affixed to either side of the mannequin with a tapered flat spacer used instead of the ear, and the robotic arm measures the electric field within the volume of the mannequin with a resolution of somewhat better than 1 cm$^3$. The SAR values are calculated from the electric field measurements along with the 3-D location of each measurement and the properties of the liquid. The resulted SAR value has a tolerance of $\pm 30\%$ (IEEE 2003, p. 55). Thus a cell phone certified at the exposure limit of 1.6 W/kg could be as large as 2.08 W/kg.

The Computer Simulation Certification Process

For the computer simulation certification process, the revised FCC Supplement C publication states, “Currently, the finite-difference time-domain (FDTD) algorithm is the most widely accepted computational method for SAR modeling. This method adapts very well to the tissue models that are usually derived from MRI or CT scans such as those currently used by many research institutions. The FDTD method offers great flexibility in modeling the inhomogeneous structures of anatomical tissues and organs (Means and Chan, 2001, p. 13).”

FIGURE 2 Robotic arm with electric field probe. Source: Speag DASY 52 Info Sheet.
The Food and Drug Administration (FDA), which has ultimate responsibility for U.S. cell phone safety, has a “Virtual Family” based on MRI scans that indicate different brain tissue properties for use with computer simulation. “Family” members currently include: a 5-year old girl, a 6-year old boy, an 8-year old girl, an 11-year old girl, a 14-year old boy, a 26-year old female, a 35-year old male, an obese male adult, and 3 pregnant women with fetuses at 3rd, 7th, and 9th months of gestation. Additional “family” members are under development (Christ et al., 2010b). “[T]he Virtual Family is already used by more than 200 research groups worldwide.” (http://www.itis.ethz.ch/research/virtual-population/virtual-population-project/, accessed 28 Dec. 2010).

Fig. 3 illustrates the members of the “Virtual Family.”

“The development of the [Virtual Family] models was carried out in cooperation with the Center for Devices and Radiological Health of the U. S. Food and Drug Administration (FDA), Silver Spring, MD, USA; the Austrian Research Centers GmbH, Seibersdorf, Austria; the University of Houston, TX, USA; the Hospital of the Friedrich-Alexander-University (FAU), Erlangen, Germany; and Siemens Medical Solutions, Erlangen, Germany” (http://www.itis.ethz.ch/services/population-and-animal-models/population-models/, accessed December 10, 2010).

The FCC also regulates medical implants in concert with the FDA. Because metal implants can interact with exogenous electromagnetic fields, computer simulation is also used to calculate resultant interactions.

In order to use the FDTD computer simulation process to certify that cell phones meet the SAR exposure standards the FDTD computer simulation model of the cell phone submitted for certification is required. Because such models are required for product development, they are available.

RESULTS (SAM CELL PHONE CERTIFICATION PROCESS IN COMPARISON TO FDTD COMPUTER SIMULATION PROCESS)

Because any head size smaller than SAM receives a larger SAR, children receive the largest SAR relative to adults modeled with the SAM process. Gandhi et al. (1996) reported that for 5- and 10-year old children, using only head size differences compared to an adult, the children’s SAR was 153% higher than adults. Wiart et al. (2008) employed MRI scans of children between 5 and 8 years of age and found approximately 2 times higher SAR in children compared to adults, and Kuster et al. (2009) reported that the peak SAR of children’s CNS tissues is “significantly larger (~2x) because the RF source is closer and skin and bone layers are thinner.” de Salles et al. (2006), using scans of a 10-year old boy’s head with children’s electrical tissue parameters found that differences in head size and other parameters increased the SAR by 60% compared to an adult. Peyman et al. (2001) found the relative permittivity of an adult brain was around 40 while a young child’s brain is from to 60–80, resulting in a child’s SAR being 50–100% higher than an adult’s independent of head size. Han et al. (2010) provided additional analyses of the underestimation of spatial peak SAR with the SAM process.

Not only are children exposed to a higher SAR, but also the relative volume of the exposed and still developing child’s brain is far greater than in adults. Fig. 4 shows the depth of the cell phone’s radiation absorption into the brain is largest for the 5-year old penetrating far beyond the mid-brain. For 10-year old children the penetration of radiation is less, but still beyond the mid-brain, and for the adult, the penetration is much less, and ends well before the mid-brain (Gandhi et al., 1996).

Of course, while no models have been developed for toddlers or infants who may be using or playing with cell phones today, their absorption would be even greater than that of a 5-year old, because their skulls are yet thinner and their brains are yet more conductive and far less developed.

A recent study (Christ et al., 2010a) details the age dependence of electrical properties on the brain, concluding that:

"Exposure of regions inside the brains of young children (e.g. hippocampus, hypothalamus, etc.) can be higher by more than 2 dB – 5 dB [1.6 – 3.2 times] in comparison to adults."

"Exposure of the bone marrow of children can exceed that of adults by about a factor of 10. This is due to the strong decrease in electric conductivity of this tissue with age."

"Exposure of the eyes of children is higher than that of adults."

"Because of differences in their position with respect to the ear, brain regions close to the surface can exhibit large differences in exposure between adults and children. The cerebellum of children can show a peak spatial average SAR more than 4 dB [2.5 times] higher than the local exposure of the cortex of adults."

Increased exposure to the eyes and cerebellum was suggested in a 1998 study of far-field exposures at resonant frequencies to the head and neck (Tinnisword et al., 1998). The authors noted, “[T]he highest absorption is in the neck as the currents generated in the head have to flow into the body through the constricted volume of the neck concentrating them (i.e., increasing the current density) and as a result increasing the SAR.” A figure (see figure 5 below) from this article suggests that there is a significantly increased SAR to the thyroid gland.

However, with a dearth of U.S. research funds provided for cell phone research, no studies have examined the exposure of the thyroid gland when using a cell phone.

Another study analyzed relatively greater absorption of children and adults smaller than SAM and concluded, “The results suggest that the recommended ICNIRP reference levels need to be revised” (Bakker et al., 2010), and proposed “fine-tuning” the ICNIRP guidelines.
The spacer used to imitate the ear in the SAM mannequin also results in an underestimation of the SAR. Radiation decreases as the square of the distance from the antenna increases in the far field, and in the near field, radiation decreases as the cube of the distance from the antenna increases. This means that even a small increase in distance has a large effect. Gandhi and Kang (2002) found that incorporating a plastic ear model (or “pinna”) with a 10 mm spacer gave artificially lowered SARs, which are up to two or more times smaller than for realistic anatomic models that hold cell phones directly to the ear. In two studies, the use of plastic spacers results in an underestimation of the SAR by up to 15% for every additional millimeter of thickness of such spacers (Gandhi and Kang, 2002, 2004).

“A mobile phone compliant with the ICNIRP standard of 2.0 W/kg SAR in 10 g of tissue may lead to a 2.5 to 3 times excess above the FCC standard of 1.6 W/kg in 1 g of tissue (i.e., 4–5 W/kg in a cube of 1 g of tissue)” (Gandhi and Kang, 2002).

When the back of a cell phone (typically where the transmitting antenna is located) was placed in a shirt pocket while using a cell phone with a headset, a 2002 study found that the SAR increased by up to 7-fold (Kang and Gandhi, 2002). This suggests when a cell phone is in a shirt pocket the surface of the heart muscle closest to the skin could be absorbing substantial cell phone radiation.

Table 1, adapted from Table 2 of Han et al. (2010), summarizes the various findings. ICNIRP, based on its 1998 Guidelines, relies on a larger 10-g volume and a higher 2 W/kg SAR for limiting brain exposures compared to the FCC’s 1-g standard.

DISCUSSION

The FDTD computer simulation process, based on MRI/CT scans, employs anatomically correct head sizes, and allows for inclusion of 80 tissues types with accurate 3-dimension locations, with the electrical properties of each tissue type used to calculate the cell phone’s SAR to a resolution of 1 mm$^3$ or better.

In contrast, the SAM process, uses a large male head, and assumes the inside of human head is homogenous via a liquid with the average electrical properties of the head. Of course a real head has an ear, not a 10 mm plastic spacer. For this reason the consumer booklets with the information of the functions, etc. of the mobile phone usually contain a page with safety information stating that the phone must not be placed closer than 10 or 15 or even 25 mm to the body. Because the

![FIGURE 5](image.png)

**FIGURE 5** The SAR distribution in the head and neck at 207 MHz under isolated conditions. Far-field power density = 1 mW/cm$^2$ (adapted from Figure 6; Tinniswood et al., 1998).
10 mm plastic spacer used in testing artificially lowers the calculated SAR for every phone, these booklets make no statement about keeping the device at a distance from the head.

The existing SAR cell phone certification process systematically underestimates exposure for any head smaller than SAM model, and also assumes that the head is homogenous. In fact, tissues and organs in the head vary substantially in density and capacity to absorb radiation and this variation changes inversely with age of children. Only 3% of the U.S. population has a head the size of SAM and no one has a uniformly consistent brain with dielectrically homogenous tissue. Adoption of the FDTD approach would generate standards that reflect the anatomic properties of the brain and correct for this systematic underestimation of the SAM cell phone certification process. Table 2 compares attributes of the SAM cell phone SAR certification process and the FDTD computer simulation cell phone SAR certification process.

For all of the reasons presented in this analysis, the existing cell phone SAR certification process does not adequately protect 97% of the population, i.e., those with heads smaller than SAM. Because children absorb more cell phone radiation than adults, this lack of adequate protection is even of more concern with their growing use of cell phones.

In addition, to these major problems, contemporary cell phones do not comply with the existing certified SAR value when held directly at the head or kept in a pocket. According to manufacturers’ advisories, cell phones can exceed the FCC exposure guidelines as commonly used. Here are some examples of manufacturer’s warnings:

TABLE 1 Summary of the results confirming that children absorb more radiated electromagnetic energy from cell phones resulting in higher specific absorption rate (SAR) as compared to adults (adapted from Table 3, Han et al 2010).

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Highlights of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gandhi et al. (1996)</td>
<td>Deeper penetration of absorbed energy for models of 10- and 5-year old children; peak 1-g SAR for children up to 53% higher than adults.</td>
</tr>
<tr>
<td>Wiart et al. (2008)</td>
<td>1-g SAR of brain tissues of children is about two times higher than adults. Spatial peak SAR of the CNS of children is “significantly larger (~2x) because the RF source is closer and skin and bone layers are thinner”; “bone marrow exposure strongly varies with age and is significantly larger for children (~10x)”</td>
</tr>
<tr>
<td>Kuster (2009)</td>
<td>The 1-g SAR for a 10-year old boy is about 60% higher than for the adults.</td>
</tr>
<tr>
<td>DeSalles et al. (2006)</td>
<td>Children’s SAR is 50–100% higher than an adult’s SAR.</td>
</tr>
<tr>
<td>Peyman et al. (2001)</td>
<td>Hypocampus and hypothalamus receive 1.6–3.1 higher SAR in children compared to adults; children’s bone marrow receive 10 times higher SAR than adults; children receive higher SAR to the eyes than adults; children’s cerebellum receive &gt; 2.5 time higher SAR than adults.</td>
</tr>
<tr>
<td>Christ et al. (2010a)</td>
<td>Up to 7 times SAR when back of cell phone in a shirt pocket is closest to skin.</td>
</tr>
<tr>
<td>Tinnisword et al. (2008)</td>
<td>10 mm spacer on SAM artificially lowers SAR. Deeper penetration of absorbed energy for smaller heads typical of women and children; peak 1-g SAR for smaller heads up to 56% higher than for larger heads.</td>
</tr>
<tr>
<td>Bakker et al. (2010)</td>
<td>Recommended ICNIRP reference levels be revised</td>
</tr>
<tr>
<td>Kang and Gandhi (2002)</td>
<td>Plastic spacer used on SAM for ear (or pinna) decreases SAR by 15% per millimeter.</td>
</tr>
<tr>
<td>Gandhi and Kang (2002)</td>
<td>ICNIRP’s 2 W/kg, 10 g spatial peak SAR results in 2.3–3 times high SAR than FCC’s 1.6 W/kg, 1 g spatial peak SAR</td>
</tr>
<tr>
<td>Wang and Fujiwara (2003)</td>
<td>Compared to peak local SAR in the adult head, we found “a considerable increase in the children’s heads.”</td>
</tr>
<tr>
<td>Martinez-Burdalo et al. (2004)</td>
<td>As head size decreases, the percentage of energy absorbed in the brain increases; so higher SAR in children’s brains can be expected.</td>
</tr>
</tbody>
</table>
TABLE 2 Comparison of cell phone certification processes.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>SAM Process</th>
<th>FDTD Process</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children’s exposures</td>
<td>No</td>
<td>Yes</td>
<td>Male &amp; female, multiple ages, 1, 3 &amp; 9 months</td>
</tr>
<tr>
<td>Pregnant women’s exposure</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Female exposure</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Small male exposure</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Large male exposure</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Electrical tissue parameters</td>
<td>Average of all tissues</td>
<td>Specific for each tissue</td>
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</tr>
<tr>
<td>3-D Resolution</td>
<td>1 cm³</td>
<td>1 mm³</td>
<td></td>
</tr>
<tr>
<td>Relative cost</td>
<td>High</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Medical implant modeling</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Testes exposure</td>
<td>No</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>Eye exposure</td>
<td>No</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>Thyroid gland exposure</td>
<td>No</td>
<td>Possible</td>
<td></td>
</tr>
</tbody>
</table>

(1) BlackBerry Torch: “To maintain compliance with FCC, IC, MIC, and EU RF exposure guidelines when you carry the BlackBerry device on your body, ... keep the BlackBerry device at least 0.98 in. (25 mm) from your body ...” “To reduce radio frequency (RF) exposure ... keep the BlackBerry device at least 0.98 in (25 mm) from your body (including the abdomen of pregnant women and the lower abdomen of teenagers ...),” i.e., implicitly indicating the importance of keeping it away from teenage boys’ testicles (BlackBerry, 2010, p. 23).

(2) Nokia 1100: “This product meets RF exposure guidelines ... when positioned at least 1.5 cm away from the body ... and should position the product at least 1.5 cm away from your body.” (Nokia, 2003, p. 63)

(3) Motorola V195 GSM: “keep the mobile device and its antenna at least 2.5 cm (1 in) from your body.” (Motorola, 2008, p. 70)

The FCC directive states, “For purposes of evaluating compliance with localized SAR guidelines, portable devices should be tested or evaluated based on normal operating positions or conditions (Cleveland et al., 1997, p. 42).” [emphasis added] In fact, phones are only tested with a spacer next to the ear or hip and are not tested in the ways that people commonly operate them, i.e., in their trouser or shirt pockets. Moreover, no tests simulate use by the 97% of the population with heads smaller than SAM.

The 5-fold reduction in SAR exposure limits for the general population in the IEEE standard, and adopted by the FCC, was intended to protect the most “sensitive”: “infants, aged, the ill and disabled.” However, no such reduction exists when SA is considered.

Finally, The FDTD resolution of brain tissues and organs is by three orders of magnitude higher than the resolution of SAM (the dimensions of the electric field probe cannot be made much smaller without losing too much sensitivity). There is a need to protect the most “sensitive” users because, due to curvature of tissue layers but also due to differences in dielectric properties of adjacent tissues and their geometry, “hot spots” (small brain volumes with intense energy absorption), the result of focusing, could occur.

CONCLUSIONS

(1) Because, the SAM-based cell phone certification process substantially underestimates the SAR for 97% of the population, especially for children, the SAM-based certification process should be discontinued forthwith.
An alternative FDTD computer simulation cell phone certification process is immediately available and provides three orders of magnitude higher resolution than the SAM-based system for the head.

The anatomically based “Virtual Family” includes sensitive groups such as small children, pregnant women, and the fetus.

Advisories found in cell phone manuals violate the FCC compliance guidelines, because they do not take into account customary use of phones in pockets and held directly next to the head.

The SAM-based cell phone certification process is unable to address exposure to sensitive tissues such as the testes or the eyes, while the FDTD method can address exposures to such sensitive tissues.

Because billions of young children and adults with heads smaller than SAM are now using cell phones extensively, and because they absorb proportionally greater cell phone radiation, it is essential and urgent that governments around the world revise approaches to setting standards for cell phone radiation, to include sufficient protection of children.

Cell phone for which SAR values were certified prior to June 2001 were not required to be replicatable between different certification facilities (see “December 1997”) above.

We have shown that children and small adults absorb significantly more cell phone radiation than SAM estimates. Accordingly, contemporary cell phone standards for all of the world’s more than five billion cell phones do not protect the young or the 97% of the population with heads smaller than SAM. Until SAR standards have been revised, Israel (Azoulay and Rinat 2008), Finland (YLE.fi 2010), France (Lean, 2010), India (India eNews, 2008), and the U.K (BBC, 2000) recommend limited use by children, using wired headsets, hands-free kits, texting, and keeping the mobile phone away from the head and from the body to substantially lower exposures with current cell phones.

Governments all over the world should urgently require that industry sell cell phones that work only with headsets (sans speakers and microphones). Then users would have to employ wired or other hands free devices for headphones with the result that the cell phone would be kept away from their heads while talking on cell phones.

The long-term impact of cell phone radiation is a matter that merits major research investment and serious public scrutiny. Anatomically based models should be employed in revising safety standards for these ubiquitous modern devices. Standard setting should not be the province of non-governmental, non-accountable agencies, such as ICNIRP which has been heavily funded by industry, but should be carried out by governmental agencies accountable to the public or by independent experts accountable to governments.

**Declaration of Interest**

Support for this work was provided by grants to Environmental Health Trust by the Flow Fund, Lucy Waletzky Fund, and the Carolyn Fine Friedman Fund. The authors report no conflicts of interest. The authors alone are responsible for the content of and writing of the article.

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ENVIRONMENTAL HEALTH TRUST
WASHINGTON RESEARCH AGENDA

2009

RESULTING FROM THE WASHINGTON, D.C. EXPERT CONFERENCE ON
CELL PHONES AND HEALTH
SEPTEMBER 12th-14th, 2009

EDITED BY
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PREAMBLE - INTRODUCTION

Convened by the non-profit research organization, Environmental Health Trust, the Washington Conference on Cell Phones and Health (September 2009) evaluated biological and possible health effects of exposure to radiofrequency electromagnetic fields (RF-EMF) emitted from mobile phones. Participants of the Conference have reviewed the current status of scientific knowledge and identified major gaps in knowledge.

It is an ongoing controversy whether the users of mobile phones should be concerned about the health safety of the radiation emitted by these devices, and whether the safety guidelines are adequate. Because of the methodological and study design limitations that are intrinsic to different types of studies (epidemiology, human volunteer, animal and in vitro studies) scientific evidence amassed to date is still insufficient to support safety claims regarding current patterns of use of RF-EMF.

In addition to the already available scientific evidence, there is the need to consider the “missing” evidence and to develop a coherent plan for conducting additional interdisciplinary studies. Only when considering both the available and the missing evidence can we determine the reliability of the current safety guidelines.

The Washington conference participants, as scientists directly involved in research on the effects of mobile phone radiation, recognize the difficulties in carrying out research caused by the shortage of funding. They recognize the need for a major, sustained commitment of funding to initiate, conduct and complete the necessary research on biological and health effects of mobile phone radiation.

Considering the large number of exposed citizens worldwide, even a small health effect associated with RF-EMF might pose a serious financial problem for health care providers. Therefore, in the present situation of scientific uncertainty, it is wise to promote research that will help to increase reliability of the current safety guidelines in addition to advocate use of precautionary approaches to mobile phone use. The research proposed in this Environmental Health Trust Washington Research Agenda-2009 is specifically tailored to answer the most urgent questions, as outlined below.

The Environmental Health Trust Washington Research Agenda-2009 acknowledges and largely agrees with the WHO Research Agenda 2006 (Annex-1). However, the new Agenda considers also the new evidence that has become available between 2006 and 2009. Finally, this Agenda also recognizes the critical need to create a well-funded, multi-year, broad, multi-disciplinary program of undergraduate, graduate, post-doctoral and continuing professional education in biomedical sciences, epidemiology, biophysics, toxicology, engineering, translational sciences and other relevant fields.

To ensure the independence of these activities, it will be important to create an independent advisory group that will identify priorities and data gaps and provide overall guidance. Funding appropriation and selection of projects for funding should be based on an impartial peer-review process free of conflict of interest. It is recommended that the research-proposal review guidelines similar to those of the US National Institutes of Health be adopted.

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1 EXPOSURE ASSESSMENT

RF-EMF exposures concern both work and private life. The range and number of RF-EMF-emitting devices is constantly changing and there are gaps in the knowledge about the assessment of such combined exposures from multiple sources of exposure, and with varying between near- and far-field exposures.

As already recognized by the WHO (Research Agenda 2006; see Annex-1), qualified surveys require a collaborative effort between epidemiologists, physicists and engineers. The studies should focus on the general population and should include, for instance, the relative contribution of occupational and residential exposures, and the impact of age, gender and mobility. Regional variations also need to be assessed. These studies will inform the feasibility of future epidemiologic studies and, if appropriate, the proper design of residential epidemiological studies.

1.1 HUMAN LIVING ENVIRONMENT EXPOSURE

The EMF emission of every single commercially available device meets the FCC and ICNIRP safety standards. However, there is no sufficient information about the human EMF exposures in environments with various devices emitting EMF simultaneously.

Research Needs:
- Assessment of typical and “worst case” exposure conditions in environments with various EMF-emitting devices.
- Simulations, real-time dosimetric monitoring and questionnaires regarding real-time patterns of use and exposure for persons of varying age groups and use conditions, ranging from children to workers whose jobs require frequent use regularly.

The research output will provide life scientists with more realistic EMF exposure scenarios for the examination of effects in cells, animals and humans, which may indicate a biological effect or health risk.

1.2 MODELING OF CHILD-HEAD EXPOSURES

There is general consensus that children’s brain tissues absorb higher level of energy from exposure to mobile phones (held to the ear) compared to adults. More realistic models for device testing are critically needed. Research projects will require an interdisciplinary approach by experienced life scientists (anatomists), physicists, and engineers.

Research needs:
- Develop model-skulls for children of various age, and
- Simulate the absorption of mobile phone radiation in children’s heads.
- Conduct simulations and validations of multiple-RF whole body exposures to
  - validate whole-body modeling of adults and children, man and woman,
  - including all stages of pregnancy, and
  - the male reproductive system.
The research output will provide safety standard setting tools with more realistic exposure scenarios for children. This will indicate whether it is appropriate to develop new safety standards addressing specifically the exposure of children.

1.3 MICRODOSIMETRY

Qualified research consortia will include an interdisciplined team of life scientists, physicists, and engineers, and will include large scale computation of model simulations. So called ‘‘hotspots’’ can vary by 1000 folds or more within a gram of tissue. Currently the use of larger tissue volumes does systematically underestimate the local radiation intensity. We can detect and measure ‘‘hotspots’’ on the macro-scale but we do not have yet technology to measure whether ‘‘hotspots’’ are created on the micro-scale (sub-cellular scale). Living tissues and cells are not homogenous environments but they are compartmentalized into cells and sub-cellular size volumes (organelles) that are delineated by lipid-containing hydrophobic membranes. Presently, dosimetry and modeling of the distribution and intensity of mobile phone radiation in the brain uses as a model a plastic container molded in the form of half-head and filled with “physiological solution” consisting of water, salt and sugar. Such models of human heads are a great oversimplification of the reality. Strong electromagnetic fields can disrupt the function of selective transport mechanisms of cellular membranes and cause profound physiological changes (e.g. electroporation). The research output will provide evidence for the understanding of cellular reaction patterns and the determination of compliance with exposure limits.
2 SENSITIVE VS NON-SENSITIVE BIOLOGICAL MATTER

There is evidence that individual sensitivity phenomenon might explain differences in reports on the biological response to RF-EMF radiation. Therefore this research line requires two steps:

1. Define sensitive populations (cells, animal species, humans)
2. Define the exposure thresholds (Intensity and time) in sensitive populations

2.1 LABORATORY STUDIES (MECHANISMS OF SENSITIVITY)

The majority of research on the biological effects of mobile phone radiation has been done in in vitro studies. Some of these studies suggest that mobile phone radiation might alter cell physiology, e.g. by triggering cellular stress response, causing DNA damage, altering gene and protein expression, etc. However, there are also studies that do not reveal such effects.

2.1.1 CELL CULTURE: ALTERATION OF DNA PROTEIN, ETC.

One of the more vigorously debated issues is whether RF-EMF exposure is associated with DNA damage. It seems clear that without further research the issue of DNA damage will not be resolved. The same might apply to many other cellular effects. In vitro studies cannot be directly used to determine the probability of health risks; they are indispensable to discover the cellular biological and biochemical mechanisms needed to complement positive outcomes from human and animal studies and to reveal the interaction mechanisms between RF-EMF and living organisms. Therefore interdisciplinary proposals with the following aims should be given high priority:

- Appropriate measures of
  - genotoxicity,
  - gene and protein expression,
  - protein de novo synthesis, etc
- Intervention studies with anti-oxidants and other free radical scavengers to identify potential chemo-protective measures.
- Intervention studies with known “sensitizing” chemicals.

2.1.2 ANIMAL STUDIES

The following issues (awaiting the outcome of in vitro research) should be pursued with various animal species/strains:

- in vivo laboratory studies with sensitive species/strains
- fertility and developmental studies
- experimental studies with flatworm C. Elegans and other lower species to determine impacts of RF on growth and development
- compare responses of young-developing vs. adult animals.

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2.1.3 HUMAN VOLUNTEER STUDIES

So far human volunteer studies have focused on mobile phone radiation effects on cognition, brain electrophysiology, blood pressure, headaches, allergy-like symptoms, sleep disorders, and direct exposure-recognition by the exposed subject.

In addition to such studies we also need to examine whether human bodies (tissues, cells) respond to mobile phone radiation at molecular levels. Such studies with methods of proteomics, transcriptomics and other reliable biochemical analyses, are urgently needed to demonstrate whether or not human tissues, organs, or cells are altered by RF-EMF exposure. Such studies will not only show whether or not humans (or human tissues) respond to RF-EMF, but also will provide information which molecules, proteins and genes react to mobile phone radiation. With this information, it will be possible to confirm existing safety standards or, alternatively, formulate new knowledge-based hypotheses for further health-risk related studies in humans.

By using easily accessible bodily materials and widely accepted methods, the exploration of various materials should be subjected to double blind tests in real and sham exposed cohorts of about 50 to 150 participants to describe thresholds in dose & time.

High priority studies to examine molecular level response in humans should investigate:

- gene expression,
- protein expression,
- protein phosphorylation,
- protein synthesis

Samples for analysis can be

- Buccal smears, hair follicles, skin biopsies, blood samples, saliva, or semen

Low priority studies to investigate cognitive functions

- Cohort and case-cross over design tests of brain function, short- and long-term memories, recall, and other performance measures on standardized cognitive tests, etc.

2.2 DEFINE THRESHOLDS (DOSE AND TIME)

Following studies with sensitive biological matter, in a series of systematic research we need to establish thresholds in dose and time. For this research different endpoints can be used:

- Cell cultures (DNA, Proteins, etc.)
- Animal studies
- Human volunteers
  - Cognitive tests
  - Investigation of exposed samples

3 DEFINE ACTIVE EMF PARAMETERS

Knowledge on EMF-Exposure parameters (e.g. frequency, modulation, etc.), which provoke or increase sensitive reactions, will have an important impact on
the development of safe EMF emitting devices, and future setting of safety standards. This programme line aims to investigate

- the contribution of different component show each component of RF-EMF signals (frequency, modulation, etc.) contributes to biological responses
- the impact and contribution of the specific field (e.g. various modulations) on molecular alterations in human cells
- the threshold (intensity and time) of exposure with fields of different modulations.

Therefore, in interdisciplinary projects, involving life-scientists and engineers, the following conditions should be systematically investigated in sensitive species.

- Various EMF signal parameters (carrier frequency, modulation, etc.)
- Exposure parameters (intensity and exposure time)
- Exposure patterns (e.g., on/off pattern compared to continuous exposure)

3.1 IN VITRO (CELL CULTURE)

For this programme line, using *in vitro* tests with widely accepted methods (e.g. DNA alterations and “protein expression”) studies of effects of EMF signal parameters on cells with established sensitivity are required.

Proposals with the following endpoints and aims should be given high priority:

- genotoxicity, protein expression and synthesis,
- investigation with free radical scavengers and
- “sensitizing” chemicals to identify potential mechanisms.

3.2 IN VIVO ANIMAL RESEARCH

In this programme line animal experiments have low priority. However, the following issues (awaiting the outcome of *in vitro* research) should be pursued with various animal species/strains:

- *in vivo* laboratory studies with lifetime exposure protocols
- reproductive and developmental studies
- developmental, behavioral and cognitivesensitive model animals (e.g. planaria)

3.3 BEHAVIOURAL ANIMAL STUDIES

Either as part of other animal studies or in projects with lower species such as flatworm the focus on neurofunction and behavior a variety of strains should be tested for their ability to

- Learn
- Memorize
- Orient
- Reaction Time and with experimental mammals decision Quality)

3.4 HUMAN VOLUNTEER STUDIES

In this programme line (impact of specific exposure parameters), by using clearly defined test systems and easily accessible bodily samples and widely accepted methods, the exploration of various field conditions should be subjected to double blind tests in
real and sham exposed cohorts. In case of positive findings further systematic research should be carried out to define thresholds (dose and time).

High priority studies to examine in humans should be about:

- gene expression,
- protein expression,
- protein phosphorylation,
- protein synthesis
- cellular signaling pathways

Samples for analysis can be

- Buccal smears, hair follicles, skin biopsies, blood, saliva, or semen.

Low priority: studies to investigate cognitive functions

- Cohort and case-cross over design tests of brain function, short- and long-term memories, recall, and other performance measures on standardized cognitive tests
- post exposure effects
- Cognitive function, in adults and children,
- Interference with sleep.

4 NEURO FUNCTION, COGNITIVE EFFECTS

4.1 HUMAN ACUTE STUDIES

So far most studies investigated reaction time, little is known about decision quality. We therefore recommend investigating in laboratory settings the quality of decision making under exposure.

4.2 HUMAN STUDIES “LONG TERM EXPOSURE EFFECTS”

Short term and long term memory

4.3 ANIMAL “ACUTE”

- Decision making
- Decision quality

4.4 ANIMAL STUDIES (LONG TERM EFFECTS)

Memory after long term exposure

5 LONG TERM EFFECTS

A specific difference to toxicological research is that EMF field intensities cannot be exaggerated to create a Maximum Tolerated Dose (MTD). At high RF-EMF intensities, heat-related damage occurs. Clearly the risk is associated with long term exposure to low-intensity (without measurable heating). Therefore, the investigation of exposure
associated toxicology must be studied with an approach, which increases the dose by extending exposure time (sometimes over years).

5.1 ANIMAL STUDIES

In vivo research (on animals) should focus on the following endpoints

- Tumor Initiation / promotion
- Other chronic endpoints evaluated in lifetime studies, such as those currently being carried out by the Ramazzini Foundation (Italy)
- Life expectancy
- Teratogenesis and other developmental studies including male-mediated teratogenesis

5.2 HUMAN EPIDEMIOLOGY

In view of the currently ongoing cohort study COSMOS, which recently has started in Europe (5 countries), similar studies should be launched in the USA to have some sort of “replication”.

In agreement with the WHO (Research agenda – 2006, Annex-1) the following epidemiological studies can contribute to describe the exposure associated risk after long term exposure to RF-EMF emitting devices.

- Epidemiology, cohort and cross-sectional evaluations of self-reported long term exposure and validated records of cell phone use with: Alzheimer’s and brain
- Salivary gland,
- Other head and neck tumors, lymphoma,
- Other tumors;
- Parkinson’s, Alzheimer’s and other neurodegenerative conditions;
- Reproductive impairment in men and women, including measures of sperm count, motility, morphology;
- Measure changes in hearing and visual acuity;
- Brain development in children
6 NETWORKING - CONFERENCES

Because the programme is fundamentally international in scope, it is critical that there be created electronic networks to enhance opportunities for exchange of information. To increase the research program’s impact and reach the interested public, an extended audience should be given the opportunity to communicate with the research consortia within this programme. Information on worldwide independent research protocols and funded studies should be exchanged among researchers.

The network communication will require and achieve:
- organization of regularly held SKYPE or goto meeting exchanges between experts on selected topics outlined
- to enhance international collaboration and exchange of information
- regular international conferences organized around major areas of expertise that will feature the results of the research agenda proposed in this document.
- involvement of extended audience
- first line information of stakeholders

Washington, Dec. 121, 2009

A list of the conference participants
7 ANNEX - 1, GRAPHICAL OVERVIEW

The diagram summarizes major research lines and tasks as detailed in the text. The views expressed in this report do not necessarily reflect the views of each participant.

<table>
<thead>
<tr>
<th>Pos</th>
<th>Priority</th>
<th>Research type</th>
<th>Additional information</th>
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</thead>
<tbody>
<tr>
<td>1a</td>
<td>High</td>
<td>Large scale, longitudinal, cohort, mobile phones, incidence, mortality</td>
<td>A prospective cohort study is being recommended to build on the results of case-control studies, such as the INTERPHONE study, which examines cell phone use for periods of &lt; 10 years, and for which it is not possible to rule out health effects that might appear after a greater latency period or longer exposure. The high priority given to the cohort study on adults reflects the recent findings from case-control studies indicating some risk increases for certain tumours, but where recall bias or selection bias may have affected the results. Non-cancer endpoints (e.g. sleep, headache) for adults are of interest because some studies have suggested these endpoints may be related, and because they can be evaluated concurrently in a cohort study. Note: Though such a study is being established in Europe, it could be significantly strengthened by increasing the size of the cohort through broader international collaboration and additional funding.</td>
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<td>1b</td>
<td>High</td>
<td>A large-scale multinational case-control study of brain cancer risk in children in relation to mobile phone use, following a feasibility study</td>
<td>Few relevant epidemiological or laboratory studies have addressed the possible effects of RF exposure on children [INTERPHONE study did not include children as the number of long term users among children at the start of the study was too low for such a study to be informative]. Because of widespread use of mobile phones among children and adolescents and relatively high exposures to the brain, investigation of the potential effects of RF fields on the development of childhood brain tumours is warranted. The uncertainty about the recent findings in adults also applies to children. Because brain cancer in young people is quite rare, a case-control study is recommended as the most appropriate and cost-effective approach.</td>
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<tr>
<td>1c</td>
<td>Other</td>
<td>Large-scale studies of subjects with high occupational RF exposure, including cohort studies as well as the use of the RF occupational exposure data within large scale existing case-control studies</td>
<td>Workers exposed to RF fields in some occupations receive high exposure levels (often to large areas of the body, and sometimes exceeding ICNIRP guidelines). Thus these populations may be well-suited to assess whether a health impact of RF exposure exists. However particular attention needs to be paid to the exposure metric.</td>
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<tr>
<td>1d</td>
<td>Other</td>
<td>Prospective cohort study of children and adolescent mobile phone users and all health outcomes other than brain cancer such as cognitive effects and effects on sleep quality.</td>
<td>Cognitive effects and other general health outcomes have been anecdotally reported in mobile phone users. These endpoints are critical for children because of the importance of cognitive abilities and learning in early development. The outcomes can be assessed in a prospective cohort study of children.</td>
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<tr>
<td>1e</td>
<td>Other</td>
<td>Surveys to characterize population exposures from all RF sources.</td>
<td>Such surveys need to be conducted as collaboration between epidemiologists, physicists and engineers. The studies should focus on the general population and should include for instance, the relative contribution of occupational and residential exposures, and the impact of age, gender and mobility. Regional variations also need to be assessed. These studies will inform the feasibility of future epidemiologic studies and, if appropriate, the proper design of residential epidemiological studies.</td>
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<td>HUMAN STUDIES</td>
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<td>2a</td>
<td>High: If ethical approval can be obtained, acute effects on cognition and EEGs should also be investigated in children exposed to RF fields in the laboratory</td>
<td>Possible RF effects on children were specifically raised by the UK’s Independent Expert Group on Mobile Telephones (IEGMP, 2000) and the Istanbul WHO workshop (Kheifets et al. Pediatrics. 2005 116: 303-313). Cognitive effects are a priority research area in RF studies. However there are only a few results concerning RF effects on children.</td>
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<tr>
<td>2b</td>
<td>Other NONE</td>
<td>n/a</td>
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<tr>
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<th>ANIMAL STUDIES</th>
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<tr>
<td>3a</td>
<td>High: Studies investigating effects from exposure of immature animals to RF fields on the development and maturation of the CNS, and on the development of the haemopoietic and immune systems using functional, morphological and molecular endpoints. Genotoxic endpoints should also be included. Experimental protocols should include prenatal and/or early postnatal exposure to RF fields.</td>
<td>In both the UK’s Independent Expert Group on Mobile Telephones (IEGMP,2000) and the Istanbul WHO workshop (Kheifets et al. Pediatrics. 2005, 116: 303-313) the central nervous system (CNS), and the haemopoietic and immune systems were considered potentially the most susceptible of the various organs and tissues that continue to develop during childhood.</td>
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<th>CELLULAR STUDIES</th>
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<td>4a</td>
<td>High: Independent replication studies of recently reported findings on HSP and DNA damage using low level (below 2 W/kg) and/or modulation- or intermittency-specific signals. The dependence of the effects on SAR levels and frequency should be included.</td>
<td>The most useful contribution of in vitro studies is to establish whether there are any reproducible biological effects at low level that are signal and/or cell specific, especially those relevant to cancer (e.g. genotoxicity) or affecting the nervous system. Therefore, in view of some recently published results (e.g. REFLEX), there is a need to ascertain the validity of the findings, possibly via a multicentre study.</td>
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<td>4b</td>
<td>Other Studies of RF effects on cell differentiation, e.g., during haemopoiesis in bone marrow, and on nerve cell growth using brain slices/cultured neurons.</td>
<td>Cancer cells are generally locked into a rapidly dividing and relatively undifferentiated state. The possibility that haemopoietic and/or neuronal tissue might show an abnormal growth response to RF exposure would be important because of lack of investigation in this area.</td>
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<td>MECHANISMS</td>
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<td>5a</td>
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<td>6b</td>
<td>Other</td>
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<td>6c</td>
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<td>7</td>
<td>SOCIAL ISSUES</td>
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<td>7a</td>
<td>Risk perception of individuals, including studies on the formation of beliefs and perceptions about the relationship between RF exposure and health.</td>
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<tr>
<td>7b</td>
<td>Studies that analyse, if possible, in an international perspective, conditions of trust and confidence of stakeholders and the general public in technologies, policies, and risk communication and management strategies associated with RF applications.</td>
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<tr>
<td>7c</td>
<td>Assess impacts of precautionary measures on public concern and the adoption of voluntary or mandatory policies.</td>
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<tr>
<td>7d</td>
<td>Assess the role of health definitions (well-being) and other important concepts in RF risk communication on risk perception and risk management policies.</td>
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<tr>
<td>7e</td>
<td>Quantify the health related beneficial effects of wireless communication.</td>
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<tr>
<td>7f</td>
<td>Evaluate the success of programmes for public and stakeholder participation in various countries.</td>
</tr>
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Exposure Limits: The underestimation of absorbed cell phone radiation, especially in children

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The existing cell phone certification process uses a plastic model of the head called the Specific Anthropomorphic Mannequin (SAM), representing the top 10% of U.S. military recruits in 1989 and greatly underestimating the Specific Absorption Rate (SAR) for typical mobile phone users, especially children. A superior computer simulation certification process has been approved by the Federal Communications Commission (FCC) but is not employed to certify cell phones. In the United States, the FCC determines maximum allowed exposures. Many countries, especially European Union members, use the “guidelines” of International Commission on Non-Ionizing Radiation Protection (ICNIRP), a non governmental agency. Radiofrequency (RF) exposure to a head smaller than SAM will absorb a relatively higher SAR. Also, SAM uses a fluid having the average electrical properties of the head that cannot indicate differential absorption of specific brain tissue, nor absorption in children or smaller adults. The SAR for a 10-year old is up to 153% higher than the SAR for the SAM model. When electrical properties are considered, a child’s head’s absorption can be over two times greater, and absorption of the skull’s bone marrow can be ten times greater than adults. Therefore, a new certification process is needed that incorporates different modes of use, head sizes, and tissue properties. Anatomically based models should be employed in revising safety standards for these ubiquitous modern devices and standards should be set by accountable, independent groups.

INTRODUCTION

History of Exposure Testing, Guidelines, and Standard-Setting

August 1974

In 1974, a study determined that at certain frequency ranges resonance increased the absorbed radiation by up to nine times higher than that previously assumed for humans (Gandhi, 1974).

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1975
In 1975, behavioral studies were performed on food-deprived rats that had learned to bar press for food rewards in order to determine what exposure levels to non-ionizing radiation (NIR) might impair their ability to work for food reward and therefore be deemed as hazardous. The exposure metric used was the specific absorption rate (SAR), the amount of power absorbed per unit mass of tissue (Watt per kilogram). It was determined that trained rats stopped working for food at a whole body average SAR exposure of 4 W/kg (D’Andrea et al., 1975). This level of exposure increased core body temperatures measured with rectal thermometers. It was deduced that the absorbed electromagnetic power was the reason that food-deprived rodents stopped working for food.

September 1982
The American National Standards Institute (ANSI) published the first exposure NIR exposure standard, which incorporated a 10-fold safety factor for humans exposed to electromagnetic fields between 300 kHz and 100 GHz. No reason per se was given for the size of the safety factor other than there was a consensus (ANSI, 1982, p. 14).

In the ANSI standard concerns were expressed that the standard might not be sufficiently protective. “It was recognized that the specific absorption rate (SAR), which provides the basis for limiting power densities, does not contain all of the factors that could be of importance in establishing safe limits of exposure. First, other characteristics of an incident field such as modulation frequency and peak intensity may pose a risk to health.” [emphasis added] Further, the ANSI standard noted that the database they used did not “provide evidence to recommend special provision for modulated fields” (ANSI, 1982, p. 14; see “In-Vivo and In-Vitro Studies” section below).

ANSI adopted a standard for whole body exposure of 0.4 W/kg averaged over 6 min, and a 20-fold greater spatial peak SAR exposure over any 1 gram of tissue of 8 W/kg averaged over 6 min. Effectively, this allowed much higher exposures within the small area of the brain than are permitted over the body. No reason was given for allowing this. The ANSI standard noted the resonant frequency (70 MHz) “results in an approximate sevenfold increase of absorption relative to that in a 2450 MHz field” (ANSI, 1982, p. 12). The intent of this standard was to protect “exposed human beings from harm by any mechanism, including those arising from excessive elevation of temperature.” (ANSI, 1982, p. 12, italics in the original)

The ANSI standard called for a review of the standard every 5 years (ANSI, 1982, p. 11).

1987–1988
ANSI, not having medical expertise, handed over the setting of exposure limits to the Institute of Electrical and Electronic Engineers (IEEE), a professional society of electrical and electronics engineers from the electronics industry as well as academia. IEEE is not chiefly a medical, biological, or public health organization.

September 1991
In 1991, IEEE first revised the ANSI standard (IEEE, 1991), which has not changed substantially since then, although minor revisions were provided by Standard C95.1 in 2005–2006, and these changes were not adopted by the FCC. It established a two-tier system: one for the general population within an “uncontrolled environment,” and one for workers in a “controlled environment,” the latter defined as “locations where there is exposure that may be incurred by persons who are aware of potential for exposure as a concomitant of employment … where … exposure levels may be
[up to a whole body SAR of 0.4W/kg for any 1 gram of tissue averaged over 6 minutes and a peak spatial SAR of 8 W/kg for any 1 gram of tissue averaged over 6 minutes]."

For the general population, the IEEE revision of the ANSI standard reduced the average whole-body and spatial peak SAR by a factor of 5. This reduction was recommended because of concerns that the general population includes a wide range of ages, vulnerabilities and health status, and in some circumstances, the potential of 24/7 exposures. In explanation of this reduction of general population exposure guidelines, the IEEE standard noted, “To some, it would appear attractive and logical to apply a larger . . . safety factor . . . for the general public. Supportive arguments claim subgroups of greater sensitivity (infants, the aged, the ill, and disabled), potentially greater exposures (24 hr/day vs. 8 hr/day) . . ., [and] voluntary vs. involuntary exposures. Non-thermal effects, such as efflux of calcium ions from brain tissues, are also mentioned as potential health hazards.” (IEEE, 1991, p. 23) For the general population the standard revised the whole body average SAR exposure to 0.08 W/kg averaged over 30 min and the spatial peak SAR for any 1 gram of tissue to 1.6 W/kg averaged over 30 min (IEEE, 1991, p. 17).

Because the resultant Specific Absorption (SA) is identical for the general population in an uncontrolled environment, as it is for workers in a controlled environment (0.08 W/kg*30 min = 0.4 W/kg*6 min), the “larger safety factor” for the general population is non-existent.

The IEEE language concerning the 20-fold larger spatial peak SAR when compared to the whole body SAR went further than the ANSI standard it replaced. The IEEE standard stated, “. . . spatial peak SARs may exceed the whole-body averaged values by a factor of more than 20 times.” (IEEE, 1991, p. 25)

Twenty years later this standard remains unchanged, despite minor alterations in 2005–2006.

1992

October 1997
In 1996, the FCC published the first U.S. regulations on maximum allowable cell phone radiation adopting the ANSI/IEEE C95.1-1992 standard, which became effective on October 15, 1997. FCC’s Bulletin 65 described how to evaluate compliance to the FCC regulations for human exposure to electromagnetic fields (Cleveland et al., 1997). The FCC exposure limits were, and remain, identical to the 1991 IEEE standard. The FCC SAR adopted values were:

(1) For occupational exposures, “0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet, and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) [averaged over 6 minutes].”

(2) For the general population exposures, “0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) [averaged over 30 minutes].”
Once again, the “larger safety factor” for the general population compared to workers was non-existent. It should be noted that these exceptions did not include the ear (also referred to as the pinna). As we shall see in “The SAM Cell phone Certification Process,” section below, this exclusion of the ear is important.

December 1997

Four months later, the FCC published Supplement C, which provided among other details, additional information for “portable devices” (AKA cell phones) certification. The introduction states, “Currently, industry groups and other organizations are working to develop standardized product test procedures to evaluate RF exposure compliance with … SAR limits” (Chan et al., 1997, p. 1). [See June 2001 below.] As this was prior to the adoption of the SAM cell phone certification process, Supplement C notes several concerns about the existing cell phone certification process:

1. “The lack of standardized test positions for evaluating handsets can result in difficulties in determining RF compliance with SAR limits;” (Chan et al., 1997, p. 1–2).
2. The liquid used to simulate the average electrical properties of an adult head had not been standardized at this time, “The permittivity and conductivity of simulated liquid tissues prepared for SAR evaluation must be measured to ensure that they are appropriate … These parameters are usually measured periodically or before each SAR evaluation to determine if it is necessary to add appropriate amounts of water …” (Chan et al., 1997, p. 12).
3. “Most test facilities use separate head models for testing handsets on the left and right side of the head. While some models included ears and others do not, a few have also used a spacer to represent the ear” (Chan et al., 1997, p. 12).

While there was a standardized method to certify the specific SAR for each cell phone, it was not repeatable from one certification facility to the next.

An alternate certification process within Supplement C was computer simulation. “Currently the finite-difference time-domain (FDTD) algorithm is the most widely accepted computation method for SAR modeling. This method adapts very well to the tissue models which are usually derived from MRI or CT scans, such as those available from the visible man projects [see “Virtual Family” discussion below]. FDTD offers great flexibility in modeling the inhomogeneous structures of anatomical tissues and organs. The FDTD method has been used in many far-field electromagnetic applications during the last three decades. With recent advances in computing technology, it has become possible to apply this method to near-field applications for evaluating handsets” (Chan et al., 1997, p. 16).

April 1998

In 1998, a non governmental organization, the International Commission on Non-Ionizing Radiation Protection (ICNIRP, 1998), provided “guidelines.” ICNIRP followed IEEE’s lead by adopting the same two-tier system except that both the general public and occupational exposures were averaged over 6 min. ICNIRP far-field guideline was, “A whole-body average SAR of 0.4 W/kg\(^{-1}\) has therefore been chosen as the restriction that provides adequate protection for occupational exposure. An additional safety factor of 5 is introduced for exposure of the public, giving an average whole-body SAR limit of 0.08 Wkg\(^{-1}\).” For general public exposures, the maximum spatial peak SAR = 2.0 W/kg averaged over 10 g, with occupational exposures, SAR = 10 W/kg (ICNIRP, 1998, p. 509).
Many governments set or recommend exposure limits based on ICNIRP’s “guidelines”. For example, the United Kingdom’s Health Protection Agency (HPA) states on their web page, “There is no explicit UK legislation that limits people’s exposure to electromagnetic fields, including the radio waves used in mobile telephony,” then goes on to state, “The Recommendation incorporates the restrictions on exposure of the general public advised by ICNIRP in its 1998 guidelines” (HPA, 2010).

The ICNIRP guidelines made no recommendation about how to certify a cell phone. It noted, “These guidelines do not directly address product performance standards, which are intended to limit EMF emissions under specified test conditions, nor does the document deal with the techniques used to measure any of the physical quantities that characterize electric, magnetic, and electromagnetic fields. Comprehensive descriptions of instrumentation and measurement techniques for accurately determining such physical quantities may be found elsewhere (NCRP, 1981, 1993; IEEE, 1992; DIN VDE, 1995)” (ICNIRP, 1998, p. 2).

June 2001
In 2001, the FCC’s Supplement C was revised (Means and Chan, 2001). For the first time, a standardized and repeatable, although not necessarily accurate, industry-designed (see December 1997 above) cell phone SAR certification process was available (the SAM cell phone certification process). Yet, the FCC continued to offer the alternative computer simulation certification process, repeating the language from the December 1997 edition (with minute language changes), and then added, “The FDTD method offers great flexibility in modeling the inhomogeneous structures of anatomical tissues and organs” (Means and Chan, 2001, p. 13).

CHRONIC EXPOSURE EFFECTS
All exposure limit standards and/or guidelines rested on avoiding acute heating effects originally observed in food-deprived rats (Chou et al., 2006). Chronic effects from levels of NIR that did not induce a measurable change in temperature were not taken into account. However, the intent of the ANSI standard was to protect the “exposed human being from harm by any mechanism,” not just heating. The IEEE standard increased safety margin was to protect “subgroups of greater sensitivity” from “24 h/day involuntary exposures,” and from “non-thermal effects, such as efflux of calcium ions from brain tissues.” Then and now, there were many studies showing important effects from chronic non-thermal NIR exposure (See September 1991 above; and BioInitiative Working Group, 2007).

The following studies reported findings of harmful effects, but this is not a comprehensive list. There are studies, often industry funded (Huss et al., 2007), that reported no significant effects. The purpose of this section is to describe the multitude of studies that suggest there is a problem.

In-Vivo and In-Vitro Studies
An extensive number of experimental studies below the exposure limits indicate that pulsed digital radiation from cell phones induces an array of biological impacts ranging from blood-brain barrier leakage to brain, liver, and eye damage in prenatally exposed offspring of rabbits and rats, to genotoxic effects on human cells (e.g., Nittby et al., 2009; Salford et al., 2003; Adlkofer, 2004; Schwarz et al., 2008; Guler et al., 2011; Mulak et al., 2011; Tomruk et al., 2010; Odaci et al., 2008).
When human fibroblast cells were exposed to GSM modulated cell phone radiation, the REFLEX project found that genotoxic effects began at \( \text{SAR} = 0.3 \text{ W/kg} \) (Adlkofer, 2004, Fig. 94, p. 135). Another REFLEX study exposed human fibroblast cells to UMTS modulated cell phone radiation found effects beginning at \( \text{SAR} = 0.05 \text{ W/kg} \) (Schwarz et al., 2008). In these studies, a UMTS modulated signal has a 6-fold lower genotoxic threshold than a GSM modulated signal. But, other studies were not consistent with this finding. This suggests that the concerns of the 1982 ANSI that “other characteristics of an incident field such as modulation frequency and peak intensity may pose a risk to health” were prescient, as the pulsed nature of signals may be more important than their power.

**Brain Cancer Studies**

While some studies of brain cancer from chronic cell phone use find no increase in risk, these studies generally have followed people who have used cell phones for a relatively short time. Where long-term, heavy use of cell phones has taken place for over a decade, several epidemiologic case-control studies have found significantly increased risks of brain cancer. The largest brain cancer case-control study was the 13-country, government and industry-funded Interphone study with 2,708 cases and 2,972 controls for glioma, the most serious among many brain cancer types, restricted to ages 30–59 years. (The Interphone Group, 2010). It examined the risk from cell phones, but not the risk from cordless phones. The second largest brain cancer case-control study was done in Sweden without industry funding by Dr. Lennart Hardell’s team. This study had 1,251 brain cancer cases and 2,438 controls (Hardell et al., 2011) and examined the risk for all malignant brain tumors, not just glioma, from both cell phones and cordless phones, ages 20–80 years.

In May 2010 the Interphone study published its first pooled results from all 13 countries. It reported no overall increased risk of brain cancer (glioma only) among short-term cell phone users, but found a more than doubled risk of brain cancer when cell phones were used for 10 or more years compared to short-term users (1–1.9 years), \( \text{OR} = 2.18, 95\% \text{ CI} = 1.43–3.31 \) (The Interphone Group, 2010).

In contrast, the Hardell et al. 2011 study found risk of malignant brain tumor from use of cell and cordless phones (wireless phones) for \( > 5–10 \text{ years} \), with \( > 195 \) cumulative hours, \( \text{OR} = 1.4, 95\% \text{ CI} = 1.1–1.8 \), and for \( \geq 10 \text{ years of use} \), \( \text{OR} = 2.4, 95\% \text{ CI} = 1.7–3.2 \). Also, it found a strong dose-response risk for all brain cancer types. For every year since first use of a wireless phone, the risk increased by 5.4\%, \( \text{OR} = 1.054, 95\% \text{ CI} = 1.036–1.073 \). Perhaps, most alarming was the risk found by age at first use. When use began as a teenager or younger the risk of astrocytoma from cell phone with \( > 195 \) cumulative hours and \( \geq 10 \text{ years of use} \), which was more than 3-fold (\( \text{OR} = 3.1, 95\% \text{ CI} = 2.1–4.4, p = 2.5 \times 10^{-8} \)).

One meta-study found a doubled risk of brain cancer when cell phones are used ipsilaterally (cell phone use on same side as tumor location) for 10 or more years, \( \text{OR} = 2.0, 95\% \text{ CI} = 1.2–3.4 \) (Hardell et al., 2008). Another meta-study found for \( > 10 \text{ years of ipsilateral use} \) nearly doubled for risk of brain cancer, \( \text{OR} = 1.9, 95\% \text{ CI} = 1.4–2.4 \) (Khurana et al., 2009).

The overall Principal Investigator (PI) of the Interphone Study, Dr. Elizabeth Cardis, along with the Israeli Interphone PI, Dr. Siegal Sadetzki, published a commentary, *Indications of possible risk in mobile phone studies: should we be concerned?* Based on the evidence of increased brain tumor and acoustic neuroma risk, they concluded, “Simple and low-cost measures, such as the use of text messages, hands-free kits and/or the loud-speaker mode of the phone could substantially reduce exposure to the brain from mobile phones. Therefore, until
definitive scientific answers are available, the adoption of such precautions, particularly among young people, is advisable” (Cardis and Sadetzki 2011).

These findings and more resulted in the International Agency for Research on Cancer (IARC) finding that RF radiation (30 kHz – 300 GHz) is a Class 2B carcinogen (“a possible human carcinogen”) (Baan et al., 2011). RF sources include: cell phones, cordless phones, Bluetooth, amateur radio, cell phone base stations, wireless routers, Wi-Fi, Wi-Max, baby monitors, and Smart Meters.

Salivary Gland Tumors
An Israeli Interphone study found a significant risk for parotid gland tumors (a salivary gland in the cheek, below the ear) from > 266.3 cumulative hours of ipsilateral cell phone use, OR = 1.49, 95% CI = 1.05–2.13, with the heaviest users (> 4,479 cumulative hours) having more than a two-fold increased risk of non-malignant parotid gland tumors, OR = 2.42, 95% CI = 1.14–5.11 of this tumor (Sadetzki et al., 2008).

A Swedish Interphone study of parotid gland tumors found a borderline significant risk for ≥10 years of ipsilateral use, OR = 2.6, 95% CI = 0.9–7.9, p = 0.078 (Lönn et al., 2006).

Scientists working with the Israeli Dental Association in 2009 reported “a sharp rise in the incidence of salivary gland cancer in Israel that researchers believe may be linked to the use of mobile phones…Among salivary gland cancer cases, researchers found a worrying rise in the number of cases of malignant growth in parotid glands.” “Most oral cancer patients were over 70, with only 2.7 percent under the age of 20.” (Even, 2009).

From 1970–2001, parotid gland tumors in Israel had averaged 37 cases per year. From 2002–2006, the cases increased by 65% to an average 61 cases per year (Czerninski et al., 2011). Fig. 1 from this study shows the number of cases per year for the 3 types of salivary gland tumors (parotid, submandibular, and sublingual glands) with smoothed trend lines. Only the parotid gland trend line grew over time. However, the figure suggests a break-point analysis would be even more informative as the data suggest a flat trend from 1970 to the early 1990s, and then a sharp upward linear trend afterwards.

Male Fertility
There is a robust and growing literature in both animals and humans that chronic exposures to cell phone radiation, far below existing standards significantly impairs sperm morphology, motility, viability, and count. Often, the mobile phone is placed in the trouser pocket which may lead to significant exposure of the scrotum in men.

One human study found a significant 59% decline in sperm count in men who used cell phones for four or more hours per day as compared with those who did not use cell phones at all (Agarwal et al., 2008). Included in their study were deleterious effects on sperm viability, motility, and morphology (Agarwal et al., 2008).

A study from Hungary found deterioration of human sperm motility associated with self-reported cell phone radiation exposure (Fejes et al., 2005). An Australian study found genotoxic effects on mice sperm (Aitken et al., 2005), while other studies from this group have reported similar effects on human sperm.

A recent study of mice exposed for 6 months to cell phone base station radiation reported, “The exposure of male mice to radiofrequency radiations from mobile phone (GSM) base stations at a workplace complex and residential quarters caused 39.78 and 46.03%, respectively, in sperm head abnormalities compared to 2.13% in control group. Statistical analysis of sperm head abnormality score showed that there was a significant (p < 0.05) difference in occurrence of sperm head abnormalities in test animals. The major abnormalities observed were knobbled hook, pin-head and
banana shaped sperm head. The occurrence of the sperm head abnormalities was also found to be dose dependent” (Otitoloju et al., 2010). The researchers reported sperm abnormalities at 489 mV/m (workplace), and 646 mV/m (residential) compared to exposure limits of 41,000 mV/m and 58,000 mV/m, respectively (ICNIRP, 1998).

Lastly, a study of human sperm warns, “RF-EMR in both the power density and frequency range of mobile phones enhances mitochondrial reactive oxygen species generation by human spermatozoa, decreasing the motility and vitality of these cells while stimulating DNA base adduct formation and, ultimately DNA fragmentation. These findings have clear implications for the safety of extensive mobile phone use by males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring” (De Iuliis et al., 2009).

**Leukemia**

Two studies have found that chronic cell phone use increased the risk for leukemia. Adjusting for leukemia risk factors, including benzene, solvents, pesticide exposures at work or home, and working or living near power lines, a study in Thailand, found a 3-fold risk of leukemia from GSM cell phone use (OR = 3.0, 95% CI: 1.4 – 6.8) and more than a 4-fold risk for any lymphoid leukemia (OR = 4.5, 95% CI: 1.3–15) (Kaufman et al., 2009).

A British study found borderline significant risks of leukemia from >15 years of cell phone use for acute myeloid leukemia (AML), OR = 2.08, 95% CI = 0.98–4.39, p = 0.051, and for all leukemia, OR = 1.87, 95% CI: 0.96–3.62, p = 0.060 (Cooke et al., 2010).
TWO CELL PHONE SAR CERTIFICATION PROCESSES

The SAM Cell Phone Certification Process
Specific Anthropomorphic Mannequin (SAM) is a plastic head mannequin (Beard and Kainz, 2004), based on the 90th percentile of 1989 United States military recruits (Gordon et al., 1989). While the exposure limit standard considered body sizes “from small infant to large adult,” (ANSI, 1982, p. 14) only a large adult male that weighed about 220 lb (100 kg) and was 6 foot 2 in (188 cm) in height was used for cell phone compliance testing.

The SAM cell phone certification process uses:

1. a plastic head mannequin with an opening at the top of the head (Fig. 1);
2. a liquid whose electrical permittivity and conductivity parameters are equivalent to the average electrical parameters of the 40 tissue types in a head;
3. a robotic arm (Fig. 2) with a small electric field probe attached (the effective 3-dimensional resolution is limited by the dimensions of the probe).

For cell phone certification a liquid is poured into the head with the average permittivity and conductivity of the head tissues. A cell phone is affixed to either side of the mannequin with a tapered flat spacer used instead of the ear, and the robotic arm measures the electric field within the volume of the mannequin with a resolution of somewhat better than 1 cm$^3$. The SAR values are calculated from the electric field measurements along with the 3-D location of each measurement and the properties of the liquid. The resulted SAR value has a tolerance of $\pm 30\%$ (IEEE 2003, p. 55). Thus a cell phone certified at the exposure limit of 1.6 W/kg could be as large as 2.08 W/kg.

The Computer Simulation Certification Process
For the computer simulation certification process, the revised FCC Supplement C publication states, “Currently, the finite-difference time-domain (FDTD) algorithm is the most widely accepted computational method for SAR modeling. This method adapts very well to the tissue models that are usually derived from MRI or CT scans such as those currently used by many research institutions. The FDTD method offers great flexibility in modeling the inhomogeneous structures of anatomical tissues and organs (Means and Chan, 2001, p. 13).”

FIGURE 2 Robotic arm with electric field probe. Source: Speag DASY 52 Info Sheet.
The Food and Drug Administration (FDA), which has ultimate responsibility for U.S. cell phone safety, has a “Virtual Family” based on MRI scans that indicate different brain tissue properties for use with computer simulation. “Family” members currently include: a 5-year old girl, a 6-year old boy, an 8-year old girl, an 11-year old girl, a 14-year old boy, a 26-year old female, a 35-year old male, an obese male adult, and 3 pregnant women with fetuses at 3rd, 7th, and 9th months of gestation. Additional “family” members are under development (Christ et al., 2010b). “[T]he Virtual Family is already used by more than 200 research groups worldwide.” (http://www.itis.ethz.ch/research/virtual-population/virtual-population-project/, accessed 28 Dec. 2010).

Fig. 3 illustrates the members of the “Virtual Family.”

“The development of the [Virtual Family] models was carried out in cooperation with the Center for Devices and Radiological Health of the U. S. Food and Drug Administration (FDA), Silver Spring, MD, USA; the Austrian Research Centers GmbH, Seibersdorf, Austria; the University of Houston, TX, USA; the Hospital of the Friedrich-Alexander-University (FAU), Erlangen, Germany; and Siemens Medical Solutions, Erlangen, Germany” (http://www.itis.ethz.ch/services/population-and-animal-models/population-models/, accessed December 10, 2010).

The FCC also regulates medical implants in concert with the FDA. Because metal implants can interact with exogenous electromagnetic fields, computer simulation is also used to calculate resultant interactions.

In order to use the FDTD computer simulation process to certify that cell phones meet the SAR exposure standards the FDTD computer simulation model of the cell phone submitted for certification is required. Because such models are required for product development, they are available.

RESULTS (SAM CELL PHONE CERTIFICATION PROCESS IN COMPARISON TO FDTD COMPUTER SIMULATION PROCESS)

Because any head size smaller than SAM receives a larger SAR, children receive the largest SAR relative to adults modeled with the SAM process. Gandhi et al. (1996) reported that for 5- and 10-year old children, using only head size differences compared to an adult, the children’s SAR was 153% higher than adults. Wiart et al. (2008) employed MRI scans of children between 5 and 8 years of age and found approximately 2 times higher SAR in children compared to adults, and Kuster et al. (2009) reported that the peak SAR of children’s CNS tissues is “significantly larger (~2x) because the RF source is closer and skin and bone layers are thinner.” de Salles et al. (2006), using scans of a 10-year old boy’s head with children’s electrical tissue parameters found that differences in head size and other parameters increased the SAR by 60% compared to an adult. Peyman et al. (2001) found the relative permittivity of an adult brain was around 40 while a young child’s brain is from to 60–80, resulting in a child’s SAR being 50–100% higher than an adult’s independent of head size. Han et al. (2010) provided additional analyses of the underestimation of spatial peak SAR with the SAM process.

Not only are children exposed to a higher SAR, but also the relative volume of the exposed and still developing child’s brain is far greater than in adults. Fig. 4 shows the depth of the cell phone’s radiation absorption into the brain is largest for the 5-year old penetrating far beyond the mid-brain. For 10-year old children the penetration of radiation is less, but still beyond the mid-brain, and for the adult, the penetration is much less, and ends well before the mid-brain (Gandhi et al., 1996).

Of course, while no models have been developed for toddlers or infants who may be using or playing with cell phones today, their absorption would be even greater than that of a 5-year old, because their skulls are yet thinner and their brains are yet more conductive and far less developed.

A recent study (Christ et al., 2010a) details the age dependence of electrical properties on the brain, concluding that:

“Exposure of regions inside the brains of young children (e.g. hippocampus, hypothalamus, etc.) can be higher by more than 2 dB − 5 dB [1.6–3.2 times] in comparison to adults.”

“Exposure of the bone marrow of children can exceed that of adults by about a factor of 10. This is due to the strong decrease in electric conductivity of this tissue with age.”

“Exposure of the eyes of children is higher than that of adults.”

“Because of differences in their position with respect to the ear, brain regions close to the surface can exhibit large differences in exposure between adults and children. The cerebellum of children can show a peak spatial average SAR more than 4 dB [2.5 times] higher than the local exposure of the cortex of adults.”

Increased exposure to the eyes and cerebellum was suggested in a 1998 study of far-field exposures at resonant frequencies to the head and neck (Tinnisword et al., 1998). The authors noted, “[T]he highest absorption is in the neck as the currents generated in the head have to flow into the body through the constricted volume of the neck concentrating them (i.e., increasing the current density) and as a result increasing the SAR.” A figure (see figure 5 below) from this article suggests that there is a significantly increased SAR to the thyroid gland.

However, with a dearth of U.S. research funds provided for cell phone research, no studies have examined the exposure of the thyroid gland when using a cell phone.

Another study analyzed relatively greater absorption of children and adults smaller than SAM and concluded, “The results suggest that the recommended ICNIRP reference levels need to be revised” (Bakker et al., 2010), and proposed “fine-tuning” the ICNIRP guidelines.

FIGURE 4 Depth of absorption of cell phone radiation in a 5-year old child, a 10-year old child, and in an adult from GSM cell phone radiation at 900 MHz. Color scale on right shows the SAR in Watts per kilogram (Gandhi et al., 1996).
The spacer used to imitate the ear in the SAM mannequin also results in an underestimation of the SAR. Radiation decreases as the square of the distance from the antenna increases in the far field, and in the near field, radiation decreases as the cube of the distance from the antenna increases. This means that even a small increase in distance has a large effect. Gandhi and Kang (2002) found that incorporating a plastic ear model (or “pinna”) with a 10 mm spacer gave artificially lowered SARs, which are up to two or more times smaller than for realistic anatomic models that hold cell phones directly to the ear. In two studies, the use of plastic spacers results in an underestimation of the SAR by up to 15% for every additional millimeter of thickness of such spacers (Gandhi and Kang, 2002, 2004).

“A mobile phone compliant with the ICNIRP standard of 2.0 W/kg SAR in 10 g of tissue may lead to a 2.5 to 3 times excess above the FCC standard of 1.6 W/kg in 1 g of tissue (i.e., 4–5 W/kg in a cube of 1 g of tissue)” (Gandhi and Kang, 2002).

When the back of a cell phone (typically where the transmitting antenna is located) was placed in a shirt pocket while using a cell phone with a headset, a 2002 study found that the SAR increased by up to 7-fold (Kang and Gandhi, 2002). This suggests when a cell phone is in a shirt pocket the surface of the heart muscle closest to the skin could be absorbing substantial cell phone radiation.

Table 1, adapted from Table 2 of Han et al. (2010), summarizes the various findings. ICNIRP, based on its 1998 Guidelines, relies on a larger 10-g volume and a higher 2 W/kg SAR for limiting brain exposures compared to the FCC’s 1-g standard.

**DISCUSSION**

The FDTD computer simulation process, based on MRI/CT scans, employs anatomically correct head sizes, and allows for inclusion of 80 tissues types with accurate 3-dimension locations, with the electrical properties of each tissue type used to calculate the cell phone’s SAR to a resolution of 1 mm³ or better.

In contrast, the SAM process, uses a large male head, and assumes the inside of human head is homogenous via a liquid with the average electrical properties of the head. Of course a real head has an ear, not a 10 mm plastic spacer. For this reason the consumer booklets with the information of the functions, etc. of the mobile phone usually contain a page with safety information stating that the phone must not be placed closer than 10 or 15 or even 25 mm to the body. Because the

**FIGURE 5** The SAR distribution in the head and neck at 207 MHz under isolated conditions. Far-field power density = 1 mW/cm² (adapted from Figure 6; Tinniswood et al., 1998).
10 mm plastic spacer used in testing artificially lowers the calculated SAR for every phone, these booklets make no statement about keeping the device at a distance from the head.

The existing SAR cell phone certification process systematically underestimates exposure for any head smaller than SAM model, and also assumes that the head is homogenous. In fact, tissues and organs in the head vary substantially in density and capacity to absorb radiation and this variation changes inversely with age of children. Only 3% of the U.S. population has a head the size of SAM and no one has a uniformly consistent brain with dielectrically homogenous tissue. Adoption of the FDTD approach would generate standards that reflect the anatomic properties of the brain and correct for this systematic underestimation of the SAM cell phone certification process. Table 2 compares attributes of the SAM cell phone SAR certification process and the FDTD computer simulation cell phone SAR certification process.

For all of the reasons presented in this analysis, the existing cell phone SAR certification process does not adequately protect 97% of the population, i.e., those with heads smaller than SAM. Because children absorb more cell phone radiation than adults, this lack of adequate protection is even of more concern with their growing use of cell phones.

In addition, to these major problems, contemporary cell phones do not comply with the existing certified SAR value when held directly at the head or kept in a pocket. According to manufacturers’ advisories, cell phones can exceed the FCC exposure guidelines as commonly used. Here are some examples of manufacturer’s warnings:

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Highlights of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gandhi et al. (1996)</td>
<td>Deeper penetration of absorbed energy for models of 10- and 5-year old children; peak 1-g SAR for children up to 53% higher than adults. 1-g SAR of brain tissues of children is about two times higher than adults. Spatial peak SAR of the CNS of children is “significantly larger (~2x”) because the RF source is closer and skin and bone layers are thinner”; “bone marrow exposure strongly varies with age and is significantly larger for children (~10x)”</td>
</tr>
<tr>
<td>DeSalles et al. (2006)</td>
<td>The 1-g SAR for a 10-year old boy is about 60% higher than for the adults.</td>
</tr>
<tr>
<td>Peyman et al. (2001)</td>
<td>Children’s SAR is 50–100% higher than an adult’s SAR.</td>
</tr>
<tr>
<td>Christ et al. (2010a)</td>
<td>Hypocampus and hypothalamus receive 1.6–3.1 higher SAR in children compared to adults; children’s bone marrow receive 10 times higher SAR than adults; children receive higher SAR to the eyes than adults; children’s cerebellum receive &gt; 2.5 time higher SAR than adults.</td>
</tr>
<tr>
<td>Tinnisword et al. (2008)</td>
<td>Far-field whole body SAR highest in neck particularly where thyroid gland is located.</td>
</tr>
<tr>
<td>Bakker et al. (2010)</td>
<td>Recommended ICNIRP reference levels be revised</td>
</tr>
<tr>
<td>Kang and Gandhi (2002)</td>
<td>Up to 7 times SAR when back of cell phone in a shirt pocket is closest to skin. 10 mm spacer on SAM artificially lowers SAR. Deeper penetration of absorbed energy for smaller heads typical of women and children; peak 1-g SAR for smaller heads up to 56% higher than for larger heads.</td>
</tr>
<tr>
<td>Gandhi and Kang (2002)</td>
<td>Plastic spacer used on SAM for ear (or pinna) decreases SAR by 15% per millimeter. ICNIRP’s 2 W/kg, 10 g spatial peak SAR results in 2.3–3 times high SAR than FCC’s 1.6 W/kg, 1 g spatial peak SAR</td>
</tr>
<tr>
<td>Wang and Fujiwara (2003)</td>
<td>Compared to peak local SAR in the adult head, we found “a considerable increase in the children’s heads.”</td>
</tr>
<tr>
<td>Martinez-Burdalo et al. (2004)</td>
<td>As head size decreases, the percentage of energy absorbed in the brain increases; so higher SAR in children’s brains can be expected.</td>
</tr>
</tbody>
</table>
TABLE 2 Comparison of cell phone certification processes.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>SAM Process</th>
<th>FDTD Process</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children’s exposures</td>
<td>No</td>
<td>Yes</td>
<td>Male &amp; female, multiple ages 1, 3 &amp; 9 months</td>
</tr>
<tr>
<td>Pregnant women’s exposure</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Female exposure</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Small male exposure</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Large male exposure</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Electrical tissue parameters</td>
<td>Average of all tissues</td>
<td>Specific for each tissue</td>
<td></td>
</tr>
<tr>
<td>3-D Resolution</td>
<td>1 cm³</td>
<td>1 mm³</td>
<td></td>
</tr>
<tr>
<td>Relative cost</td>
<td>High</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Medical implant modeling</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Testes exposure</td>
<td>No</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>Eye exposure</td>
<td>No</td>
<td>Possible</td>
<td></td>
</tr>
<tr>
<td>Thyroid gland exposure</td>
<td>No</td>
<td>Possible</td>
<td></td>
</tr>
</tbody>
</table>

(1) BlackBerry Torch: “To maintain compliance with FCC, IC, MIC, and EU RF exposure guidelines when you carry the BlackBerry device on your body, ... keep the BlackBerry device at least 0.98 in. (25 mm) from your body ...” “To reduce radio frequency (RF) exposure ... keep the BlackBerry device at least 0.98 in (25 mm) from your body (including the abdomen of pregnant women and the lower abdomen of teenagers ...),” i.e., implicitly indicating the importance of keeping it away from teenage boys’ testicles (BlackBerry, 2010, p. 23).

(2) Nokia 1100: “This product meets RF exposure guidelines ... when positioned at least 1.5 cm away from the body ... and should position the product at least 1.5 cm away from your body.” (Nokia, 2003, p. 63)

(3) Motorola V195 GSM: “keep the mobile device and its antenna at least 2.5 cm (1 in) from your body.” (Motorola, 2008, p. 70)

The FCC directive states, “For purposes of evaluating compliance with localized SAR guidelines, portable devices should be tested or evaluated based on normal operating positions or conditions (Cleveland et al., 1997, p. 42).” [emphasis added] In fact, phones are only tested with a spacer next to the ear or hip and are not tested in the ways that people commonly operate them, i.e., in their trouser or shirt pockets. Moreover, no tests simulate use by the 97% of the population with heads smaller than SAM.

The 5-fold reduction in SAR exposure limits for the general population in the IEEE standard, and adopted by the FCC, was intended to protect the most “sensitive”: “infants, aged, the ill and disabled.” However, no such reduction exists when SA is considered.

Finally, The FDTD resolution of brain tissues and organs is by three orders of magnitude higher than the resolution of SAM (the dimensions of the electric field probe cannot be made much smaller without losing too much sensitivity). There is a need to protect the most “sensitive” users because, due to curvature of tissue layers but also due to differences in dielectric properties of adjacent tissues and their geometry, “hot spots” (small brain volumes with intense energy absorption), the result of focusing, could occur.

CONCLUSIONS

(1) Because, the SAM-based cell phone certification process substantially underestimates the SAR for 97% of the population, especially for children, the SAM-based certification process should be discontinued forthwith.
(2) An alternative FDTD computer simulation cell phone certification process is immediately available and provides three orders of magnitude higher resolution than the SAM-based system for the head.

(3) The anatomically based “Virtual Family” includes sensitive groups such as small children, pregnant women, and the fetus.

(4) Advisories found in cell phone manuals violate the FCC compliance guidelines, because they do not take into account customary use of phones in pockets and held directly next to the head.

(5) The SAM-based cell phone certification process is unable to address exposure to sensitive tissues such as the testes or the eyes, while the FDTD method can address exposures to such sensitive tissues.

(6) Because billions of young children and adults with heads smaller than SAM are now using cell phones extensively, and because they absorb proportionally greater cell phone radiation, it is essential and urgent that governments around the world revise approaches to setting standards for cell phone radiation, to include sufficient protection of children.

(7) Cell phone for which SAR values were certified prior to June 2001 were not required to be replicatable between different certification facilities (see “December 1997”) above.

We have shown that children and small adults absorb significantly more cell phone radiation than SAM estimates. Accordingly, contemporary cell phone standards for all of the world’s more than five billion cell phones do not protect the young or the 97% of the population with heads smaller than SAM. Until SAR standards have been revised, Israel (Azoulay and Rinat 2008), Finland (YLE.fi 2010), France (Lean, 2010), India (India eNews, 2008), and the U.K (BBC, 2000) recommend limited use by children, using wired headsets, hands-free kits, texting, and keeping the mobile phone away from the head and from the body to substantially lower exposures with current cell phones.

Governments all over the world should urgently require that industry sell cell phones that work only with headsets (sans speakers and microphones). Then users would have to employ wired or other hands free devices for headphones with the result that the cell phone would be kept away from their heads while talking on cell phones.

The long-term impact of cell phone radiation is a matter that merits major research investment and serious public scrutiny. Anatomically based models should be employed in revising safety standards for these ubiquitous modern devices. Standard setting should not be the province of non-governmental, non-accountable agencies, such as ICNIRP which has been heavily funded by industry, but should be carried out by governmental agencies accountable to the public or by independent experts accountable to governments.

Declaration of Interest
Support for this work was provided by grants to Environmental Health Trust by the Flow Fund, Lucy Waletzky Fund, and the Carolyn Fine Friedman Fund. The authors report no conflicts of interest. The authors alone are responsible for the content of and writing of the article.

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Electromagnetic Biology and Medicine


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Highlights from Cell Phones and Health Conference in Istanbul

June 14th, 2011

Stunning new findings from Research Teams at Biophysics in Gazi University, Ankara, confirm that prenatal exposures to pulsed digital signals from cellphones in rabbits and rats damage the brain, eyes, liver and skin of offspring. Detailed analyses of changes in different types of brain cells and structure after prenatal exposure to cellphone radiation were presented by Prof. Sulleyman Kaplan, Ondokuz Mayis University, Samsun, and biomarkers of genetic and other damage to cells and organs were provided by Prof. Nesrin Seyhan and her students and colleagues from Gazi University, Department of Physics. Prof. Annie Sasco, drawing on work of Profs. Elisabeth Cardis and Siegal Sadetzki, explained the limits of epidemiologic studies to date and noted that long-term regular cellphone use is linked with significantly elevated risk of gliomas, acoustic neuromas, and parotid gland tumors. The Interphone published results to date only have reported gliomas. Note: On May 31, International Agency for Research on Cancer determined that radiofrequency radiation and electromagnetic fields are “possible” human carcinogens.

Conference Highlights: Findings on The Effects of Cell Phone Radiation

1. In newborns:

- elevated patterns of well-established markers of cancer risk
- DNA base modification
- oxidative stress parameters
- other accepted biomarkers of chronic degenerative diseases (Arin Tomruk)
- increased apoptosis (cell death) in liver, brain, heart, spleen, and eyes of exposed newborns. (Guler et al)

2. Increased carcinogenesity risk (Prof. Dr. Livio Giuliani)
3. **Destroyed or damaged lymphocytes**—human blood cells that are critical to healing the immune system. (Meric Arda Esmekaya)

4. **DNA damage in hair root cells** derived from the region close to the antenna of the irradiating mobile phone as well as **skin aging**. (Semra Tepe Çam)

5. **Changes of two main regions of the brain**, the hippocampus and cerebellum, related to memory and other functions. (Prof. Dr. Süleyman Kaplan)

6. **Significant damage to human sperm** from cell phone radiation, confirming studies that have been carried out in Australia, the US and Greece. (Prof. Dr. Emin Oztas)

***

The studies reviewed at this conference showed that levels of microwave radiation produced by cell phones in the real world today **significantly damage and reduce sperm, impair DNA and memory, and cause deficits in offspring whose mothers are exposed during pregnancy**.

These new findings demand the attention of the Media and the action of the governments for the **establishment of new biologically based guidelines**, as has been proposed by well-known scientists in a **recent publication**. In any case, the **precautionary principle** should be followed. The major advice would be to use cell phones and other EMR sources at a safe distance.

[Go here to see the full workshop agenda.](www.saferphonezone.com/highlights-from-istanbul's-cell-phones-and-health-workshop/)

***

**Full List of Participants:**

Devra Davis, PhD, MPH Founder and President of Environmental Health Trust

Nesrin Seyhan, PhD Founder and Chairperson, Gazi University, Biophysics Department

Murat Tuncer, MD Head of Cancer Control, Ministry of Health of Turkey

Livio Giuliani, PhD, Direttore di dipartimento ISPESL, International Commission on Electromagnetic Safety (ICEMS) spokesman

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Wilhelm Mosgoeller, MD, Professor, Medical University of Vienna
Emin Oztas, MD, Professor Ankara, Medical Military Institute GATA

Siegal Sadetzki, MD, MPH Cancer & Radiation Epidemiology Unity, Gertner Institute, Chaim Sheba Medical Center, Tel-Hoshomer 52621, Israel and Sackler School of Medicine, Tel-Aviv University, Israel

Annie Sasco, MD, Dr.PH Director of Epidemiology, INSERM, National Institute of Health, Bordeaux, France

Latest Research

A Summary – Exposure Limits: The underestimation of absorbed cellphone radiation, especially in children

Worldwide Cell Phone Safety Recommendations and Policies
Mobile phones and head tumours. The discrepancies in cause-effect relationships in the epidemiological studies – how do they arise?

View All Research »

Latest Tweets

- "Experts from five different countries say study that dispels the link between cellphones and cancer is "deeply flawed". bit.ly/tgUxeo" 25 Oct

This website is sponsored by the Environmental Health Trust (EHT). EHT is a non-profit organization that educates individuals, health professionals and communities about controllable environmental health risks and policy changes needed to reduce those risks. For more than three decades, advising some of the world's top health agencies, EH Trust has come up with effective strategies to curb harm from hormone replacement, tobacco, radon, asbestos and pesticides.

Donate Now »

Safer Phone Zone is a web portal dedicated to providing reliable information and educational tools to the public, health professionals and policy makers regarding the dangers of prolonged cell phone use, cell phone radiation and the links between cell phones, cancer and other health problems. Safer Phone Zone is intended to be an open source forum for information based on sound scientific research by recognized authorities. Due to the open source nature of this web portal all information is provided as is without any warranties expressed or implied.

Devra Lee Davis Charitable Foundation is a Registered IRS Public Charity Doing Business As (DBA) Environmental Health Trust

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16:00 1.8 GHz Radiofrequency Radiation induces chromosomal damage in human peripheral blood lymphocytes (hPBLs)
Meriç Arda Eşmekaya, MSc, PhD Candidate, Prof. Dr. Nesrin Seyhan, Gazi University, Biophysics Department.

16:40 Commentary on new developments with DNA technologies
Prof. Dr. Wilhelm Mosgoeller, Medical University of Vienna.

16:50 Effects of 900 MHz RF on Human Sperm Motility
Prof. Dr. Emin Oztas, GATA.

17:10 Mobile Phone Radiation Induces Reactive Oxygen Species Production and DNA Damage in Human Spermatoza in vitro.
Dr. Geoffrey N. De luliis, ARC Centre of Excellence in Biotechnology and Development, Callaghan, New South Wales, Australia.

17:35 Policy Implications of New Findings - Epidemiological studies
Dr. Siegal Sadetzki, Cancer & Radiation Epidemiology Unit, Gertner Institute, Chaim Sheba Medical Center, Tel-Hashomer S2621, Israel and Sackler School of Medicine, Tel-Aviv University, Israel.

17:55 Commentary on Dr. Siegal Sadetzki’s lecture.
Dr. Annie Sasco, Director of Epidemiology, INSERM, National Institute of Health, Bordeaux, France.

18:10 Concluding ROUND TABLE Discussion
Chair: Nesrin Seyhan

18:30 Close of the Conference
Good morning. My name is Ellen Marks. It is an honor to be here on behalf of my family, other victims and the Environmental Health Trust. We are the only non-profit in the nation focusing solely on promoting public education, public policy and conducting critical research on the serious public health threats posed by the ways we use cell phones. I flew across the country from Northern California to talk with you about three things.

First, as the wife of a man struggling with a cell phone induced brain tumor, I want to explain my family’s deep interest in this issue.

Second, I want to release a shocking compilation that EHT has prepared of world actions on cell phone safety and share with you my deep disappointment regarding how our country lags behind the rest of the world on this issue and the reasons why this is happening.

And I want to share with you some of the personal stories of others whose families are coping with tremendous challenges from brain tumors that their physicians believe have been caused by their heavy or long term use of cell phones. And sadly many are already dealing with the loss of a loved one from a brain tumor attributed to cell phone use.
I am proud to be here with Dr. Herberman whose courageous warnings and impeccable scientific credentials have added a tremendous boost to this issue. In 2008, Dr. Herberman issued an advisory on safe cell phone use to his faculty and staff and then we testified together later that year at a Congressional hearing on cell phone health risks. Despite the hearing being the same week as the financial meltdown and bailout, headline news in D.C. was that the CTIA refused to testify. It is painful to think how many have been exposed over the past 3 years while the public continues to be intentionally misled by industry and our regulatory agencies. It is apparent that local and state governments, like you who are to be commended for your foresight, must take the lead to correct this atrocity. We cannot afford to wait.

I am here with you today because my husband of 31 years cannot be. Alan has a malignant brain tumor that experts believe was caused by his long term use of cell phones. Alan began using a cell phone in 1987 when we were a happy hard working family with 3 small children. Alan has stated that “if someone had told me that holding the phone right next to my head could result in a death sentence I never would have played Russian roulette with it. How can they knowingly market a product that can rob a man of his life and not warn him?”
On May 5th, 2008 my husband and I excitedly packed to leave the next day for our youngest child’s college graduation. At 2 a.m. I awoke to Alan’s strange noises and thrashing. I tried to wake him but couldn’t and the nightmare has yet to end. Witnessing a grand mal seizure is something you can never erase from your memory. At 4 a.m. we were told my lifelong love had a large mass in his right frontal lobe, the part of the brain that allows us to differentiate between right and wrong, and relate to those we love. For years, he had been exhibiting unexplainable behavior that caused emotional chaos in our family. Alan desperately tried to continue to be a loving father and husband as he willingly sought professional help and took antidepressants and bipolar medications to no avail as it was not a psychiatric disorder, but a lethal brain tumor!

10 days after Alan’s diagnosis Senator Kennedy had a seizure with the same diagnosis and ironically our son had interned for him in his private office. Zack came to me after hearing a report that the Kennedy family felt his glioma may be related to his cell phone use and said “mom, it can’t be just a coincidence- dad and the Senator were both glued to their cell phones”. I was stunned as Alan’s cell phone was a vital part of his work always held to the side of the head where the tumor developed.
Alan and Senator Kennedy had their skulls cut open days apart; fortunately Alan is still alive. Alan’s craniotomy lasted 7 hours—titanium now holds his skull in place and the tumor will grow back. I immersed myself in research on cell phones and brain tumors and was shocked and outraged at what I found. I sent worldwide experts Alan’s medical and cell phone records. Every expert agreed with Dr. Elihu Richter, head of Occupational and Environmental Medicine at Hebrew University- Hadassah School of Medicine, whose research calculates risk assessment of exposure to radiation, including cell phones. He stated that “the weight of the evidence suggests it is more likely than not that there is a cause and effect between Marks’s cell phone use and his glioma. This is consistent with the emerging body of knowledge on exposure, latency and laterality of cell phone use. We cannot exclude the possibility that even with less than 10 years of use, these tumors may appear in those with very high exposures.”

Mays Swicord at the FDA, now with the CTIA, gave cell phones a free pass from the required testing of all radiation emitting devices when they were released here in 1983. Months later Swicord went to work for Motorola setting precedence for the cozy relationship and revolving door between industry and the federal agencies mandated to regulate cell phone radiation that continues to this day.
This has the potential of becoming a public health catastrophe the likes of which we have never experienced as malignant gliomas and salivary gland tumors are lethal and cell phone use in the United States has escalated dramatically. According to Pew Research, children as young as 6 use cell phones and greater than 4 out of 5 children and teens 12 years and older sleep with their phones on next to them, often under the pillow. The President’s Cancer Panel states special caution is prudent as children will have a lifetime of exposure.

This past May an expert group of the IARC/WHO confirmed the wisdom of Dr. Herberman’s earlier advice and listed cell phone radiation a “possible” human carcinogen based on an increased risk of gliomas associated with wireless phone use. That is the exact cancer that afflicted my husband, Senator Kennedy, Johnnie Cochran, Seve Ballesteros and many others. To ignore this declaration, as is being done in the United States currently, is a horrible disservice to all of us.

Microwave radiation from cell phones joins a long list of well reviewed cancer causing agents that includes engine exhaust, ddt, lead, and gasoline exhaust fumes. Despite the IARC/ WHO classification our FCC and FDA have taken no steps to communicate the importance of this to our citizens- shockingly their websites continue to use outdated information which is a betrayal of public trust. The CTIA hangs their hats on our government agencies who are captured by this industry and are still wrongly claiming there are no adverse health effects from cell
phone use while hundreds of studies have shown definitive health risks, including producing defective offspring in animals, related to cell phone use. We desperately need warnings.

Supposedly the FCC, after consultation with the FDA, OSHA and EPA, adopted standards governing radio frequency emissions from cell phones and the FCC asserts those standards represent the best science to protect public health. However, the standards were not set by the FCC but by industry dominated non-government agencies decades ago. One of those agencies, ANSI (American National Standard Institute) decided in the mid 80’s that they would no longer be involved in health safety standards because of the possibility of lawsuits since these standards may be unduly influenced by parties with commercial interests.

The current standard, SAR (specific absorption rate) has serious limitations as it ignores all biological effects of non-ionizing radiation, such as gliomas like the one my husband has. The SAR fails to take into account that hundreds of studies have shown damage from below thermal levels and the SAR is based only on heating. Phones are now tested on a plastic dummy with a head the size of a 6-foot-2, 200-pound man—characteristic of only 3% of our population. Then, to make matters worse, the manufacturers are left to report the results from the so called independent testing facilities to the FCC themselves.

Dr. Om Gandhi, chair of the Department of Electrical Engineering at the University of Utah and also a past Motorola consultant who was on the original committee to set the standards for
radiofrequency devices, states industry has played around with the way in which cell phones are tested as they test them up to a half of an inch from the ear and up to an inch from the body. This may seem like a small distance but for radiation from a cell phone it is enormous; if held at the body you are absorbing at least 375% more radiation than the way in which the phone is tested!

How many of you have read the small manuals that come with your phone? In tiny font the iPhone manual tells you the SAR measurement may exceed the FCC exposure guidelines if the device is kept closer than 5/8 of an inch from the body. The Blackberry fine print says to maintain compliance with FCC exposure guidelines when you carry the device on your body keep it at least .98 in. from the body, especially the abdomen of a pregnant woman and the lower abdomen of a teenager, while their advertisement tells you to “keep your friends in your pocket! The manuals also tell you to limit use while offering you free unlimited minutes. With this language being hidden in the manuals, and the industry fighting simple precautionary measures it worries many of us how much more they know and are not telling us. Another interesting aspect is that while the FCC maintains on their website that cell phones are safe and they list precautions which they do not endorse, they insist that manufacturers place the safe distance warnings in every manual. Confused? Perhaps that is the intent.

In a very recent article about the studies proving cell phones kill and damage sperm, John Walls, CTIA spokesperson, did not
comment on the sperm studies but cautioned that organizations like the WHO and FDA have concurred that wireless devices are not a public health risk and that peer-reviewed scientific evidence has overwhelmingly indicated that wireless devices within the limits established by the FCC do not cause any adverse health effects.” Who are they kidding? Sadly, 300 million innocent Americans who deserve the right to know!

As you can see from the worldwide advisory handout many nations such as Finland, France, Russia, Israel, India, Brazil and more have legislated for warnings or advised their citizens of precautions and banned the marketing and sales of cell phones to children, while the United States remains suspiciously quiet and the FCC and FDA say no problem! The FCC web page, the Kid’s Zone, currently lists the question “Do Cell Phones cause cancer? and the answer reads “there is no evidence linking cell phone use to cancer”! Many countries are taking action to protect their citizens NOW. Why on earth is it that our great nation lags behind the rest of the world in cell phone safety?

Our children and grandchildren deserve the same protection as children around the globe.

On the Dr. Oz show our 25 year old year old daughter spoke eloquently of her dad, her best friend and how at her brother’s wedding she prayed her dad would be there to walk her down the aisle. She also stated her generation uses only cell phones. They began using phones as teens and if other parents were like us, we
would not pay the extra fees for texting - forcing our children to hold the phone to their still developing brains. Now, they text often but sleep with them on near their heads, and keep them on in their pockets. Considering excellent studies show that cell phone use kills and damages sperm and is a possible carcinogen her generation certainly does deserves the right to know.

Those opposed to warnings about safe cell phone use feel doing so would challenge the United States government’s determination on wireless device safety. My colleagues and I could not agree more and let’s bring on the challenge now before it is far too late. Scientist’s warnings about tobacco and asbestos were long suppressed and ignored- fueled by sophisticated campaigns such as the one we are witnessing now with cell phones. In a country where a drug cannot be launched without its safety subjected to the deepest scrutiny, the idea that mobile phones can be used by children without warnings is a double standard gone mad. You have the opportunity to help stop this madness and to save lives.

In a moment I would like to introduce you to some of the people that I have come to know and love as I’ve spoken out about on this issue the past three years and they have reached out to me. These are just a few of many. Please listen closely to the words, hopes and losses of those who live with or have lost loved ones to this insidious disease which doctors believe was caused by their long term use of cell phones.
I would like to thank the committee, Chairperson Sturla, Rep. Brown and the other Representatives that have traveled here today for you willingness to educate yourselves on this critical issue and hopefully take action now to prevent serious illness and deaths later.
PRESS RELEASE: Insights on Cell Phone Safety Spotlighted at International Symposium Held in Istanbul, Turkey on May 23

ISTANBUL, TURKEY -- May 26, 2011 -- Children, workers, pregnant women, the elderly and the general public must be better protected from microwave radiation from cell phones and other Electromagnetic Fields (EMF) producing devices. A symposium hosted by Environmental Health Trust (EHT) with experts from major research centers in Turkey, France, Greece, Italy, Austria, Israel and the U.S., convened on May 23 to discuss a range of scientific research supporting this conclusion.

Turkish publishers co-sponsored the symposium and released the Turkish edition of Disconnect: The Truth about Cell Phone Radiation, What Industry Has Done to Hide It and How to Protect Your Family, written by EHT President and award-winning author Dr. Devra Davis.

At the opening of the symposium Professor Dr. Murat Tuncer, Cancer Prevention Director of the Turkish Ministry of Health, announced that the Turkish government will be banning advertisements for cell phones with and for children.

In addition, symposium participants learned that the Turkish government plans to act to ensure that manufacturers of cell phones follow Turkish law requiring that the public be provided legible information at the point of sale about cell phone radiation levels.

The call for warning labels for cell phones is a key part of the Global Campaign for Safer Cell Phones (http://www.saferphonezone.com/) , organized by EHT in North America, Europe, Latin America, Australia and Asia.

A broad array of pioneering studies produced over the past decade under the leadership of Prof. Dr. Nesrin Seyhan who is the Chair of Gazi University’s Biophysics Department, Director of GNKR, Turkish Representative of NATO RTO HFM, and Member of International Advisory Committee of WHO EMF Project, shows that current levels of cell phone radiation damage the newborn brain, liver and eyes of experimental animals. “We urgently need to revise our approach to cell phones and other microwave radiating devices”, Prof. Seyhan urged. “Children and workers immediately need special protections”.

Studies from Athens University, from the “Electromagnetic Biology Research Team” (Group Leader, Dr. Lukas H. Margaritis, Professor Emeritus) of the Department of Cell Biology and Biophysics were presented to the conference by Adamantia Fragopoulou (live) and Dr. Lukas Margaritis (via skype) revealing that cell phone signals significantly impair memory, alter the expression of neurological proteins and proteins of the brain metabolism and can damage reproductive organs and cause DNA damage.

Representative videos that show clearly the memory impairment can be found in the link


Mice that have learnt to run a water maze get lost after exposure to cell phone radiation.

The same group underlies that equally dangerous are other EMF sources besides cell phones, such as wireless DECT telephones, wireless networks (Wi-Fi), baby monitors, blue tooth and even the
microwave oven.

The Symposium concurred with recent recommendations from the Council of Europe and advisories in Israel, U.K., France, India, and Russia that children and teenagers should only use cell phones as telephones on a limited basis, and that the young be encouraged to send text messages and use speakerphones. Prof. Dr. Seyhan also advised that Turkey should exercise special caution about the location of base stations and take steps to ensure people not to overexposed and not to have direct contact with the base stations.

**Prof. Annie Sasco**, a physician-researcher from INSERM in Bordeaux and formerly with the World Health Organization, International Agency for Research on Cancer, noted that the City of Bordeaux has passed a law banning the installation of new cell phone antennas or the reinforcement of existing ones on schools, daycare centers or areas where young children congregate, such as playgrounds.

Dr. Davis noted, “Turkey is leading the world in producing first-class research on this important issue. Cell phones are here to stay, but must be made as safe as possible both in their design and in the ways that we use them. The Israeli government’s steps to curtail the spread of microwave radiation into schools should be taken seriously by the rest of the world.”

**Key Highlights:**

**Arin Tomruk** of Gazi University, presented a detailed study of Biophysics Dept. on the impact of microwave radiation from cell phones on pregnant and nonpregnant adult rabbits, their offspring, and newborns. They found elevated patterns of well-established markers of cancer risk, including DNA base modification, oxidative stress parameters and other accepted biomarkers of chronic degenerative diseases.

**Meric Arda Esmekaya** of Gazi Univ. Biophysics Dept. revealed that pulsed digital cell phone signals destroyed or damaged lymphocytes—human blood cells that are critical to healing the immune system.

DNA damage in hair root cells derived from the region close to the antenna of the irradiating mobile phone near to the ear has been reported by **Semra Tepe Çam**, Gazi University, Biophysics Dept. She found that radiofrequency radiation similar to emitted by GSM mobile phones increasehydroxyproline” content of skin protein that is the first point of contact of mobile phone signals on the body.

Increase of carcinogenesis risk after EMF exposure has been supported by **Prof. Dr. Livio Giuliani**, ISPESL, Italy.

**Prof. Dr. Süleyman Kaplan** from Ondokuz Mayis University, Samsun, documented histologically changes of two main regions of the brain, the hippocampus and cerebellum, related to memory and other functions.

**Prof. Dr. Emin Oztas** of Ankara’s Gulhane Military Research Institute described significant damage to human sperm from cell phone radiation, confirming studies that have been carried out in Australia, the US and Greece.

The studies reviewed at this conference showed that levels of microwave radiation produced by cell phones in the real world today significantly damage and reduce sperm, impair DNA and memory, and cause deficits in offspring whose mothers are exposed during pregnancy.

These new findings demand the attention of the Media and the action of the governments for the establishment of new biologically based guidelines taking the precautionary principle into account. The major advice would be to use cell phones and other EMF sources at a safe distance.

For more information log on to [www.saferphonezone.com](http://www.saferphonezone.com/)

Editor’s note: Scientific papers and bios available for media interested in learning more about the different studies.
PRESS RELEASE: Updated Cell Phone Study Deeply Flawed, Say Experts

Environmental Health Trust and Other Experts Expose Major Flaws in New Danish Study Claiming No Significant Cancer Risks from Cell Phone Use.

“Unsurprising, biased and misleading,” says EHT President, cancer epidemiologist, Devra Davis, PhD, MPH

JACKSON, WY -- October 20, 2011 EMBARGOED until 5:30 PM EST – A new study to be released online today “Use of mobile phones and risk of brain tumours: update of Danish cohort study,” in the British Medical Journal, claims “to show no link between mobile phone use and tumours.” However, the study is seriously flawed, say technical experts from the U.K., United States, Austria, Sweden and Australia, who have provided critical reviews on the embargoed study to Environmental Health Trust, a research and public educational group and ElectromagneticHealth.org, a health education and advocacy group in the United States.

The study, “Use of mobile phones and risk of brain tumours: update of Danish cohort study,” by Patrizia Frei et al., published online claims there is no link between long-term use of cell phones and tumors of the brain or central nervous system among 358,403 mostly male cell phone subscribers over the age of 30 during the period 1990-2007. The report is a follow-up to an earlier Danish analysis of the same group when the average use of cellphones was less than a decade that also reported no cell phone-cancer link.

Devra Davis, PhD, MPH, cancer epidemiologist and President of Environmental Health Trust, commented: "From the way it was set up originally, this deeply flawed study was designed to fail to find an increased risk of brain tumors tied with cellphone use. In order for any study of a relatively rare disease like brain tumors to find a change in risk, millions must be followed for decades. By extending an earlier analysis on the same group of cellphone users this new report provides unsurprising, biased and misleading conclusions. It uses no direct information on cell phone use, fails to consider recent and rapidly changing nature and exposure to microwave radiation from cellphones, cordless phones and other growing sources, and excludes those who would have been the heaviest users—namely more than 300,000 business people in the 1990s who are known to have used phones four times as much as those in this study."

Highlights of the critique of the BMJ study are below:

The new report misrepresents risk of brain tumors for the very same reason the original Danish study was previously criticized. Removing more than 300,000 cell phone users who were business users from the analysis (almost 30% of the original group), defining as a user anyone making one call a week for 6 months, and ignoring the fact that phone calls were more expensive and shorter years ago, reduces the group’s average exposure and makes it very unlikely to find any evidence of increased risk.

Secondly, the report analyzed the rates of brain tumors that occurred between 1990-2007 in those who began using cellphones after 1987, compared to those who were non-subscribers when the study started. This also understates risk, because most of those who began as ‘non-subscribers’ to cell phone service (i.e. the ‘controls’ at the time the cohort was collected) became cell phone users later on, and accumulated almost as many years (on average per person) as the ‘exposed’ subscribers. Hence, the
comparison to the population not contained in the subscriber sample is a comparison between two exposed groups. When Michael Kundi and colleagues from the Medical University of Vienna mathematically corrected for this concern in the earlier Danish study, they found a significantly increased risk for brain tumors.

Cell phone users who began using cell phones after 1995 and those under the age of 30 were not considered 'subscribers' in the study (as with the business users and pay-as-you go users), thus significantly diluting the results and underestimating the risk.

An accompanying editorial on the study by Anders Albom, notes several design limits of this study and repeats a concern raised about this problem in 2005, where he noted:

“Not being able to include corporate users, likely to be among the earliest and heaviest users of mobile phones, also weakens the statistical power of the study.” (See Page12: http://www.stralsakerhetsmyndigheten.se/Global/Publikationer/Rapport/Str... http://www.stralsakerhetsmyndigheten.se/Global/Publikationer/Rapport/Stralskydd/2005/ssi-rapp-2005-01.pdf).

Finally, and importantly, the current, updated Danish study being published today in fact did find increased risk, even though the study is currently being promoted to the media as if it did not. Davis notes

“Statistical significance tests are tools used in science to help understand the chance that a finding is real. In fact, the article reports a significant increased risk of a very rare form of glioma of the cerebral ventricle based on eight cases (2.58, 1.08-6.1) but the authors chose to make no mention of this significant finding. In this instance despite the small number the finding is significant.”

“Statistical analyses provide tools, but do not provide rules, for interpreting evidence. This means that findings can be important even when they do not reach significance statistically. In this report, the authors reject all other findings of borderline significance completely. In a study of relatively rare diseases such as brain tumor, the failure to obtain statistical significance should not be confused with a lack of public health importance. In fact, most of the reported numbers of brain tumors in this article give estimated risks where the result goes from below 1 (a negative result meaning no increased risk), to above 1 (a positive result indicating in some instances a doubled or greater risk).

“All of the few well-designed case-control studies of this issue have found significantly increased risk. Thus, these borderline findings of increased risk may well signal an important association.”

Commenting further on major flaws in this study, Alasdair Philips, an expert in electromagnetic health from Powerwatch in the U.K., has said of this study’s design,

“This study only looks at 7% of the Danish population who had a personal cellphone subscription for at least one year during the period 1987 to 1995. It ignores corporate subscribers (the heaviest users then) and the researchers have no data at all on cellphone use since 1995 so the extra 86% of the population who started to use a cellphone since 1996 were left in the "non subscriber part of the population. This study uses seriously flawed data to make a flawed analysis and should be condemned as misleading spin.”

Camilla Rees, MBA, Founder of ElectromagneticHealth.org and a seasoned campaigner on the issue says,

“This churning of the handicapped Danish cohort study is likely intended to counter the recent WHO IARC classification of cell phone radiation as a Class 2B ‘Possible Carcinogen’. The misrepresentation to the media evidenced here parallels the recent misleading CEFALO brain tumor study that purported to show that there is no higher risk of brain cancer in children. In fact, that study did find increased risk of brain tumors in children that the authors dismissed. But, experts in pediatric oncology understand that brain tumors in children could well occur in shorter time periods than in adults. The overlap in investigators in these two studies should also be noted.” (See Careful Analysis of Study Claiming No Brain Tumor Risk from Childhood Cell Phone Use Shows the Abstract and Conclusions Are Misleading http://electromagnetichealth.org/electromagnetic-health-blog/cefalo/ http://electromagnetichealth.org/electromagnetic-health-blog/cefalo/)
The writer of the editorial commentary “Mobile telephones and brain tumours”, Ahlbom from Sweden’s Karolinska Institute has come under increased scrutiny himself for conflicts of interest.

Mona Nilsson, an investigative journalist from Sweden has documented a number of these conflicts. Ahlbom recently lost significant credibility when he was dismissed from the WHO’s IARC Expert Panel in May. Nilsson reported that he had failed to disclose links to the telecom industry.

“Ahlbom has been a member of the Board of his brother’s telecom consulting company, Gunnar Ahlbom AB. He also did not declare his industry affiliation to the Swedish Radiation Protection Authority, where he resigned after this disclosure. Ahlbom is a member of the International Commission on Nonionizing Radiation Protection (ICNIRP), an industry loyal organisation, and participated in setting the ICNIRP radiation exposure limits in 1998. These standards assume that the only biological impact of microwave radiation from cellphones is heat and fail utterly to take into effect non-thermal biological effects thereby greatly underestimating risk.

Nilsson says the authors also claim that almost 90% of the Swedish population had been using mobile phones for at least 7 years by 2009. “However typical usage was very low in 2002 because of relatively high prices per minute, compared to today as shown in a graph from the Swedish Post and telecommunications authority. The red curve is Millions of mobile phone minutes.”

Donald Maisch, PhD, of EMFacts Consultancy, Australia, who has researched the hidden and important influence of the telecommunications industry on radiofrequency standard setting around the world.

“If anything, this paper is evidence that the peer review process that this paper went through is inadequate. How could the glaring error of excluding corporate subscribers from the analysis be overlooked and the fact that all new subscribers post 1995 were relegated to being considered as non-users. As the old saying goes, “rubbish in rubbish out.”

Denis L Henshaw, PhD, Emeritus Professor of Human Radiation Effects, University of Bristol in U.K., echoes these concerns,

“This seriously flawed study misleads the public and decision makers about the safety of mobile phone use. I consider that their claims are worthless.”

URL of British Medical Journal paper once embargo is lifted:
http://www.bmj.com/cgi/doi/10.1136/bmj.d6605

About Environmental Health Trust

Environmental Health Trust (EHT) educates individuals, health professionals and communities about controllable environmental health risks and policy changes needed to reduce those risks. Capitalizing on growing public interest in award-winning cancer epidemiologist and toxicologist, Dr. Devra Lee Davis’s popular books, including Disconnect--The Truth about Cell Phone Radiation, What Industry Has Done to Hide It and How to Protect Your Family, the foundation’s website offers clear, science-based information to prevent environmentally based disease and promote health, for the general public, children, and health professionals. For more information about the renowned scientific advisors to EHT and numerous special projects please log on to www.ehtrust.org.

About ElectromagneticHealth.org

ElectromagneticHealth.org is a health education and advocacy group focused on the biological and health effects of electromagnetic fields. It was founded by former investment banker Camilla Rees, MBA, who is also co-author of “Public Health SOS: The Shadow Side of the Wireless Revolution” and founder of Campaign for Radiation Free Schools and co-founder of the International EMF Alliance.

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PRESS RELEASE: Updated Cell Phone Study Deeply Flawed, Say Experts | Environmental Health Trust
Telecom Industry Sound-Bites concerning cell phones and cancer

INDUSTRY STATEMENT: “The weight of the evidence shows there is no problem.”
THE TRUTH: That statement is a deliberate attempt to mislead the public. It is false.
When one removes the industry-funded tainted studies, the overwhelming weight of the evidence shows there is a significant problem.

INDUSTRY STATEMENT: “There is no known biological mechanism (implying that data must be wrong).”
THE TRUTH: First, there are credible mechanisms. This industry statement is an anti-scientific statement again attempting to mislead the public. It implies that science already knows every mechanism. In the history of science, it commonly takes decades to centuries before a mechanism is understood. In science data is gospel, not "known mechanisms."

INDUSTRY STATEMENT: “If cell phones were causing brain tumors, with so many people using them, we should be seeing an increase in brain tumor incidence, and we are not.”
THE TRUTH: Many doctors are seeing an increase in brain tumors the past few years. Unfortunately our national registry is about 5 years behind. There have been increases shown in some age groups—especially 20-29—same group that uses only cell phones. The average latency period for brain tumors is 30 years (similar to all solid tumors such as lung cancer).
The question to ask is what percentage of the whole population was using a cell phone 30 years ago.

INDUSTRY STATEMENT: “The World Health Organization (WHO), the American Cancer Society (ACS), the National Cancer Institute (NCI in the US), and many other organizations say there is no problem.”
THE TRUTH: WHO’s EMF Project is funded by the cell phone industry. ACS’ Board of Directors is industry dominated. Additionally, ACS spends only 10% of their funding on research. NCI’s only cell phone study was completed in the mid-1990s, far too early to expect to find a risk of brain tumors.

CALIFORNIA BRAIN TUMOR ASSOCIATION
www.cabta.org
925-285-5437
www.ehtrust.org
Worldwide Cell Phone Safety Recommendations and Policies
October 2011

On May 31, 2011 the World Health Organization/International Agency for Research on Cancer classified the electromagnetic radiation from cell phones as possibly carcinogenic to humans based on an increased risk for glioma, a malignant type of brain cancer, associated with use of mobile phones.

http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(11)70147-4/fulltext

LAWS, RULES, AND ADVISORIES PASSED

IN THE UNITED STATES:

SAN FRANCISCO, CALIFORNIA: was the first city and county in the nation to pass cell phone safety legislation in July 2011. The “Right to Know” ordinance passed the Board of Supervisors unanimously and was signed by Mayor Lee on August 2, 2011. The ordinance requires cell phone retailers to distribute an educational sheet created by the San Francisco Department of Environment that explains radiofrequency emissions from cell phones and how consumers can minimize their exposure. This informational sheet will be given to purchasers at the point of sale. Each retailer must also display a poster (also created by the SFDOE) that states that cell phones emit radiofrequency energy that is absorbed by the head and body. http://www.sfbos.org/ftp/uploadedfiles/bdsupvrs/bosagendas/materials/bag072611_110656.pdf

BERKELEY, CALIFORNIA: In December 2010, Berkeley city council passed a resolution directing their city manager to draft a cell phone ordinance modeled on San Francisco’s ordinance. The legislation is currently being drafted by the City Manager with assistance from Environmental Health Trust. The Berkeley Health Commission has added precautions to their website. http://www.sfbos.org/ftp/uploadedfiles/bdsupvrs/bosagendas/materials/bag072611_110656.pdf

BURLINGAME, CALIFORNIA: On August 15, 2011, Burlingame city council voted to include cell phone guidelines as part of their Healthy Living in Burlingame initiative. The guidelines will be distributed to residents and will include the WHO classification and precautions a consumer can take if concerned. The CTIA-Wireless Association presented to Burlingame City Council in September 2010. The Council then determined to include guidelines in their initiative.

NEW MEXICO: 2011
http://www.nmlegis.gov/lcs/ _session.aspx?Chamber=H&LegType=M&LegNo=32&year=11
State Rep. Brian F. Egolf (D-Santa Fe) sponsored HM 32, which directs the state government to “study available literature and reports on the effects of cell phone radiation on human health.” Also, by November 11, 2011, the Department of Health and the Department of the Environment must prepare a report with “recommendations on how to alleviate any dangerous effects that cell phone radiation has on human health.”
PORTLAND, MAINE: Mayor Nicholas M. Mavodenes, Jr. declared October 2010 “Cell Phone Awareness Month” and will do so again in 2011.

JACKSON, WYOMING: 2010

INTERNATIONAL:

CANADA: 2011
“Health Canada reminds cell phone users that they can take practical measures to reduce RF exposure. The department also encourages parents to reduce their children’s RF exposure from cell phones since children are typically more sensitive to a variety of environmental agents. As well, there is currently a lack of scientific information regarding the potential health impacts of cell phones on children.”

“Health Canada scientists continually review scientific studies in this area to ensure safety guidelines are sufficient for the protection of the health and safety of Canadians. The guidelines were updated in 2009, and the next update is planned for 2012.”

AUSTRALIA: 2010
An official caution for children to text rather than talk on their cell phones was issued in June 2010 by the Australian Radiation Protection and Nuclear Safety Agency. The agency said children must take precautions to protect themselves from exposure to radiation because health risks from their long-term mobile phone use are unknown: “Children should be encouraged to limit exposure from mobile phones to their heads by reducing call time, by making calls where reception is good, by using hands-free devices or speaker options, or by texting.”

FRANCE: 2010
http://www.legifrance.gouv.fr/affichTexteArticle.do;jsessionid=1E9805FB777CC9228F41FE523855508D.tpddio14v_1?idArticle=JORFARTI0000022471515&cidTexte=JORFTEXT0000022470434&dateTexte=29990101&categorieLien=id
The new French cell phone statute, part of a sweeping legislative package called the “National Engagement for the Environment” was approved by French parliament July 12, 2010 and is set to take effect in April 2011. France's law requires SAR posting, headsets, and protects kids. It requires French electronics stores and other cell phone vendors to post each device's Specific Absorption Rate (SAR)—the standard measure of radiofrequency energy absorbed by the human body.

France's statute requires merchants to display SAR numbers in legible French to give consumers easy access to radiation information for different models. It will allow cell phone shoppers looking for a low-SAR model to make on-the-spot comparisons in stores. The French law also requires that all cell phones be sold with a headset, bans cell phone ads aimed at children and adolescents younger than 14, and bars the sale of phones specifically made for kids younger than 6.

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), and limits use of cell phones in schools.
COUNCIL OF EUROPE:

“The Assembly regrets that, despite calls for the respect of the precautionary principle and despite all the recommendations, declarations and a number of statutory and legislative advances, there is still a lack of reaction to known or emerging environmental and health risks and virtually systematic delays in adopting and implementing effective preventive measures. Waiting for high levels of scientific and clinical proof before taking action to prevent well-known risks can lead to very high health and economic costs, as was the case with asbestos, leaded petrol and tobacco.” Parliamentary Assembly, Council of Europe, May 2011, Resolution 1815 (excerpt):

“8. In light of the above considerations, the Assembly recommends that the member states of the Council of Europe:
8.1. in general terms:
8.1.1. take all reasonable measures to reduce exposure to electromagnetic fields, especially to radio frequencies from mobile phones, and particularly the exposure to children and young people who seem to be most at risk from head tumours;
8.1.2. reconsider the scientific basis for the present standards on exposure to electromagnetic fields set by the International Commission on Non-Ionising Radiation Protection, which have serious limitations, and apply ALARA principles, covering both thermal effects and the athermic or biological effects of electromagnetic emissions or radiation;
8.1.3. put in place information and awareness-raising campaigns on the risks of potentially harmful long-term biological effects on the environment and on human health, especially targeting children, teenagers and young people of reproductive age;
8.1.4. pay particular attention to “electrosensitive” people who suffer from a syndrome of intolerance to electromagnetic fields and introduce special measures to protect them, including the creation of wave-free areas not covered by the wireless network;
8.1.5. in order to reduce costs, save energy, and protect the environment and human health, step up research on new types of antenna, mobile phone and DECT-type device, and encourage research to develop telecommunication based on other technologies which are just as efficient but whose effects are less negative on the environment and health;
8.2. concerning the private use of mobile phones, DECT wireless phones, WiFi, WLAN and WIMAX for computers and other wireless devices such as baby monitors:
8.2.1. set preventive thresholds for levels of long-term exposure to microwaves in all indoor areas, in accordance with the precautionary principle, not exceeding 0.6 volts per metre, and in the medium term to reduce it to 0.2 volts per metre;
8.2.2. undertake appropriate risk-assessment procedures for all new types of device prior to licensing;
8.2.3. introduce clear labelling indicating the presence of microwaves or electromagnetic fields, the transmitting power or the specific absorption rate (SAR) of the device and any health risks connected with its use;
8.2.4. raise awareness on potential health risks of DECT wireless telephones, baby monitors and other domestic appliances which emit continuous pulse waves, if all electrical equipment is left permanently on standby, and recommend the use of wired, fixed telephones at home or, failing that, models which do not permanently emit pulse waves;
8.3. concerning the protection of children:
8.3.1. develop within different ministries (education, environment and health) targeted information campaigns aimed at teachers, parents and children to alert them to the specific risks of early, ill-considered and prolonged use of mobiles and other devices emitting microwaves;
8.3.2. for children in general, and particularly in schools and classrooms, give preference to wired Internet connections, and strictly regulate the use of mobile phones by schoolchildren on school premises;
8.4. concerning the planning of electric power lines and relay antenna base stations:
8.4.1. introduce town planning measures to keep high-voltage power lines and other electric installations at a safe distance from dwellings;
8.4.2. apply strict safety standards for the health impact of electrical systems in new dwellings;
8.4.3. reduce threshold values for relay antennae in accordance with the ALARA principle and install systems for comprehensive and continuous monitoring of all antennae;
8.4.4. determine the sites of any new GSM, UMTS, WiFi or WIMAX antennae not solely according to the
operators’ interests but in consultation with local and regional government authorities, local residents and associations of concerned citizens;

8.5. concerning risk assessment and precautions:
8.5.1. make risk assessment more prevention oriented;
8.5.2. improve risk-assessment standards and quality by creating a standard risk scale, making the indication of the risk level mandatory, commissioning several risk hypotheses to be studied and considering compatibility with real-life conditions;
8.5.3. pay heed to and protect “early warning” scientists;
8.5.4. formulate a human-rights-oriented definition of the precautionary and ALARA principles;
8.5.5. increase public funding of independent research, in particular through grants from industry and taxation of products that are the subject of public research studies to evaluate health risks;
8.5.6. create independent commissions for the allocation of public funds;
8.5.7. make the transparency of lobby groups mandatory;
8.5.8. promote pluralist and contradictory debates between all stakeholders, including civil society (Århus Convention).”

RUSSIA: 2011
http://www.who.int/peh-emf/project/mapnatreps/RUSSIA%20report%202008.pdf

The Russian National Committee on Non-Ionizing Radiation Protection has expressed concern at the marketing of mobile phones to children and teenagers and has stated that it believes that the risk to children from mobile phones is not much lower than the risk to children’s health from tobacco or alcohol. The Committee explains this high potential risk as follows:

- “The absorption of electro-magnetic energy in a child’s head is considerably higher than that in the head of an adult
- Children are more sensitive to electromagnetic fields than adults
- Children’s brains have higher sensitivity to the accumulation of the adverse effects from chronic exposure to the electromagnetic fields
- Today’s children will spend a longer time using phones than today’s adults.

Of particular concern is the morbidity increase among young people aged 15 to 19 years (it is very likely that most of them are mobile phone users for a long period of time). Compared to 2009, the number of CNS disorders among 15 to 17 year-old has grown by 85%, the number of individuals with epilepsy or epileptic syndrome has grown by 36%, the number of “mental retardation” cases has grown by 11%, and the number of blood disorders and immune status disorders has grown by 82%. In group of children aged less than 14 years there was a 64% growth in the number of blood disorders and immune status disorders, and 58% growth in nervous disorders risk assessment for EMF exposure.

Taking into account the RNCNIRP position and the precautionary measures suggested by WHO, the Committee considers that urgent measures must be taken because of the inability of children to recognize the harm from the mobile phone use and that a mobile phone itself can be considered as an uncontrolled source of harmful exposure.

- It is required that the information that a mobile phone is a source of RF EMF is clearly shown on the phone’s body (or any other telecommunication device).
- It is required that the “User’s Guide” contains information that a mobile phone (personal wireless communication tool using electromagnetic communication method, etc.) is a source of harmful RF EMF exposure. Usage of a mobile phone by children and adolescents under 18 years old is not recommended. Mobile phone use by pregnant women is not recommended in order to prevent risk for a fetus.
- The easiest way to reduce RF EMF exposure is to move the mobile phone away from one’s head during the phone call which may be achieved by using the hands-free sets (protection by distance). Shortening the call duration is another way to reduce the exposure (protection by time).
• The RNCNIRP considers it is reasonable to develop mobile phones with reduced EMF exposure (with hands-free sets, included limitation functions, such as limitation of the number of daily phone calls, possibility of forced limitation of phone call duration, etc.).
• It is required to include courses on mobile phones use and issues concerning EMF exposure in the educational program in schools.
• It is reasonable to set limits on mobile telecommunications use by children and adolescents, including ban on all types of advertisement of mobile telecommunications for children (teenagers) and with their participation.
• The RNCNIRP is ready to assist the mass-media in their awareness-raising work and educational activities in the area of EMF and, in particular, to provide information about the newest research of the impact of EMF on human health and the measures to curb the negative impact of this physical agent.
• Better safety criteria for children and teenagers are required in the nearest term. Features of the developing organism should be taken into account, as well as the significance of bioelectric processes for human life and activities, present and future conditions of EMF, prospects of technological and technical development should be addressed in a document of legal status.
• Development of a funded national program for studying possible health effects from chronic EMF exposure of the developing brain is necessary.

OTHER PENDING ACTIVITY

U.S. FEDERAL COMMUNICATIONS COMMISSION
Regulatory powers of developing safety standards of cellular phones was given by the FDA to the FCC. The FCC and FDA have not updated their consumer information subsequent to the WHO classification in May 2011. Unbeknownst to most consumers, the FCC requires that every cellular phone manual include a safe distance warning because when the phone is held to the body the user may be exposed to microwave radiation that could exceed the federal safety limit for exposure. This requirement is due to the way in which the FCC has the devices tested. Unfortunately, this information is hidden in fine print in cellular phone manuals most users never read.

MAINE:
The first cell phone warning labels legislation in the world was introduced in Maine in the Spring of 2010, by representative Andrea Boland (D-142) that would require manufacturers of cell phones to include legible prominent on both cellular telephones and their packaging. The warning would read: “WARNING: THIS DEVICE EMITS ELECTROMAGNETIC RADIATION, EXPOSURE TO WHICH MAY CAUSE BRAIN CANCER. USERS, ESPECIALLY CHILDREN AND PREGNANT WOMEN, SHOULD KEEP AWAY FROM THE HEAD AND BODY.” It would also have included a graphic of the radiation penetration into a 5 year old child’s brain based on the model created by professor Om P. Gandhi. The legislation did not pass but the legislature voted to have the Maine Center for Disease Control to disseminate information regarding the issue, the studies and ways to reduce exposure through their network and on their website. In May of 2011 Representative Boland introduced a new version of the label that aimed to make consumers aware of the warnings within cell phone manuals themselves. “Our cell phone warning label bill passed the Maine House of Representatives. The bill would have required whatever warnings were in the manual to be placed on the package OR a label on the package directing users to check the manual for safe usage guidance, and at what pages that appeared. In the Senate all the Democrats present except one, and two Republicans, voted in favor of the bill. The Senate Majority Leader worked aggressively to defeat it, and succeeded. The vote was 20-13, with two Democrats excused. Clearly the choice was whether to protect the industry or the consumers because the wording in our proposed warning label legislation was carefully chosen to use only the manufacturers' own words.” July 4, 2011 Andrea Boland, Maine state legislator.

CALIFORNIA:
http://info.sen.ca.gov/cgi-bin/postquery?bill_number=sb_932&sess=CUR&house=B&site=sen
SB 932: Senator Mark Leno introduced legislation which calls for posting language at the point of sale advising consumers to read the safe use instructions in their cell phone user manual. This passed the Senate Environmental Quality committee May 9, 2011. The full Senate vote has been postponed until next session.
OREGON: 2010
http://www.leg.state.or.us/11reg/measpdf/sb0600.dir/sb0679.intro.pdf
Senate Bill 679 sponsored by Oregon Senator Shields would prohibit retailers from selling, leasing, offering for sale or lease or otherwise distributing cellular telephone unless telephone and packaging bear specific label. The proposed label reads:
“WARNING: This is a radio-frequency (RF), radiation-emitting device that has nonthermal biological effects for which no safety guidelines have yet been established. Controversy exists as to whether or not these effects are harmful to humans. Exposure to RF radiation may be reduced by limiting your use of this device and keeping it away from the head and body.”
This proposal will be brought to the Senate in 2011.

STATE OF PENNSYLVANIA: 2011
http://www.legis.state.pa.us/cfdocs/billinfo/BillInfo.cfm?syear=2011&sind=0&body=H&type=B&bn=1408
Representative Vanessa Brown (D-190) and Former House Speaker Dennis O'Brien (R-169) introduced HR 1408 “The Children's Wireless Protection Act” in April 2011. Stores and retailers would be required to display paraphernalia bearing the warning as well. If a cellular telephone does not fall under these provisions, the Attorney General may order its recall or order that it meet these requirements. The bill orders that the Office of Attorney General issue a warning of the effects of cell phone usage to the public on its website. This bill proposes to:
“Require manufacturers of cell phones in Pennsylvania to include legible, prominent, non-removable warning labels on both cellular telephones and their packaging. The proposed label would include the following statement:
WARNING: This device emits electromagnetic radiation, exposure to which may cause brain cancer. Users, especially children and pregnant women, should keep this device away from the head and body.”
Public hearings are planned September 1, 2011; Environmental Health Trust’s Chair of the Board, Ronald B. Herberman, MD, and Environmental Health Trust’s Director of Government and Public Affairs, Ellen Marks, will be testifying.

PHILADELPHIA, PENNSYLVANIA: 2010
Philadelphia City Councilwoman-at-large Blondell Reynolds Brown developed and passed a strong City Council resolution regarding the issue of cell phone radiation and authorizing the Council's Public Health and Welfare Committee to hold hearings on actions the City can take to promote public awareness of the health risk from cell phone emissions to children and pregnant woman. The Resolution passed unanimously in December 2010. The Councilwoman will be working to schedule the hearing in early Fall.

IRELAND: 2011
Mobile Phone Radiation Warning Bill 2011
“An Act to provide that a warning label shall be affixed to the exterior casing of mobile phones and on related packaging, which shall state clearly that mobile phones emit electromagnetic radiation. Be it enacted by the Oireachtas as follows:
Every mobile phone and its packaging must have a clearly legible warning affixed to it. Such warning must:
(a) specify the mobile phone's non-ionising radiation level, and
(b) the specific absorption (SAR), and
(c) contain a warning as set out in the Schedule of this Act”

ISRAEL: 2011
“A new bill tabled by Knesset member Yulia Shmalov Berkovitz has received support of dozens of Knesset. The most prominent demand is to send an SMS every day at 12 o'clock in which it will be written: ‘Warning: this mobile phone emits non-ionizing radiation. The WHO has decided that it can cause cancer.’ And each time the phone is turned on, a similar warning will appear on the screen. Anyone who purchases a cell phone will have to sign that they understand the risks of use, especially in children. Participation of children in advertisements will be banned. An earpiece will have to be given at each purchase. At least 15% of the company’s revenues will go to education to minimize the use of cell phones. Advertisements will include warning such as those found on cigarettes ads. The minister Gilad Arden said that public awareness of cell phone use risk is needed. Although he does not
support all of the clauses of the bill, he considers most of them positively. Over the next few weeks this bill will be brought to Knesset discussion.” [Yediot (newspaper) June 23, 2011.]

In 2008, Israel’s Ministry of Health 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. 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.

FINLAND: 2009
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…. 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.]

UNITED KINGDOM: 2011
“Therefore, as a precaution, the UK Chief Medical Officers advise that children and young people under 16 should be encouraged to use mobile phones for essential purposes only, and to keep calls short.” (Mobile Phones and Health Leaflet, 2011.)
JURISDICTIONS THAT ENCOURAGE LIMITING USE OF PHONES BY CHILDREN

UNITED STATES NOT TAKING ACTION

Be it noted that the United States' FCC’s Kid’s Zone (not updated since 2009) on the FCC website states: 2011

“Do cell phones cause brain cancer?

There is no scientific evidence to date that proves that wireless phone usage can lead to cancer or a variety of other health effects, including headaches, dizziness or memory loss. However, studies are ongoing and key government agencies, such as the Food and Drug Administration (FDA) continue to monitor the results of the latest scientific research on this topic. In 1993, the FDA, which has primary jurisdiction for investigating mobile phone safety, stated that it did not have enough information at that time to rule out the possibility of risk, but if such a risk exists, "it is probably small." The FDA concluded that there is no proof that cellular telephones can be harmful, but if individuals remain concerned several precautionary actions could be taken, including limiting conversations on hand-held cellular telephones and making greater use of telephones with vehicle-mounted antennas where there is a greater separation distance between the user and the radiating antennas. The Web site for the FDA's Center for Devices and Radiological Health provides further information on mobile phone safety: www.fda.gov/cdrh/phones/index.html.”

http://transition.fcc.gov/cgb/kidszone/faqs_cellphones.html#docellphonescausebraincancer

INDIA: 2007


FINLAND: 2009

In 2009, Finnish Radiation and Nuclear Safety Authority (STUK) advised that children’s mobile phone use should be restricted. The Authority says that: children will have more time to use a mobile phone for a longer period of time than adults, the long-term risks from the use of mobile phones cannot be assessed before the phones have been in use for several decades, and children’s brains are developing up to the age of 20 years. “With children, we have reason to be especially carefully, because there is not enough research on children’s mobile phone use. Unfortunately, it will not be easy to obtain this information in the future either, because of ethical considerations, the use of children as research subjects must always be heavily justified,” according to STUK research director Sisko Salomaa.

The Authority suggests that children’s mobile phone use could be restricted in the following ways:

• favouring the use of text messages rather than calls,
• parents limiting the number of calls and their duration,
• using hands-free devices
• avoid talking in an area with low connectivity or in a moving car or a train.

EUROPEAN UNION MEMBER STATES: 2008

European Parliament (2008b, 2009) suggested that current limits are obsolete and do not consider developments in vulnerable groups (e.g., pregnant women, newborns, children). A wide-ranging awareness campaign was suggested to familiarize young Europeans with good mobile phone techniques (e.g., hands-free kit, keep calls short, switch off phones when not in use, use phones in good reception areas).

EUROPEAN ENVIRONMENT AGENCY: 2009

Director J. McGlade made a policy statement in 2009, advising against regular use of cell phones by children and proposing precautionary actions to reduce the general public’s radiation exposures.
RUSSIA: 2011
In 2011, the Russian National Committee on Non-Ionizing Radiation Protection advised potential risk for children’s health is very high. Current safety standards for exposure to microwaves from mobile phones have been developed for adults and do not consider characteristic features of a child’s body. RNCNIRP stated ultimate urgency to defend children’s health from the influence of the EMF of the mobile communications systems. Usage of a mobile phone by children and adolescents under 18 years old is not recommended and mobile phone use requires implementation of precautionary measures in order to prevent health risks. Mobile phone use by pregnant women is not recommended in order to prevent risk for a fetus.

SWITZERLAND:
“Either keep your calls short or send a text message (SMS) instead. This advice applies especially to children and adolescents.” (Federal Office of Public Health)

GERMANY: 2008
Federal Office for Radiation Protection (Bundesamt fur Strahlenschutz 2008d) recommends exposure minimization for children.

KOREA: 2009
Seoul Metropolitan Council (2009) bans the use of cell phones at schools.

UNITED KINGDOM: 2005, 2010
Chief Medical Officers in the Department of Health strongly advise that where children and young people use mobile phones, encourage: use for essential purposes only and short calls (2005).

FRANCE: 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 14 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.”

JAPAN: 2008
General limitation under 18 years of age.

TAJIKISTAN:
http://af.reuters.com/article/oddlyEnoughNews/idAFTRE52A1AF20090311
Tajikistan bans mobile phones from schools and universities to boost education. Anyone caught carrying or talking on a cell phone will be fined.

TORONTO, CANADA: 2008
and
“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).

In collaboration with the California Brain Tumor Association & Consumers for Safe Cell Phones